Posttraumatic stress reactions of Norwegian children and families after the Southeast Asian tsunami

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Summary

On December 26, 2004, the deadliest tsunami in recorded history hit Southeast Asia and killed approximately 230,000 people. Approximately 4,000 Norwegians were in the affected area, most of whom were tourists, and many had horrific experiences. Fifty-eight Norwegian adults and 26 Norwegian children were killed. Previous research has indicated that both adults and children may develop posttraumatic stress disorder (PTSD) in the aftermath of natural disasters. However, the etiology of posttraumatic stress reactions in children and families are relatively unknown, and no studies have investigated PTSD among natural disaster victims who evacuated from the disaster area to intact homes and communities.

The main objective of the present study is to expand the knowledge about the factors that contribute to the development of and recovery from posttraumatic stress reactions following a single traumatic event from a child and family perspective. The results are based on quantitative information from interviews with Norwegian children (6 to 17 years of age) conducted 10 months and 2 ½ years post-tsunami and questionnaires completed by adults six months and two years after the tsunami. The thesis includes three longitudinal and two cross-sectional studies.

Most of the children and adults who participated in the study had been exposed to a potentially traumatizing event. However, Paper I found that the children in the current sample had low levels of posttraumatic stress reactions 10 months after the tsunami compared to the children in studies of tsunami victims living in the disaster area. There was a significant decrease in the level of reactions at 2 ½ years. Thus, most children who experienced a single natural disaster and were protected against many secondary adversities did not have serious longitudinal stress reactions related to the traumatic event.

Levels of posttraumatic stress reactions at 10 months after the tsunami were related to the trauma experiences, whereas the levels of reactions at 2 ½ years post-tsunami were related to gender, the receipt of professional help for mental health problems before the tsunami, tsunami-related parental sick leave, and the death of family members (Paper I). Thus, factors related to levels of posttraumatic stress reactions seemed to shift over time from tsunami-related features to features related to general mental health.

Family cohesion and expressiveness were not found to be related to children's levels of posttraumatic stress reactions (Paper I). Marital and parental statuses were also not found to be related to the level of posttraumatic stress reactions in adults (Paper IV). However, the levels

of children's posttraumatic stress reactions were found to be related to their parents' levels of posttraumatic stress (Paper II). Other studies have also related a wide range of family factors to children's levels of stress reactions. Thus, it was surprising to find that siblings' posttraumatic stress reactions were not significantly similar (Paper III). Indeed, siblings' reactions varied as much as the reactions of unrelated children did. Differences between the stress reactions of siblings have only been investigated in one previous study, in which siblings' reactions were also found to be dissimilar.

Although the self-reported reactions among siblings were unrelated, parents reported similar reactions among their children (Paper II). This result indicates that parental reports of children's posttraumatic stress reactions may be biased.

Three previous studies have reported similarities between the reactions of the members of couples following disasters, though none of these studies specifically investigated posttraumatic stress reactions. Adults in the present study who lived in same household reported posttraumatic stress reactions that were more alike than those of adults who were not living together (Paper IV).

The findings indicate that family members may influence each other in the aftermath of a natural disaster. However, it is probable that adults and children are influenced differently, with adults in a family having a greater tendency for convergence in their definitions of the events and in their posttraumatic stress reactions than siblings do. Thus, the results indicate that treatments for adults with posttraumatic stress reactions should incorporate a family perspective. However, the results also indicate that children's need for help may vary considerably within the family. While it is often important to incorporate parents in the treatment of children, the current study offers little evidence in support of including siblings in the treatment of an individual child.

There is an ongoing discussion of the definition of PTSD in the upcoming *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5). The last paper (Paper V) of the present thesis contributes to knowledge of two themes: how the symptom criteria should be grouped and the potential overlap between posttraumatic stress reactions and other mental ailments. A four-factor model using the symptoms of intrusion, avoidance, numbing, and arousal was found to describe children's posttraumatic stress reactions better than the present three-factor model specified in the current diagnostic manual, DSM-IV-TR. This study also found a significant overlap between general mental health problems and posttraumatic stress reactions, especially for mental health problems that were associated with arousal symptoms.

The participants had very different experiences compared to disaster victims who were not protected against common secondary adversities and compared to people who experience interpersonal violence or longitudinal exposure to traumatic events. Thus, care should be taken when generalizing from the present study to other groups of children and families who experience potentially traumatic events.

List of papers

I. Jensen, T. K., Dyb, G., & Nygaard, E. (2009). A longitudinal study of posttraumatic stress reactions in Norwegian children and adolescents exposed to the 2004 tsunami. *Archives of Pediatric and Adolescent Medicine*, 163(9), 856-861.

II. Dyb, G., Jensen, T. K., & Nygaard, E. (2011). Children's and parents' posttraumatic stress reactions after the 2004 tsunami. *Clinical Child Psychology and Psychiatry*. 16(4), 621-634.[1]

III. Nygaard, E., Jensen, T. K., & Dyb, G. (2010). Posttraumatic stress reactions in siblings after mutual disaster: Relevance of family factors. *Journal of Traumatic Stress*, 23(2), 278-281.

IV. Nygaard, E., Wentzel-Larsen, T., Hussain, A., & Heir, T. (in press). Family structure and posttraumatic stress reactions: A longitudinal study using multilevel analyses. *BMC Psychiatry.*[2]

V. Nygaard, E., Jensen, T. K., & Dyb, G. (in press). Stability of posttraumatic stress reaction factors and their relation to general mental health problems in children: A longitudinal study. *Journal of Clinical Child and Adolescent Psychology.*

[1] The article was in press when the thesis was presented, and was published in 2011.
[2] The article was submitted but not accepted for publication when the thesis was presented. It has later been accepted for publication with a few revisions.

Abbreviations

α	Cronbach's alpha
A1	Exposure, diagnostic criteria for posttraumatic stress disorder
A2	Immediate subjective responses, diagnostic criteria for posttraumatic stress disorder
CI	Confidence interval
CSDC	Child Stress Disorder Checklist
DSM-IV-TR	*Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision*
DSM-5	*Diagnostic and Statistical Manual of Mental Disorders, 5th Edition*
ICC	Intra-class correlation
ICD-10	*International Classification of Diseases and Related Health Problems, 10th Revision*
IES-R	Impact of Event Scale – Revised
N	Number of participants in the complete sample
n	Number of participants in a subsample
NKVTS	Norwegian Centre for Violence and Traumatic Stress Studies
PTSD	Posttraumatic stress disorder
PTSD-RI	The University of California, Los Angeles Posttraumatic Stress Disorder Reaction Index
r	Pearson's correlation coefficient
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences

1 Introduction

1.1 Background

The experience of a life-threatening situation and mass destruction affects most people. The body's stress response system and the brain's emotional regulation system attempt to cope with an overwhelming situation through self-protective reactions. For example, dissociative reactions may provide an emotional buffer, hyperarousal may mobilize physical energy, and hypervigilance may enable the person to react rapidly when needed (Ford, 2009). However, these normal reactions to abnormal situations can become persistent and counterproductive, impairing the victims' quality of life. The pre-traumatic characteristics of the victim, the characteristics of the possibly traumatic event, and the post-disaster recovery environment may be important for determining the development of and recovery from posttraumatic stress reactions.

Knowledge regarding the consequences of disasters for adults' mental health has been accumulating over the last two decades, especially for adults who continue to live in disaster-stricken areas. However, limited knowledge exists about the consequences of disasters for children. Likewise, very little is known about the consequences of natural disasters for children and families who are evacuated and who return to intact homes and unaffected communities. For example, the most comprehensive literature review of epidemiological studies of posttraumatic stress reactions after disasters includes 160 samples, only 27 of which include school-aged children (Norris et al., 2002). Of these studies, only one study examined children who had been exposed to disaster and then returned to their unaffected home community (Yule et al., 2000). Additional literature searches revealed only one other study that included such samples (Winje & Ulvik, 1998). Both of these samples consisted of people who had experienced mass accidents (the Jupiter shipping disaster and a bus accident), not natural disasters. Thus, knowledge about the mental health problems of children who are protected from common secondary adversities after a natural disaster is lacking. Paper I presents the levels of posttraumatic stress reactions in Norwegian children at 10 months and 2 ½ years after the Southeast Asian tsunami of 2004 and the risk factors related to these reactions.

Children of distressed parents have been found to experience more posttraumatic stress reactions than do children of non-distressed parents after a disaster, as reported in a review of 17 studies (Scheeringa & Zeanah, 2001) and in later studies (Birmes et al., 2009; Chemtob et al., 2010; Demir

et al., 2010; Endo, Shioiri, Toyabe, Akazawa, & Someya, 2007; Kilic, Özgüven, & Sayil, 2003; Li et al., 2010; Nomura & Chemtob, 2009; Vijayakumar, Kannan, & Daniel, 2006; Vila et al., 2001; Wickrama & Kaspar, 2007). However, earlier studies had some limitations. First, few studies have separated the disaster experiences of parents and their children (Chemtob, et al., 2010; McFarlane, 1987b; Nomura & Chemtob, 2009). Second, to the best of our knowledge, only one study has evaluated the combined effects of disaster experiences and parental distress after a disaster to explain the interactive effects of these two risk factors on children's distress, but that study found no significant interaction effect (Cornely & Bromet, 1986). Third, no study has accounted for the inclusion of several children from the same family. Such studies could provide information about variations in posttraumatic stress reactions within families as compared to variations across families. Paper II reports on the relation between children's posttraumatic stress reactions and those of their parents. Additionally, Paper II considers the levels of exposure of parents and children and the interactive effects of exposure and parental distress. The paper uses statistical analyses that account for the inclusion of more than one child from the same family.

A majority of the children interviewed in the present research program had siblings who participated in the study. Several studies have found family factors to be related to children's levels of posttraumatic stress reactions. Parental posttraumatic distress and psychopathology (Scheeringa & Zeanah, 2001), parental alcohol abuse, and family violence (Catani, Jacob, Schauer, Kohila, & Neuner, 2008; Wasserstein & La Greca, 1998; Wickrama & Kaspar, 2007) have been found to be risk factors for increased levels of posttraumatic stress reactions in children, while social support and positive family relations have been found to protect against stress reactions (La Greca, Silverman, Vernberg, & Prinstein, 1996; Wickrama & Kaspar, 2007). A genetic factor for the development of posttraumatic stress reactions has also been reported (Koenen, 2007). All of these findings suggest that siblings would show similar posttraumatic stress reactions because they have similar family experiences and backgrounds. However, to our knowledge, only one study has investigated similarities among the posttraumatic stress reactions of siblings after mutual experiences of disaster. Surprisingly, this study found that siblings' reactions were not significantly correlated (Asarnow et al., 1999). Thus, further studies are needed to investigate whether the contribution of family factors to posttraumatic stress reactions is less clinically important than previously believed. Paper III reports on the differences in siblings' levels of posttraumatic stress reactions compared to random pairs of children.

A similar theme is the effect of family structures on adults' posttraumatic stress reactions. Do adults also lack the expected within-family similarities in posttraumatic stress

reactions? Do adults' posttraumatic stress reactions differ depending on their family structure with respect to marital and parental status? To our knowledge, only three studies have reported on the similarities of the reactions of romantic partners after a disaster (Gleser, Green, & Winget, 1981; Kristensen, Heir, Herlofsen, Langsrud, & Weisæth, in press; Vila, et al., 2001). These studies found that couples' general mental health status and rates of depression were more similar than those of randomly paired adults. However, no studies have measured the similarities of the posttraumatic stress reactions of couples. Only five studies have reported on the influence of marital status on stress reactions after common disaster experiences, with discrepant results (Brooks & McKinlay, 1992; Gleser, et al., 1981; Hollifield et al., 2008; Ranasinghe & Levy, 2007; Wahlström, Michelsen, Schulman, & Backheden, 2008). Similar discrepancies have been reported in studies of the effect of parental status. Five studies have found that parents have higher levels of posttraumatic stress reactions than do non-parents (Gleser, et al., 1981; Havenaar et al., 1997; Solomon, Bravo, Rubio-Stipec, & Canino, 1993; Stuber et al., 2002; Stuber, Resnick, & Galea, 2006), whereas two studies conducted after the 2004 tsunami did not find parental status to be a risk factor (Ranasinghe & Levy, 2007; Wahlström, et al., 2008). Thus, Paper IV evaluates the effects of marital and parental statuses on posttraumatic stress reactions and whether the reactions of adults sharing a household are more similar reactions than those of randomly paired adults.

The present thesis primarily investigates the posttraumatic stress reactions of children using an assessment tool that measures the levels of symptoms as specified by the diagnostic criteria for PTSD in the DSM-IV-TR (2000). However, the diagnostic criteria are currently under revision, and two important themes have evolved in discussions concerning the criteria for PTSD. One theme questions whether the current division of PTSD into three symptom clusters is the best way to describe this mental health problem. Several studies of children have found other divisions of the symptoms to fit better (Anthony, Lonigan, & Hecht, 1999; Ford, Elhai, Ruggiero, & Frueh, 2009; Kassam-Adams, Marsac, & Cirilli, 2010; Saul, Grant, & Carter, 2008; Stewart et al., 2004), but these studies reveal discrepant results concerning which division is best. No studies have investigated possible changes in factor structure over time. A second theme involves the overlap between the criteria for PTSD and those for other mental health problems. Specifically, discussion has focused on whether some criteria for PTSD should be removed (Spitzer, First, & Wakefield, 2007). Are the current criteria of PTSD, and thus the assessments used in the present project, specific measures of reactions after traumatic events, or are they also a measure of other mental health problems? Paper V evaluates the cluster structure of the

assessed posttraumatic stress reactions over time and the relations of the clusters to disaster experiences and general mental health.

As indicated above, the main aim of this thesis is to shed light on the etiology of posttraumatic stress reactions in children and families after disasters. The etiology of posttraumatic stress reactions after a single trauma, such as the tsunami, may differ from that of reactions to repeated or multiple traumas (Fletcher, 2003). This difference may be especially significant for interpersonal traumas such as violence (Ford, Elhai, Connor, & Frueh, 2010). Thus, this thesis will concentrate on disaster research rather than on studies of repeated traumas or interpersonal violence. Disasters are interpreted here as "events that are relatively sudden, highly disruptive, time-limited (even though the effects may be longer lasting), and public (affecting people from more than one family)" (Vogel & Vernberg, 1993). There may also be important differences between the etiologies of posttraumatic stress reactions in children and adults (Franks, 2011). Thus, this thesis concentrates mainly on the development of children's stress reactions. One exception is the evaluation of the relevance of family structures to the adults' posttraumatic stress reactions in Paper IV.

1.2 Posttraumatic Stress Reactions

1.2.1 History of posttraumatic stress disorder

It is important to consider the historical context of posttraumatic stress reactions to understand them. The word "trauma" originates from the ancient Greek word for "injury" or "wound" and has mainly been used in conjunction with an event that may wound a person psychologically (Ford, 2009). "Trauma" has been used to describe both an event and an individual's response to it (Ford, 2009). It is rare that all persons are traumatized after a traumatic event. However, it is common to use the expression "traumatic event" instead of the more correct expression "possibly traumatizing event". The present thesis will use both expressions. The definition of a traumatic event and the possible consequences of traumatic events for individuals have differed throughout history.

Psychological reactions after natural disasters have long been described in literature. For example, the Roman historian Pliny the Younger described the feeling of numbing in people trapped in the eruption of Mount Vesuvius (AD 79) (Birmes, Hatton, Brunet, & Schmitt, 2003; Ford, 2009), and Shakespeare portrayed posttraumatic stress reactions such as re-experiencing, frightening dreams, fright, being startled, hallucinations, and rumination following a variety

of traumatic events, such as natural disasters, rape, war, political violence, family violence, and murder (Birmes, et al., 2003; Ford, 2009).

The medical field has long acknowledged that natural disasters may have longitudinal emotional consequences, even though it has often focused more on somatic problems. For example, both emotional ("her sleep was often interrupted by confused dreams and sudden starts") and somatic ("tremor in her eyes and the pains in her legs and knees") longitudinal consequences of traumatic events were evaluated in three people rescued 37 days after they were engulfed by an avalanche in 1755 (Somis, 1764 in Parry-Jones & Parry-Jones, 1994, pp. 19 and 20). In the late nineteenth and early twentieth centuries, a wide variety of concepts were used to evaluate emotional consequences after trauma, and this terminology is often descriptive of the perceived causation: railway spine (Erichsen, 1866), soldier's heart (A. B. R. Myers, 1870), irritable heart (Da Costa, 1871), hysteria (Breuer & Freud, 1893 in Ford, 2009), anxiety neurosis (Freud, 1894 in Parry-Jones & Parry-Jones, 1994), fright neuroses after earthquake (Stierlin 1909, 1911 in Van der Kolk, Weisaeth, & Van der Hart, 1996), shell shock (C. S. Myers, 1915), psychoneurotic, neuro-circulatory asthenia (Oppenheimer & Rothschild, 1918), war psycho-neurosis (Mott, 1918), battle fatigue, and combat exhaustion (Kardiner & Spiegel, 1947 in Parry-Jones & Parry-Jones, 1994). The first study to investigate the etiology of children's emotional reactions to natural disasters was conducted in the 1950s (Bloch, Silber, & Perry, 1956), but few studies of children's posttraumatic stress reactions after natural disasters were conducted until the 1980s. Norwegian research on posttraumatic stress reactions began by studying adults (mainly men) who had experienced war (Askevold, 1976; Egede-Nissen, 1978; Major, 1996; Sund, 1976) and captivity (Eitinger, 1964; Strøm, 1968). However, studies have also investigated stress reactions after other traumatic experiences, such as burns (Malt & Ugland, 1989), rape (Dahl, 1989, 1992), stress training situations (Hytten, 1989), industrial disasters (Weisæth, 1984), maritime disasters (Eid, Johnsen, & Thayer, 2001; Holen, 1990), transportation accidents (Winje & Ulvik, 1998), other accidental injuries (Malt, 1986), nuclear threats (Tønnesen, 2002), and avalanche (Herlofsen, 1994). Other Norwegian studies have focused on the treatment of adults (Sveeas, 2000; Varvin, 2002) or children (Dodge & Raundalen, 1991; Dyregrov, 1997) who have had such experiences. However, Norway had very little experience with the reactions of families and of child victims of massive natural disasters prior to the beginning of the tsunami research program. In the aftermath of the tsunami, two doctoral theses have been completed in Sweden concerning adult tourists (Johannesson, 2010; Wahlström, 2010), and one has been completed in Norway concerning children who experienced the tsunami as tourists (Hafstad, 2011).

The first version of the American *Diagnostic and Statistical Manual* (DSM) in 1952 included "Gross Stress Reactions" as a diagnosis, but the symptoms of this disorder were not

expected to persist unless prior character traits led the reactions to evolve into chronic neurotic reactions (Turnbull, 1998). In 1968, the second edition of the DSM did not include stress reactions as a diagnosis, but it did include a diagnosis of "Transient Situational Disturbance" that emphasized the temporality of the symptoms. Social protests against sexual assault, domestic violence, and posttraumatic reactions after the Vietnam War influenced the first appearance of PTSD as a diagnosis in the third edition of the DSM in 1980 (Ford, 2009; Turnbull, 1998). The manual specified that stressors were "generally outside the range of usual human experience" and would "evoke significant symptoms of distress in almost everyone" (Ford, 2009). The DSM-III was revised in 1987 to include more specific symptoms, making its diagnosis for PTSD quite similar to the diagnosis found in the fourth version (APA, 1994), which was revised into the present version (DSM-IV-TR) in 2000 (APA, 2000). However, the DSM-IV made one significant change by acknowledging that children's intrusive symptoms may be different from those of adults. The diagnostic system used in Norway, the *International Classification of Diseases* (ICD), has a similar history of the development of the PTSD diagnosis. The present version of this diagnostic system is the ICD-10. The two diagnostic systems now share nearly identical definitions of PTSD (code 309.89 in DSM-IV-TR and code F43.1 in ICD-10). The DSM-IV-TR (APA, 2000) definition of the diagnosis is used in this thesis.

1.2.2 Current diagnostic criteria for Posttraumatic Stress Disorder

The criteria for PTSD (Box 1) require the person to have been exposed to a traumatic event, including both objectively experienced exposure (A1) and immediate subjective distress (A2). The symptoms are divided into three categories. The person must have at least one intrusive symptom (B1-B5), at least three symptoms of avoidance or numbing (C1-C7), and at least two symptoms of increased arousal (D1-D5). The duration of the symptoms must exceed one month (E), and the disturbance must cause clinically significant distress or impairment (F).

Box 1. DSM-IV-TR Criteria for PTSD (APA, 2000):

Criterion A: Exposure:

The person has been exposed to a traumatic event in which both of the following have been present:

A1: The person has experienced, witnessed, or been confronted with an event or events that involved actual or threatened death or serious injury or a threat to the physical integrity of oneself or others.

A2: The person's response involved fear, helplessness, or horror. Note: In children, this may be expressed instead by disorganized or agitated behavior.

Criterion B: Intrusion:

The traumatic event is persistently re-experienced in at least one of the following ways:

B1: Recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions. Note: In young children, repetitive play may occur in which themes or aspects of the trauma are expressed.

B2: Recurrent distressing dreams of the event. Note: In children, there may be frightening dreams without recognizable content.

B3: Acting or feeling as if the traumatic event were recurring (includes a sense of reliving the experience, illusions, hallucinations and dissociative flashback episodes, including those that occur upon awakening or when intoxicated). Note: In children, trauma-specific re-enactment may occur.

B4: Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

B5: Physiologic reactivity upon exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

Criterion C: Avoidance/numbing:

Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by at least three of the following:

C1: Efforts to avoid thoughts, feelings, or conversations associated with the trauma.

C2: Efforts to avoid activities, places, or people that arouse recollections of the trauma.

C3: Inability to recall an important aspect of the trauma.

C4: Markedly diminished interest or participation in significant activities.

C5: Feeling of detachment or estrangement from others.

C6: Restricted range of affect (e.g., unable to have loving feelings).

C7: Sense of foreshortened future (e.g., does not expect to have a career, marriage, children, or a normal life span).

Criterion D: Arousal:

Persistent symptoms of increasing arousal (not present before the trauma), indicated by at least two of the following:

D1: Difficulty falling or staying asleep.

D2: Irritability or outbursts of anger.

D3: Difficulty concentrating.

D4: Hypervigilance.

D5: Exaggerated startle response.

Criterion E: Duration:

Duration of the disturbance (symptoms in B, C, and D) is more than one month.

Criterion F: Impairment in functioning:

The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Specifications:

Specify if:

Acute: if duration of symptoms is less than three months.

Chronic: if duration of symptoms is three months or more.

With delayed onset: if onset of symptoms is at least six months after the stressor.

The diagnostic manual has other related diagnoses, including a) acute stress disorder in the DSM-IV-TR (code 308.3), which is similar to acute stress reactions in the ICD-10 (F43.0); b) enduring personality change in the ICD-10 (F62.0) after a catastrophic experience; and c) dissociative disorders, such as dissociative identity disorder in the DSM-IV-TR (300.14) and multiple personality disorder in the ICD-10 (F44.8). A range of other psychopathology is common in survivors of traumatic events, such as specific phobias, social anxiety disorder, major depressive disorder, and dysthymic disorder (e.g., Hussain, Weisaeth, & Heir, 2011; Kassam-Adams, et al., 2010). Other changes in children after traumatic events include disturbances in identity, ego resources, brain development, the development of cognitive abilities, and social interaction (Nader, 2008). The present thesis will focus on symptoms of PTSD and will not address alternative related diagnoses, psychopathology, or disturbances after traumatic events.

1.2.3 Suggested changes in diagnostic criteria

Both the DSM and the ICD are under revision, and several potential areas for revision have been discussed. For example, it has been suggested that subjective distress (A2) should be removed as a criterion, that three more criteria should be included, that children should have specific diagnostic criteria (APA, 2011a), and that a specific diagnosis of posttraumatic stress disorder in preschool children should be included (APA, 2011b). These suggestions will not be discussed in the present thesis. Rather, two other suggestions will be evaluated: the suggestion to cluster the symptoms differently than in the present DSM-IV and the suggestion to remove from the diagnostic criteria some symptoms that are commonly found in patients with other mental ailments.

It has been suggested that the current cluster of symptoms of active avoidance and numbing should be divided (APA, 2011a), placing the two symptoms of active avoidance in a separate cluster and clustering the earlier symptoms of numbing into a group of symptoms called cognitions and mood. This proposed change has both theoretical and empirical motivations. It has been suggested that there is a distinct difference between active avoidance and passive numbing. Active avoidance is interpreted as the active strategies that individuals use to avoid emotionally disturbing reminders, while passive numbing is interpreted as the automatic processes that influence cognitions and moods (Foa, Riggs, & Gershuny, 1995). In addition, all of the studies of children that have compared the three-factor structure in the DSM-IV-TR with other clusters have found ways of clustering the symptoms that better fit the empirical data (Anthony, et al., 1999; Ford, et al., 2009; Kassam-Adams, et al., 2010; Saul, et al., 2008; Stewart, et al., 2004). However, the

empirical data have not conclusively indicated which model should replace the DSM-IV-TR model. Paper V contributes to this discussion through its analysis of different possible models for the factor clustering of posttraumatic stress reactions.

There may be a considerable overlap between some posttraumatic stress reactions and other mental ailments, such as depression, anxiety, and poor general mental health, in children (Goenjian et al., 1995; Kassam-Adams, et al., 2010; Kolaitis et al., 2003; Lonigan, Shannon, Taylor, Finch, & Salle, 1994) and adults (e.g., Hussain, et al., 2011). Thus, it has been suggested that these symptoms should be removed from the diagnosis of PTSD (Spitzer, et al., 2007) or that overlapping symptoms should be grouped together (Simms, Watson, & Doebbelling, 2002). However, the suggested changes in the DSM-5 do not take comorbidity into account. Paper V investigates the potential overlap between the factors that contribute to posttraumatic stress reactions and general mental health in children.

1.2.4 Disorder versus reactions

The levels of symptoms in the present study varied from no symptoms to very serious symptoms that fulfilled all criteria for the diagnosis of PTSD. Thus, the present thesis does not directly evaluate PTSD; rather, it evaluates posttraumatic stress reactions after exposure to a traumatic event. In the present study, posttraumatic stress reactions are defined as any level of symptoms included in the PTSD criteria of intrusive, avoidance/numbing, or arousal symptoms (APA, 2000). Whereas PTSD only includes clinically significant distress or impairment, posttraumatic stress reactions include a wide range of levels of distress, including normal reactions to distressing events.

Although the diagnosis of PTSD is dichotomous in that the symptoms either fulfill or do not fulfill the diagnostic criteria, most research in the field of disasters is conducted using samples in which a majority of participants do not fulfill all diagnostic criteria. Some studies compare participants who fulfill the criteria for PTSD with participants who do not (e.g., Lonigan, et al., 1994), while others interpret the measure of posttraumatic stress reactions as a continuous variable (e.g., La Greca, et al., 1996). When the symptoms are interpreted as a continuous variable and the sample includes participants who do not fulfill all criteria for PTSD, the study investigates posttraumatic stress reactions rather than PTSD. Although a dichotomous definition may be advantageous in some settings, a continuous spectrum definition that includes a wide variety of symptoms may be advantageous in studies that investigate complex relations. A continuous measure enhances the statistical strength of a study and thereby enhances the likelihood of revealing significant findings (Royston, Altman, & Sauerbrei, 2006). A theoretical view of a

disorder as a spectrum as opposed to a dichotomous diagnosis also allows for the investigation of subclinical symptoms that may influence the quality of life for people who do not fulfill all requirements for a diagnosis of PTSD.

Although the present studies have investigated posttraumatic stress reactions, the literature review will be based on studies of both PTSD and posttraumatic stress reactions.

1.3 The Etiology of Posttraumatic Stress Reactions

1.3.1 Theoretical models

How can we understand the development of and recovery from symptoms of intrusion, avoidance, numbing, and hyperarousal in children? Several theoretical models exist. Cognitive-oriented theories are most commonly referenced in the clinical literature and the most fully developed and tested (e.g., Smith, Perrin, Yule, & Clark, 2010). I prioritize these theories in the present thesis rather than examining alternative theories, such as neurobiological theories (e.g., Nutt, 2000; Van der Kolk, 1996), learning theories (e.g., Foa, Steketee, & Rothbaum, 1989; Kilpatrick, Veronen, & Best, 1985), or psychodynamic theories (e.g., Freud, 1894 in Parry-Jones & Parry-Jones, 1994). However, most cognitive-oriented theories also include ideas from these alternative perspectives. Most cognitive theories were first developed to describe posttraumatic stress reactions in adults, but some of these theories have also been used to understand responses in children.

One of the earliest and most comprehensive cognitive theories of posttraumatic stress reactions was presented by Horowitz in 1976 and subsequently updated (Horowitz, 2001). Horowitz's main principle is a completion tendency, a psychological need for new information to be integrated with existing inner models. Such cognitive maps include "body image, various other self-concepts, role relationship models, scripts and agendas, spatial layouts of their repeated environmental circumstances, and other schemas that help them organize their perceptions and plan their next moves" (Horowitz, 2001, p 119). The integration of stressful events with such preconceived schemas requires considerable cognitive change and extended time for the necessary information processing. Thus, there is an initial phase of information overload, and psychological defense mechanisms such as denial and numbness help to protect the person. However, the stressful event is stored in what Horowitz calls active memory, and it comes to consciousness as intrusive memories that are then processed. The preconceived schemas and the memory of the stressful event are thus gradually integrated during a mixed phase of psychological defense mechanisms and intrusive memories. If such

information processing fails, then partially processed memories of the stressful event may remain in active memory, leading to chronic stress responses.

Janoff-Bulman (1985) concentrated on the nature of trauma victims' preexisting assumptions about the world and about themselves that are shattered during a traumatic event. She concentrated originally on three assumptions: personal invulnerability, the world as meaningful and comprehensible, and a positive view of oneself. She presented later a scale for measuring world assumptions within three similar major categories: benevolence of the world, meaningfulness of the world, and worthiness of self (Janoff-Bulman, 1989). Uncontrollable and unpredictable events that are perceived to threaten these assumptions can produce symptoms similar to PTSD (Foa, et al., 1989). Thus, a trauma victim may no longer feel safe, may no longer regard the world as controllable and just, and may experience a negative self-image. These assumptions may differ based on how victims are affected by trauma experiences. For example, adolescents who experienced the tsunami of 2004 as tourists expressed negative assumptions about the world's meaningfulness but positive assumptions about the world's benevolence (Stormyren & Jensen, 2008; Winsnes, 2007). Janoff-Bulman hypothesizes that victims of trauma need to rework their prior assumptions to fit with their new personal data. The more incongruent prior assumptions are with the trauma experiences, the more difficult it is for trauma victims to create new, integrated assumptions about the world and themselves. This hypothesis contrasts with later findings that the more traumas a person experiences, the greater his or her risk of posttraumatic stress reactions becomes (see below in chapter 1.3.3). Janoff-Bulman (1985) suggested several coping strategies, including seeking social support. Social support after trauma is thought to be important for enhancing victims' self-esteem and reestablishing a benevolent view of the world. Through contact with others who have experienced similar life crises, the impact of the trauma on the person's assumptions about the world and about themselves may be redressed.

Brewin, Dagleish, and Joseph (1996) proposed a dual-representation theory of PTSD. According to their theory, the memories of the trauma are stored in two different ways. *Situationally accessible memories* are sensory, physiological, and motor aspects of the trauma experience. Such memories are not easily accessible by conscious means, but they may emerge as intrusive memories when the person encounters trauma-related cues (reminders) and can include detailed sensory and physiological information. In contrast, *verbally accessible memories* are conscious experiences of the traumatic event and include the meaning of the event in addition to some sensory, emotional, and physiological reactions to

the trauma. In principle, verbally accessible memories can be retrieved deliberately and consciously. The trauma memories and preconceived assumptions about the world are integrated through emotional processing of the intrusive situational memories and conscious accommodation of the verbally accessible memories. However, secondary emotional reactions may interfere with emotional processing. For example, feelings of guilt, anger, or distress may prevent a habituation of the fear response when situationally accessible memories are activated. Most cognitive theories indicate that the integration of memories with pre-trauma assumptions can have outcomes ranging from complete integration to chronic symptoms similar to PTSD (Ehlers & Clark, 2000; Horowitz, 2001; Janoff-Bulman, 1985). However, Brewin et al. suggest three possible outcomes. Integration suggests that memories of the traumatic event have been fully processed and integrated with the person's other memories and self-concept. Chronic emotional processing (PTSD) suggests that there has been little or no integration of the memories; the person continues to have aversive intrusive memories and attentional and memory biases toward trauma-related information. The third outcome, premature inhibition of processing, may occur if the trauma victim inhibits the reactivation of both verbally and situationally accessible memories. In such cases, the avoidance can become automated, and the person may develop trauma-related scripts that enable him/her to incorporate the trauma experiences into verbally accessible memories. However, there will not be an integrated memory across both memory systems, and the situationally unconscious memories may still be accessible in the right circumstances. This may explain why some people develop posttraumatic stress reactions long after a trauma.

Ehlers and Clark (2000) combine the theoretical approach of world assumptions from Horowitz (2001) and Janoff-Bulman (1985) with the dual memory approach of Brewin et al. (1996). They indicate that the interpretation of the event and its consequences as well as the elaboration and integration of the memory of the event with its context and with previous assumptions are important for recovery from posttraumatic stress reactions.

According to Ehlers and Clark (2000), people who are unable to view the trauma as a time-limited event that does not have global negative implications for their future will have a greater risk for PTSD. An overgeneralization of future danger may both enhance their feelings of fear and prevent them from actions that may reduce their symptoms. Similarly, overgeneralizing or negative interpretations of the feelings during or shortly after the traumatic event may negatively influence people's self-perception and encourage them to

engage in dysfunctional coping strategies. For example, people may use avoidance strategies that paradoxically enhance posttraumatic stress reactions.

Ehlers and Clark (2000) use a division of memory similar to Brewin et al.'s (1996) to understand why traumatic memories can be difficult to retrieve in detail at the same time that victims experience a high frequency of involuntary, triggered, vivid, and emotionally intrusive memories. Ehlers and Clark indicate that intrusive memories mainly consist of sensory impressions rather than thoughts; therefore, intrusive memories are similar to the mostly unconscious, situationally accessible memories suggested by Brewin et al. Ehlers and Clark also propose that the use of higher-order, meaning-based retrieval strategies (similar to the conscious retrieval of verbally accessible memories suggested by Brewin et al.) inhibit unintentional intrusive memories from being retrieved. Thus, both Ehlers and Clark (2000) and Brewin et al. (1996) indicate that intrusive memories and the elaborate avoidance of such memories are related yet reflect two distinctly different memory and retrieval systems.

Ehlers and Clark (2000) propose a reciprocal relationship between the appraisal of consequences of the traumatic event and trauma memory. Persons with PTSD are biased in what they recall, and they selectively retrieve memories that support their appraisals, such as their exaggerated fears or negative self-evaluation. The lack of integration between memory systems may also create problems in incorporating a stable view of oneself and the world. Persons with PTSD may therefore be more cue driven (for example, with involuntary flashbacks) than consciously driven in their retrieval of trauma memories compared to people who have an integrated sense of themselves.

Ehlers and Clark (2000) suggest that people who experience extreme fear and threat symptoms use strategies that may become maladaptive. Attempting to avoid thinking about the event may increase the frequency of unwanted intrusive memories and may prevent the person from understanding that the fear is exaggerated; attentiveness to threat cues may enhance fear; avoiding situations similar to the event may prevent the person from gaining evidence that future situations are not dangerous; and rumination may strengthen the problematic appraisals of the trauma.

Whereas most cognitive theories within the trauma field are based on research with adults, Ehlers and Clark's (2000) theoretical approach has also been used to understand children's posttraumatic stress reactions (Meiser-Stedman, 2002) and the treatment of these symptoms in children (Smith, et al., 2010). Other cognitive models and theories of children's posttraumatic stress reactions have also integrated a developmental perspective (Franks, 2011; Pynoos, Steinberg, &

Wraith, 1995; Salmon & Bryant, 2002). Developmental models take into account the influences on children's normal development and how the development of psychopathology during the disaster, shortly after the disaster, and in the distant future may influence the child's development. Developmental models also incorporate family factors, such as parental symptomatology and coping styles. Thus, cognitive models of children's posttraumatic stress reactions account for interactions between the characteristics of children and their environment using a longitudinal developmental perspective.

Developmental level may influence children's interpretation and memory encoding of disaster experiences (Salmon & Bryant, 2002). Infants' appraisals of danger are based on social referencing to attachment figures (Klinnert, Campos, Sorce, Emde, & Svejda, 1983; Stern, 1985) and knowledge about the world (Salmon & Bryant, 2002). With less previous knowledge and fewer experiences, disasters may not initially be interpreted as traumatic by infants and young children, whereas other situations may be interpreted as dangerous even if they are not (Franks, 2011). Due to the children's lack of previous knowledge, parents' responses during a disaster may have a marked impact on children's appraisal of the event (Pynoos, et al., 1995; Salmon & Bryant, 2002). For example, parents may communicate their own fear, and children may thus interpret the situation as dangerous. However, if caregivers are available and not frightened during the disaster, then children's previous schemas of positive self-perception and invulnerability may not be disrupted (Janoff-Bulman, 1985). This is supported by a study of children's narratives after the tsunami that found the separation from parents and siblings described as more distressing than being in a life-threatening situation was (Hafstad, von Tetzchner, & Haavind, 2011). However, parents may also communicate their own fear, and children may thus interpret the situation as dangerous.

The developmental levels of emotion regulation, retrieval of information from memory, and communication skills influences how children adapt after a disaster (Salmon & Bryant, 2002). For example, children's understanding of their own thoughts and emotions develops gradually, and even children aged 8 to 10 years may include little information about their own affective response when describing traumatic experiences (Salmon & Bryant, 2002). Thus, young children are less able to understand a traumatic event, including their own thoughts and emotional reactions to it, without assistance. Family members, such as caregivers and siblings, are therefore given much more consideration in cognitive theories of children's posttraumatic stress reactions than in theories focused on adults. A child's family may play a considerable role not only in interpreting the situation but also in helping the child to

verbalize his or her experiences after the trauma and thereby to emotionally process these experiences (Salmon & Bryant, 2002). Nonverbal communication between family members, such as fear or avoidance, may also be important for children's integration and emotional processing of trauma experiences. The children's emotional processing may be inhibited if parents communicate verbally or nonverbally to the child an unwillingness towards thinking about the traumatic event.

Family support and communication are also important for children who are trying to integrate their basic assumptions about the world and themselves with their traumatic experiences (Janoff-Bulman, 1985). The continuation of care and love from caregivers after a trauma may support children's earlier views of themselves as valuable and lovable persons, whereas the loss of a caregiver may have the opposite consequence. Verbalization within the family may correct children's misconceptions about the risk of future disaster and thus reinstate children's beliefs of personal invulnerability. Parents can also provide alternative explanations for how and why the traumatic event occurred, thus helping children to reinstate a view of the world as meaningful, understandable, and controllable. Thus, Janoff-Bulman's theory concerning basic assumptions can also be used towards children. However, children have fewer prior experiences and therefor probably fewer alternative schemas. The youngest children often have fewer persons outside the family to use as reference points and communication partners during their integration of prior assumptions and trauma experiences. Thus, children's assumptions may theoretically be more influenced by family members than what adult's assumptions are.

Because their language and conversational skills are immature, young children may have less conscious memory of an event, similar to what Brewin et al. (1996) called verbal accessible memory, than adults do (Salmon & Bryant, 2002). Thus, communication with caregivers may play a significant role in compensating for children's immature cognitive and language skills and may help children to retrieve appropriate memories and to interpret traumatic experiences (Franks, 2011; Salmon & Bryant, 2002). The development of emotion regulation skills and the willingness to confront fear-eliciting internal and external cues may also be important for children's ability to process their traumatic experiences and reactions (Meiser-Stedman, 2002). There is considerable evidence that children, like adults, have what Brewin et al. called situationally accessible memories, which are emotionally laden memories composed of sensory fragments that are easily elicited by reminders of an event and are experienced as intrusive memories (Meiser-Stedman, 2002). For example, children's behavioral reenactments of trauma can readily be

interpreted as the elicitation of motor responses recorded during the trauma (Meiser-Stedman, 2002). Thus, it seems that the dual memory theory of Brewin et al. (1996) and Ehlers and Clark (2000) can also be used for children. However, the process of integrating the traumatic memories and assumptions about the world may differ by developmental level. For example, it is possible that very young children who lack the verbal abilities and emotion-regulating capacities to process their situationally accessible memories of a trauma may have difficulties integrating them in a positive manner. Failure to consciously reevaluate a traumatic event may deprive the youngest children of the opportunity to correct misinterpretations (Salmon & Bryant, 2002). Therefore, these children may remain aroused and experience intrusive symptoms for a longer period of time than older children do (Meiser-Stedman, 2002).

However, this immaturity may also protect young children from some symptoms because they do not understand the objective danger and because they are more easily influenced by the sense of safety that develops after the situation has passed, the limited use of memory retrieval strategies such as rumination, and the absence of inappropriate cognitive coping strategies in the aftermath of a disaster, such as negative self-appraisals (Franks, 2011; Salmon & Bryant, 2002). It is also possible that children are more flexible than adults in changing their assumptions of the world (Janoff-Bulman, 1985) and more readily reject assumptions that threaten their sense of security (Meiser-Stedman, 2002). Thus, the theoretical total effect of developmental age on the level of posttraumatic stress reactions is uncertain.

Whereas the above-mentioned theoretical models address the process by which children develop and recover from posttraumatic stress reactions, empirical studies often investigate possible risk and protective factors related to the levels of these reactions without examining the underlying processes. In the present thesis, the terms “risk factor” and “protective factor” will be used for features related to the level of posttraumatic stress reactions. Thus, a risk/protective factor does not automatically indicate a causal mechanism in which the risk factor causes or the protective factor prevents posttraumatic stress reactions. Rather, a risk/protective factor is one that groups of persons with posttraumatic stress reactions more commonly/seldom possess than do persons without posttraumatic stress reactions (a difference that may or may not be caused by the risk/protective factor). Due to the nature of trauma, almost all research on posttraumatic stress reactions is retrospective. Thus, it is difficult to determine the causal paths between features that seem to be related to posttraumatic stress reactions. Does the risk factor cause an increased level of posttraumatic stress reactions? Is the risk factor rather a vulnerability factor that only matter under certain

conditions? Is there a spurious effect caused by other causal factors? Is there a transitional process wherein the risk factor and the stress reactions influence each other over time? Most of these questions have not been investigated, and the underlying relationships between risk/protective factors and posttraumatic stress reactions are therefore uncertain (Silverman & La Greca, 2002). Most studies are correlational and do not analyze causal mechanisms and processes; even longitudinal studies seldom provide direct evidence of the processes by which these relationships develop.

Based on the above-mentioned theoretical approaches, several studies have presented models of risk factors for posttraumatic stress reactions in children. One common approach divides risk/protective factors into three chronological parts: preexisting characteristics of the person, characteristics of the traumatic event, and the post-trauma recovery environment (La Greca, et al., 1996). All three parts can include both vulnerability/risk factors and protective factors (Ford, 2009; Pynoos, et al., 1995). The risk/protective factors and the symptoms of PTSD commonly interact (Pynoos, et al., 1995), and different factors may relate to acute stress reactions and longer-term reactions (Pynoos, et al., 1995). The factors related to posttraumatic stress reactions may also differ according to whether the person experiences a single traumatic event or repeated traumatic events (Pynoos, et al., 1995), and in children, their effects are moderated by developmental stage (Franks, 2011; Meiser-Stedman, 2002; Pynoos, et al., 1995; Salmon & Bryant, 2002). Figure 1 presents an etiological model of children's posttraumatic stress reactions after disasters. The model is a simplified version of one presented by La Greca et al. (1996). However, in contrast to La Greca et al.'s model, children's coping strategies are included in the post-disaster recovery environment in Figure 1.

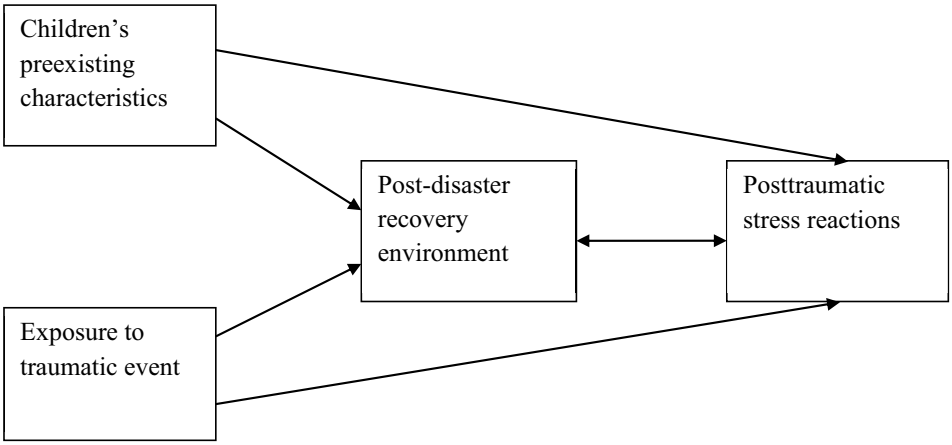

Figure 1. Etiological model of children's posttraumatic stress reactions after natural disasters.

The model in Figure 1 follows the logic of a timeline, with children's preexisting characteristics (see chapter 1.3.2), traumatic experiences (see chapter 1.3.3), and features of the post-disaster recovery environment (see chapter 1.3.4) as groups of factors that may be important for determining the levels of posttraumatic stress reactions. Whereas all three groups of factors can be directly related to the level of posttraumatic stress reactions, the effect of the post-disaster recovery environment can also be moderated (Baron & Kenny, 1986) by the other risk/protective factors and by the children's posttraumatic stress reactions. For example, gender differences may exist in how the loss of a house or a job after a disaster influences adults. In addition to traumatizing people directly, a disaster can have a significant impact on the recovery environment (secondary adversities), especially after natural disasters, which can have long-lasting material and psychological effects. It is not easy to overcome the psychological effects of a traumatic event if daily life continues to be seriously and negatively affected by, for example, a lack of housing, employment, or health services. Likewise, children's loss of caregivers may have serious consequences for their recovery environment. In many cases, the post-disaster recovery environment interacts with posttraumatic stress reactions. The recovery environment can influence levels of distress in both positive and negative directions. However, the level of distress may also influence the recovery environment. The most obvious example is that, ideally, the more distressed a person is, the greater the likelihood is that the person will receive professional mental health care. However, more subtle interactional processes may exist, especially within families. For

example, children's distress may influence their parents and, in turn, the feedback that the parents give to their children (Salmon & Bryant, 2002).

Figure 1 presents one of theoretical etiological models from the literature. One advantage of the model is its simplicity in organizing the risk/protective factors of posttraumatic stress reactions. More complex models may be more naturalistic in that they account for interactional processes from a longitudinal perspective and/or for the great diversity in traumatic events, people who experience traumas, developmental levels, and environments (e.g., Pynoos, et al., 1995). In the present thesis, risk/protective factors have been divided as presented in Figure 1. Findings from empirical studies will be presented in the next three chapters.

1.3.2 Preexisting characteristics in children

Preexisting characteristics that may be related to stress reactions after disasters include gender, age, ethnicity, socioeconomic status, pre-disaster mental health, and personality.

Females have been reported to have a higher risk for posttraumatic stress reactions than males in 46 out of 49 studies that reported gender differences, according to Norris et al.'s (2002) comprehensive literature review. These studies also included children and adolescents. Similar findings have been reported in more recent disaster studies of children (e.g., Bal & Jensen, 2007; Giannopoulou, Strouthos, et al., 2006; Groome & Soureti, 2004). The underlying process by which gender differences emerge is unknown, although differences in posttraumatic stress reactions may result from gender differences in the perceptions of threat and loss of control and in the recollection and interpretation of subjective distress during the disaster (Norris, et al., 2002; Olff, Langeland, Draijer, & Gersons, 2007). However, because of the interactive process between posttraumatic stress reactions and the recollection of subjective distress during the disaster, care should be taken when interpreting such findings. It is possible that the criteria for PTSD are not gender neutral. For example, aggressive behavior may be an under-evaluated but clinically significant behavioral symptom for young children after disaster (Demir, et al., 2010), and boys may be more likely to manifest such behavior after a disaster than girls are (Nomura & Chemtob, 2009). However, female adolescents have been reported to experience more problems regulating their emotional responses after disaster than boys do (Marsee, 2008).

Researchers continue to debate the effect of age on posttraumatic stress reactions. In the fourteen studies we found that reported an effect of age on posttraumatic stress reactions among school-aged children, three reported that older children were at higher risk (Garrison et al.,

1995; John, Russell, & Russell, 2007; Wiguna, Guerrero, Kaligis, & Khamelia, 2010), nine reported that younger children were at higher risk (Giannopoulou, Strouthos, et al., 2006; Jones, Frary, Cunningham, Weddle, & Kaiser, 2001; Kronenberg et al., 2010; McFarlane, 1987b; Osofsky, Osofsky, Kronenberg, Brennan, & Hansel, 2009; Parvaresh & Bahramnezhad, 2009; Pullins, McCammon, Lamson, Wuensch, & Mega, 2005; Roussos et al., 2005; Weems et al., 2010), and two reported a nonlinear relationship. Specifically, one study found schoolchildren (grades 7-9) to have more reactions than both younger children (grades 4-6) and older children (grades 10-12) (McDermott & Palmer, 2002). An additional study showed that 6- to 10-year-old children had more reactions than 0- to 5- and 11- to 18-year-old children (Piyavhatkul, Pairojkul, & Suphakunpinyo, 2008). Several reports have suggested that age has no significant effect on levels of posttraumatic stress reactions (Bal & Jensen, 2007; Catani, et al., 2008; Groome & Soureti, 2004; Hensley & Varela, 2008; Li, et al., 2010; McDermott, Cobham, Berry, & Stallman, 2010). Exposure and age may interact to affect posttraumatic stress reactions such that younger children are more vulnerable when experiencing serious disasters and older children are more vulnerable when experiencing disasters with more indirect effects (Groome & Soureti, 2004). The differences in findings between studies do not seem to be related to the age groups that were investigated. None of these studies reported on children younger than five years old.

It is difficult to determine whether there are differences between preschool children, school-aged children, and adults in levels of posttraumatic stress reactions because different assessment tools are needed for the different age groups. A meta-analysis of a limited number of studies from 1993 and 1994 found the most symptoms among preschoolers and the fewest symptoms among adults (Fletcher, 2003). One study found that preschool children had a higher level of PTSD than their caregivers did when using age-modified criteria (Scheeringa & Zeanah, 2008). Some studies have found preschool children to have higher levels of posttraumatic stress reactions than school-aged children do (Endo, et al., 2007), whereas others have found preschool children to experience less distress than school-aged children (Demir, et al., 2010; Piyasil et al., 2008). It is currently unclear whether preschoolers have a higher risk of posttraumatic stress reactions compared to older children or adults.

Ethnicity, most often defined as being part of a minority group, has been found to be a risk factor for posttraumatic stress reactions in adults (Norris, et al., 2002). However, studies of children show highly discrepant results (Alisic, Jongmans, van Wesel, & Kleber, 2011; Garrison, et al., 1995; Garrison, Weinrich, Hardin, Weinrich, & Wang, 1993; Gleser, et al., 1981; Hensley & Varela, 2008; Jones, et al., 2001; La Greca, et al., 1996; La Greca, Silverman, & Wasserstein, 1998; March, Amaya-Jackson, Terry, & Costanzo, 1997; Osofsky, et al., 2009; Pina et al., 2008; Scheeringa & Zeanah, 2008; Shannon, Lonigan, Finch, & Taylor, 1994; Spell et al., 2008; Terranova, Boxer, & Morris, 2009; Weems, et al., 2010). Thus, it is difficult to determine whether children from specific ethnic or minority groups have higher risks of posttraumatic stress reactions than others.

Socioeconomic status, as measured by education, income, literacy, or occupational prestige, has been found to be related to many different health problems (CSDH, 2008) and to posttraumatic stress reactions in adults (Heir et al., 2011; Norris, et al., 2002). However, few studies of children have reported on socioeconomic status, and these studies have found either small or no differences in posttraumatic stress reactions across socioeconomic status (Alisic, et al., 2011; Catani, et al., 2008; Hensley & Varela, 2008; Scaramella, Sohr-Preston, Callahan, & Mirabile, 2008; Spell, et al., 2008; Vila, et al., 2001; Warheit, Zimmerman, Khoury, Vega, & et al., 1996). It is possible that socioeconomic status is less influential in the wealthiest countries with the smallest income disparities (Sapolsky, 2005). However, socioeconomic status has often been found to be related to mental health in Norway (Mykletun, Knudsen, & Mathiesen, 2009). It is therefore difficult to conclusively determine the effects of socioeconomic status on children's levels of posttraumatic stress reactions.

Pre-disaster mental health problems have been found to be related to more posttraumatic stress reactions in adults (Norris, et al., 2002). We found only six studies that investigated the relation between children's pre-disaster mental health and their posttraumatic stress reactions after disasters. Four of these studies reported that pre-disaster anxiety (Asarnow, et al., 1999; La Greca, et al., 1998; Lonigan, et al., 1994; Udwin, Boyle, Yule, Bolton, & O'Ryan, 2000) was related to posttraumatic stress reactions. One study reported that depression (Warheit, et al., 1996) was related to posttraumatic stress reactions, and one study found that pre-disaster mental health was unrelated to posttraumatic stress reactions (McDermott, et al., 2010). Only three of these studies controlled for concurrent mental health problems when analyzing pre-disaster mental health as a risk factor for posttraumatic stress reactions (Asarnow, et al., 1999; McDermott, et al., 2010; Warheit, et al., 1996) and thus were able to distinguish between concurrent comorbidity and pre-disaster mental health as a risk factor for posttraumatic stress reactions. Although several studies of children have identified comorbidity between posttraumatic stress reactions and other concurrent mental health problems, such as depression, anxiety, and oppositional defiant disorder (Asarnow, et al., 1999; Goenjian, et al., 1995; Hensley & Varela, 2008; Hukkelberg & Jensen, 2011; Kassam-Adams, et al., 2010; Kolaitis, et al., 2003; Lonigan, et al., 1994; McDermott & Palmer, 2002; Scheeringa & Zeanah, 2008; Warheit, et al., 1996), it is unclear whether children with pre-disaster mental health problems are more adversely affected by disaster experiences compared to children without pre-disaster mental health problems.

Temperament and psychological resources are possible confounding factors in the resilience against or development of posttraumatic stress reactions (Pynoos, et al., 1995). There is some evidence that self-efficacy (Hardin, Weinrich, Weinrich, Hardin, & Garrison, 1994; March, et al., 1997) and academic skills (La Greca, et al., 1998) are protective factors for children and that attention problems are a risk factor (La Greca, et al., 1998). These characteristics are thought to be relatively stable (Berk,

2009) and would thus exist prior to the disaster. However, it is possible that these characteristics change and develop in the aftermath of disasters (Pynoos, et al., 1995). Unfortunately, most studies of disasters and posttraumatic stress reactions are retrospective, and few studies have distinguished between the characteristics existing before and after the disaster.

1.3.3 Exposure

A prerequisite for the diagnosis of PTSD is that the person must have been exposed to a potentially traumatizing event. Indeed, the term "posttraumatic" stress disorder indicates that exposure to a traumatic event may have negative emotional consequences. Thus, it is not surprising that a large body of research has confirmed that exposure is a risk factor for posttraumatic stress reactions in both adults and children (Norris, et al., 2002). Exposure is a broad concept that includes both objective features of the disaster and a person's subjective appraisal and interpretation of the situation during the disaster.

Examples of the objective exposure features of disasters that have been found to be related to higher levels of posttraumatic stress reactions in children include physical injury to oneself (Green et al., 1994; Hsu, Chong, Yang, & Yen, 2002; Kolaitis, et al., 2003; Parvaresh & Bahramnezhad, 2009; Ularntinon et al., 2008), threat to one's life (Green et al., 1991; Groome & Soureti, 2004; La Greca, et al., 1996; McDermott & Palmer, 2002; Thienkrua et al., 2006; Udwin, et al., 2000; Vernberg, La Greca, Silverman, & Prinstein, 1996), witnessing an injury or death (Li, et al., 2010; Udwin, et al., 2000), separation from family (Kolaitis, et al., 2003; McFarlane, 1987b), property damage (Demir, et al., 2010; John, et al., 2007; Lonigan, et al., 1994; Wickrama & Kaspar, 2007), entrapment (Udwin, et al., 2000), and proximity to the epicenter of the disaster (Goenjian, et al., 1995; Groome & Soureti, 2004; Kitayama et al., 2000; Piyasil et al., 2007; Pynoos et al., 1987; Pynoos et al., 1993).

The severity of disasters may differ greatly. Some disasters are so horrendous that almost all survivors would be expected to experience serious mental health consequences, whereas other disasters have so little impact that few people have mental health problems after the event (Catani, et al., 2008; Norris, et al., 2002). Several studies have found that experiencing more stressors is associated with higher levels of posttraumatic stress reactions among children (Catani, et al., 2008; Hensley & Varela, 2008; Lonigan, Shannon, Finch, Daugherty, & Taylor, 1991; Piyavhatkul, et al., 2008; Pullins, et al., 2005; Vijayakumar, et al., 2006). This phenomenon is called the "dose-response relationship", in which the dose refers to both the number and severity of stressors (Ford, 2009; Franks, 2011). However, other studies have not found evidence for this relationship (Fernando, Miller, & Berger, 2010; Neuner, Schauer, Catani, Ruf, & Elbert, 2006). In addition, the accumulated amount of exposure across situations has been found to be important. Studies have reported that other potentially traumatic events

experienced before the disaster (Osofsky, et al., 2009), after the disaster (Garrison, et al., 1995; La Greca, et al., 1996), or throughout the lifetime (Hardin, et al., 1994) are related to levels of post-disaster stress reactions in children. For example, children in Sri Lanka who experienced war, family violence, and the tsunami had a higher prevalence of PTSD than did children who experienced fewer stressful events (Catani, et al., 2008). All children who had experienced all three types of stressful events developed PTSD. This result indicates that almost all children who accumulate a certain amount of exposure to serious, potentially traumatic events will develop posttraumatic stress reactions. However, some studies have found the number of previous traumas to be unrelated to levels of posttraumatic stress reactions after a disaster (Kronenberg, et al., 2010).

The death of a family member is often analyzed as an exposure variable and has been found to be a risk factor for posttraumatic stress reactions in children (e.g., Bhushan & Kumar, 2007; Catani et al., 2010; Gleser, et al., 1981; Goenjian, et al., 1995; Hsu, et al., 2002; Neuner, et al., 2006; Parvaresh & Bahramnezhad, 2009; Wickrama & Kaspar, 2007). However, bereavement has many longitudinal consequences and influences the post-disaster recovery environment in a much more dramatic way than do most other exposure criteria. Thus, it is possible that the consequences of loss should be evaluated separately from other measures of exposure. Green et al.'s finding that bereavement was a risk factor for posttraumatic stress reactions 17 years after the Buffalo Creek dam collapse but not two years after the disaster supports this hypothesis (Green, et al., 1994; Green, et al., 1991).

How survivors interpret the situation and which subjective emotional reactions are displayed during the disaster have been found to be related to later levels of posttraumatic stress reactions. Children who were fearful, panicked, and horrified during a disaster have a greater risk of posttraumatic stress reactions (Lonigan, et al., 1994; Thienkrua, et al., 2006; Udwin, et al., 2000). Feelings of sadness, loneliness, and anger during a disaster have also been found to be strongly related to posttraumatic stress reactions (Lonigan, et al., 1994). Similar findings for children have been identified in studies using composite variables that contain a combination of subjective emotional responses during a disaster (Neuner, et al., 2006). Some studies have found that emotional reactions during a disaster are more strongly related to levels of posttraumatic stress reactions than objective exposure to the disaster is (Lonigan, et al., 1994; Neuner, et al., 2006).

There is some evidence that for adults, interpersonal violence may have more serious consequences than disasters do (Creamer, Burgess, & McFarlane, 2001). A similar trend is found within disasters, with mass violence having a more severe impact than technological disasters and technological disasters possibly having a more severe impact than natural disasters (Norris, et al.,

2002). It is probable that similar trends exist for children. The reason for these differences is unclear. However, it has been hypothesized that trauma caused by humans may be experienced as humiliating and insulting and may thereby represent an attack on the victims' integrity and self-esteem (Weisæth, 2006). It has also been found that disasters in the developing world may have more serious consequences than disasters in the developed world (Norris, et al., 2002), possibly due to a combination of greater severity of disasters, poorer pre-disaster infrastructure, and fewer post-disaster resources in developing countries.

1.3.4 Post-disaster recovery environment

While the initial level of exposure is important for the development of posttraumatic stress reactions, the post-disaster environment is important for recovery. A wide variety of post-disaster environments exist. Whereas some disaster victims are re-traumatized repeatedly due to their living conditions after the disaster, others live in conditions that help them to recover. An important secondary adversity that is related to levels of posttraumatic stress reactions in children are living conditions. Children who are evacuated away from their homes (Kreuger & Stretch, 2003; McDermott & Palmer, 2002) or who are displaced at the time of posttraumatic stress assessment (Lonigan, et al., 1994; Osofsky, et al., 2009) often have more symptoms than do children who have a stable and intact home. The continued disrepair of property has also been found to be a significant risk factor for posttraumatic stress reactions in children (McFarlane, 1987b; Osofsky, et al., 2009; Weems, et al., 2010). Many people in Aceh, Indonesia, the area with the highest death rate following the tsunami, lost their homes, schools, and jobs and continued to live in a poverty-stricken area with a history of civil war. The participants in the present study are at the opposite extreme. They were evacuated away from the disaster area and returned to intact homes and communities that were less influenced by the disaster. Thus, the levels of secondary adversities were lower in the present study compared to many other studies of children after disasters.

Children's coping strategies in the aftermath of disasters may also be important for the development of PTSD and the recovery process (Terranova, et al., 2009). For example, a coping strategy of blaming others (La Greca, et al., 1996; Vernberg, et al., 1996) and an avoidant coping style (Pina, et al., 2008) have been found to be related to higher levels of posttraumatic stress reactions. An active cognitive coping strategy, including preparing for the worst, drawing on past experiences, and reviewing the situation to understand it, has been found to be related to higher levels of distress (Asarnow, et al., 1999). This result may indicate that children with high

levels of distress ruminated about the disaster. Another study found the active coping style to be unrelated to levels of stress reactions (Pina, et al., 2008), and one study found that effortful control protected against the negative effects of disaster experiences (Terranova, et al., 2009). The aforementioned studies that found self-efficacy to be an important personality factor also indicated that an internal locus of control might be an important protective coping strategy both during and after a disaster (Hardin, et al., 1994; March, et al., 1997).

Social support has been found to be one of the most important protective factors against posttraumatic stress reactions in adults (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003) and in children (La Greca, et al., 1996; McDermott, et al., 2010; Pina, et al., 2008). This support includes both perceived (Hardin, et al., 1994; Khoury et al., 1997; Liu et al., 2009) and received social support (Udwin, et al., 2000). Social support may be received from professionals, teachers, classmates, friends, parents, and other family members. The type of social support received and its source may differ between age groups. However, we have not found any disaster research that investigates these differences in social support by age and developmental level.

Support from caregivers is important for most children. Continued separation from caregivers has been found to be a risk factor for posttraumatic stress reactions in children (Osofsky, et al., 2009; Parvaresh & Bahramnezhad, 2009). In natural disasters, often the whole family experiences the trauma. Thus, the caregivers may be influenced in a way that may reduce the amount and quality of support that they make available to their children. This effect is supported by many studies that have found that children of parents who became distressed after a disaster have more posttraumatic stress reactions than do children with less distressed parents (Birmes, et al., 2009; Bloch, et al., 1956; Chemtob, et al., 2010; Endo, et al., 2007; Gleser, et al., 1981; Li, et al., 2010; Nomura & Chemtob, 2009; Scheeringa & Zeanah, 2008; Spell, et al., 2008; Vila, et al., 2001). In addition to the children's own earlier symptoms, parental stress reactions were found to be the most significant predictor of levels of posttraumatic stress reactions in a meta-analysis of longitudinal studies across different types of traumatic events (Alisic, et al., 2011). Children's posttraumatic stress reactions have even been found to be more strongly related to their mothers' responses after a disaster than to the children's own exposure during the disaster (McFarlane, 1987b; Swenson et al., 1996). Transgenerational transmission of parents' traumatic torture experiences to their children has also been identified (Daud, 2008). Parental psychopathology (Green, et al., 1991; Vijayakumar, et al., 2006; Wickrama & Kaspar, 2007), parental alcohol abuse (Catani, et al., 2008), family violence (Catani, et al., 2008), family problems (Kronenberg, et al., 2010), and parental marital conflicts (Fernando, et al., 2010; Wasserstein & La Greca, 1998) have also been found to be risk factors for children's development of posttraumatic

stress reactions after disasters. However, parental efficacy (Scaramella, et al., 2008) and positive mother-child relationships have been found to be protective factors (Wickrama & Kaspar, 2007). Whereas some older studies used parents' reports of their children's posttraumatic stress reactions instead of children's self-reports (Bloch, et al., 1956; McFarlane, 1987b; Swenson, et al., 1996), a few later studies have used parents' reports of children's reactions, usually when the participants included children younger than 6 years of age (Chemtob, et al., 2010; Endo, et al., 2007; Nomura & Chemtob, 2009; Scheeringa & Zeanah, 2008; Vila, et al., 2001).

For adults, marital and parental statuses have been evaluated as risk factors in a few studies, but the results have been discrepant. One study found that married people have more stress reactions than unmarried people do (Brooks & McKinlay, 1992), whereas other studies have found the opposite (Fullerton, Ursano, Kao, & Bharitya, 1999; Ursano, Fullerton, Kao, & Bhartiya, 1995; Wahlström, et al., 2008) or have found marital status to be unrelated to posttraumatic stress reactions (Gleser, et al., 1981; Hollifield, et al., 2008; Ranasinghe & Levy, 2007). Two studies have found that people who were previously married were at a higher risk for posttraumatic stress reactions than were people who were married at the time of the disaster (Creamer, et al., 2001; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995), but another study found that this risk factor disappeared when other socio-demographic risk factors and traumatic event types were controlled for (Breslau, Peterson, Poisson, Schultz, & Lucia, 2004). The results are just as discrepant among studies that investigate common disaster experiences (Brooks & McKinlay, 1992; Gleser, et al., 1981; Hollifield, et al., 2008; Ranasinghe & Levy, 2007; Wahlström, et al., 2008) and studies that investigate couples in which only one partner experienced a disaster, such as rescue personnel and their spouses. One study found gender differences in the effect of spousal support. Women with excellent spousal relationships were found to have worse outcomes following a disaster than did women with weaker spousal ties, whereas the opposite was found for men (Solomon, 2002). Although some studies have found that parents, especially single parents (Stuber, et al., 2006), had higher levels of posttraumatic stress reactions than non-parents did after the Chernobyl disaster (Havenaar, et al., 1997), floods (Gleser, et al., 1981; Solomon, et al., 1993), and the 9/11 terrorist attack (Stuber, et al., 2002), parenthood or traveling with children were not found to be risk factors after the 2004 tsunami (Ranasinghe & Levy, 2007; Wahlström, et al., 2008).

1.4 Similarities of Posttraumatic Stress Reactions within Families

It is important to evaluate similarities in posttraumatic stress reactions within families for two reasons. Several studies have reported that family factors, especially family functioning and intra-family support, are important determinants of the course of posttraumatic stress

reactions for children (as reported above) and for adults (Catapano et al., 2001; Fullerton, et al., 1999; Kaniasty & Norris, 2008; McFarlane, 1987a; Norris & Uhl, 1993; Schwarz & Kowalski, 1993; Wickrama & Wickrama, 2008). However, the family environment is complex, and it is possible that different factors influence posttraumatic stress reactions in opposite directions. It is also difficult to separate the different family factors. Thus, it is difficult to determine the total effects of family environment by investigating each family factor separately. An easier approach is to simply investigate the similarity of the posttraumatic stress reactions of family members, thereby assessing the total effect of family factors. Effects of clustering are the second reason for investigating similarities in family members' reactions. Family members are expected to be more similar than non-family members are in terms of their pre-disaster characteristics, their experiences during a disaster, and their post-disaster recovery environment. Thus, family members are expected to be more similar in their posttraumatic stress reactions than unrelated people are. Therefore, it has been suggested that disaster research should take into account such clustering effects (Norris, 2006). However, we are aware of only three other studies that have accounted for clustering effects when investigating risk/protective factors for posttraumatic stress reactions (Gleser, et al., 1981; Nomura & Chemtob, 2009; Wahlström, et al., 2008). This trend may be due to the lack of knowledge about the possible clustering of posttraumatic stress reactions within families combined with the limits of statistical tools that lack the ability to easily analyze data with two or more grouping levels.

Siblings' relationships have rarely been studied in the disaster research field. At the time Paper III was written, no study were found that reported on similarities between siblings' posttraumatic stress reactions after common disaster experiences. More recent literature searches identified only one such study, the results of which showed that siblings' posttraumatic stress reactions were not significantly related in 63 children from 43 families one year after an earthquake (Asarnow, et al., 1999). Many studies have found family factors, such as parental support and parental distress, to be related to children's posttraumatic stress reactions (see chapter 1.3.4). Two studies have found that approximately 30% of the variance in PTSD in adults was related to genetic vulnerability (Stein, Jang, Taylor, Vernon, & Livesley, 2002; True et al., 1993). These observations make the lack of a relationship between siblings' posttraumatic stress reactions surprising.

Three studies have found that levels of general mental health or depression are more similar between members of a couple than they are between unrelated adults after common traumatic experiences (Gleser, et al., 1981; Kristensen, et al., in press; Vila, et al., 2001). However, we have found

no studies that investigated the similarities in posttraumatic stress reactions between members of couples.

1.5 The Tsunami of 2004 and the Tsunami Research Program

On the 26th of December, 2004, an enormous underwater earthquake off the coast of Banda Aceh, Indonesia, created the deadliest tsunami in modern history, with a registered death toll of 227,898 people (NGDC, 2010). It was the fourth most powerful earthquake recorded since 1900, with a magnitude of at least 9.0 (NGDC, 2010). Waves spiraled out of the epicenter, with devastating effects on the nearest coastal areas. The highest registered death tolls were from Indonesia (165,659 deaths), followed by Sri Lanka (35,322 deaths), India (18,045 deaths), and Thailand (8,212 deaths). The strength of the tsunami was so great that it killed people as far away as Somalia (289 deaths). Although most of the deceased were citizens of local countries, the death toll included nearly 2,500 tourists who were visiting the afflicted areas (Vymetal, 2006).

It is estimated that nearly 4,000 Norwegian citizens were in the afflicted countries, most of whom were tourists in Thailand. Most of the families and their children were in areas that were severely affected by the disaster. Many were in acute danger, and 84 Norwegians died (58 adults and 26 children). Many Norwegians also had other potentially traumatizing experiences both during and after the tsunami. Some were separated from their family members and unsure of their well-being, encountered people who were injured or dead, and experienced despair and bereavement. Most Norwegian survivors were quickly evacuated back to Norway.

After the tsunami, the Norwegian Directorate of Health initiated a tsunami research program through the Norwegian Centre for Violence and Traumatic Stress Studies (NKVTS). The goal of the research was to provide the authorities with knowledge about how to directly or indirectly help people who have experienced a disaster (*St.meld. nr. 37 (2004-2005) Flodbølgekatastrofen i Sør-Asia og sentral krisehåndtering*). The research program was divided into eight subprograms, including "Experiences and Reactions of Those Who Were There, Adults and Children" and "Affected Children and Parents". I was employed in the "Affected Children and Parents" subprogram, which published its final report on September 3, 2008 (Jensen, Dyb, Hafstad, Nygaard, & Lindgaard, 2008). The present thesis presents results from both subprograms.

2 Research Objectives

The main objective of the present study was to expand knowledge about the factors that contribute to the development of and recovery from posttraumatic stress reactions after a single traumatic event from a child and family perspective. This objective was accomplished by investigating the following specific research questions:

I. What was the prevalence of posttraumatic stress reactions among Norwegian children who experienced the tsunami of 2004, and which factors were related to the level of these reactions from a longitudinal perspective? (Paper I)

II. How were parents' and children's levels of posttraumatic stress reactions related? (Paper II)

III. Were the levels of posttraumatic stress reactions among siblings more similar than the levels in random pairs of children after a mutually experienced disaster? (Paper III)

IV. How were family structure and adults' posttraumatic stress reactions related from a longitudinal perspective? (Paper IV)

V. What factor structure best describes participants' posttraumatic stress reactions, and how do the factors relate to children's general mental health from a longitudinal perspective? (Paper V)

3 Methods

3.1 Procedures

Figure 2 gives an overview of the study design. After the tsunami, Norwegian nationals were evacuated primarily through the Oslo Airport at Gardermoen. All Norwegians who arrived at Oslo Airport from the disaster-stricken area during the first three weeks after the disaster were registered. All registered adults aged 18 years or older who were traceable received a postal questionnaire six months after the tsunami (N = 2468 adults). Therefore, people who returned to Norway from the disaster areas and did not personally experience the tsunami or its direct consequences were also invited to participate. Adults who had travelled with children aged 6 to 17 years of age were also asked to complete a questionnaire about the children (N = 781 children). The questionnaire was not clear about the definition of age, so some parents completed questionnaires about children born in 1999 (who were approximately 5 years old at the time of the tsunami) (N = 32 children). The adult questionnaire was comprehensive and included questions about exposure, immediate reactions, posttraumatic stress reactions, general mental health, family relations, and demographic information in addition to many questions that were not analyzed in the articles included in this thesis. The child questionnaire included questions about the child's exposure during the tsunami, his or her immediate reactions and posttraumatic stress reactions, and demographic information.

A second questionnaire was sent to all registered adults two years after the tsunami (N = 2468 adults). This questionnaire was shorter and included questions about posttraumatic stress reactions, general mental health status, and demographic information. This questionnaire did not include questions about their children.

Children of adults who responded to the first questionnaire and answered questions concerning children 6 years or older were invited to participate in a longitudinal interview study. The children and their parents were interviewed in their homes approximately 10 months and 2 ½ years after the tsunami. All interviews were conducted in person, and parents and children were interviewed separately. All interviews were conducted by psychologists, psychiatrists, or educators who had completed two days of training for the study by the project leaders. The use of professional personnel ensured that negative reactions to the interview could be addressed professionally. The training facilitated consistency across interviewers and accuracy in their assessments. All interviews were semi-structured and

included open-ended questions and standardized measures. The children's interviews included questions about their emotional reactions during the tsunami, their posttraumatic stress reactions, and their general mental health at the time of the interview in addition to information about their family environment and demographic information. The parents' interviews included questions about their posttraumatic stress reactions, general mental health, tsunami-related sick leave, and demographic information. The parents were also asked whether they or their children had experienced other potentially traumatizing events. The child and parent interviews included questions that were not analyzed in the articles included in the present thesis.

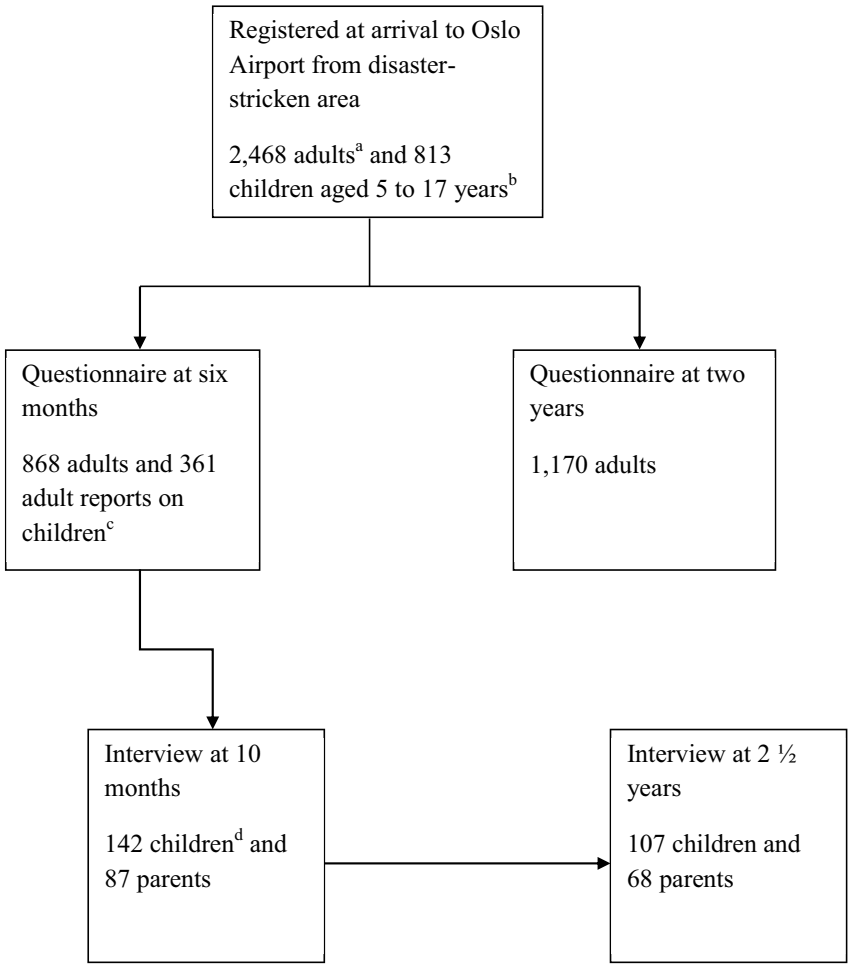

Figure 2. Flow chart of participants and design

Note. [a] In addition, 172 adults were registered at arrival but were not traceable.

[b] Including 781 children aged 6 to 17 years and 32 children born in 1999.

[c] Including 345 children aged 6 to 17 years and 16 children born in 1999.

[d] Aged 6 to 17 years. In addition, four children outside of the age range were interviewed, and one child refused to participate after the parent had been interviewed.

3.2 Participants

The differences in the aims of the five papers resulted in differences in the participants included in each paper (Table 1).

Papers I and V had longitudinal designs and prioritized comparable information over time. These papers focus on posttraumatic stress reactions reported by children in the interviews at 10 months and 2 ½ years post-tsunami. Inclusion in the study required that the children fulfill the exposure criteria of the DSM-IV-TR (scores above 0 on the sum variables of exposure, A1, and immediate subjective distress, A2). The included children had higher levels of exposure than did children in same age group (6 to 17 years, $N = 305$) from the questionnaire study at six months post-tsunami (mean difference = 0.5, 95% $CI = 0.1$ to 0.9, $p = .01$), and the included children had higher levels of posttraumatic stress reactions, as reported by their parents (mean difference = 1.7, 95% $CI = 0.1$ to 3.2, $p = .04$). The interviewed children did not significantly differ from the questionnaire sample in age, gender, parents' education level, or children's immediate subjective distress. There were no significant differences between children at 2 ½ years post-tsunami and children who dropped out between interviews with respect to age, gender, immediate subjective distress, general mental health, or total levels of posttraumatic stress reactions reported at the first interview. However, children included at the follow-up had more educated parents than did children who dropped out between the two interviews (Paper I).

Paper II aimed to analyze the relationship between parents' and children's levels of posttraumatic stress reactions. Therefore, it was important to assess children and parents concurrently. Combined with the need to include as many participants as possible, this requirement indicated the use of data from the questionnaire at six months post-tsunami. However, a weakness of this approach was the use of parental reports of children's posttraumatic stress reactions (see Discussion in chapter 5.2.1). The questionnaire was feasible for use in reports on children who were too young to be interviewed, so the parents' reports on children born in 1999 were included. Children who had not been exposed to the tsunami (criterion A1) were excluded from the paper. A lack of immediate subjective reactions (criterion A2) was not an exclusion criterion in Paper II because parents' reports of the children's immediate reactions were considered less reliable than the children's own reports, which were used in Papers I, III, and V. Detailed information about the children who experienced the tsunami but did not participate in the study is unavailable. It is therefore not possible to determine whether the included participants differed from the non-responders.

Paper III compared the degrees of similarity between siblings' posttraumatic stress reactions and those of random pairs of children. To enhance reliability, information from the children was used instead of information from their parents. To incorporate as many children as possible, data from the first interview at 10 months were used. As in Papers I and V, children who were not exposed to the tsunami or who did not experience subjective distress during the tsunami were excluded. To ensure that the family environment was similar, siblings who had different parents or lived in different households were excluded. No genetic tests were performed to ensure that the siblings had the same biological parents. In seven families with three siblings, one sibling from each family was randomly excluded. The included siblings did not differ from the other children interviewed 10 months after the tsunami in age, gender, exposure, or posttraumatic stress reactions. However, the included siblings did report a higher level of immediate subjective distress then the excluded children did (Paper III).

Paper IV analyzed the relationship between family structure and adults' posttraumatic stress reactions using a longitudinal perspective. One analysis addressed the possibility that parents had different levels of posttraumatic stress reactions than did adults without children. Thus, both parents and non-parents who responded to both questionnaires were included. Because of the longitudinal perspective, only adults who had responded to both assessments were included. This restrictive inclusion criterion was possible because of the large samples of the questionnaire studies. One important feature of Paper IV was its analysis of whether adults who were living together had posttraumatic stress reactions that were more similar than those of adults who were not living together. Therefore, respondents with unknown addresses were excluded. In contrast to the other papers, exposure and immediate subjective responses were not used as exclusion criteria in Paper IV because they were measured by a few dichotomous variables. Exclusion due to lack of exposure or immediate subjective responses would have excluded too many of the participants and would have induced a low level of variability in the exposure and immediate subjective responses of respondents in Paper IV. Analyses of non-responding adults showed that they primarily were tourists in locations that were less severely affected by the tsunami, were primarily men, and were of similar age as the participants (Heir, Piatigorsky, & Weisæth, 2009; Heir, Sandvik, & Weisæth, 2009). A follow-up telephone interview study found a lack of interest or time, followed by a lack of relevant experiences, to be the main reasons for not responding (Hussain, Weisaeth, & Heir, 2009). The participants included in Paper IV did not differ significantly from excluded responders in the number of participants

from the same household, marital status, level of education, rate of employment, proportion of parents, witness experiences during the tsunami, death of family or friends, or immediate subjective responses. However, the mean age of the included participants was significantly older (mean difference = 2.0, 95% *CI* = 0.6 to 3.4, $p = .004$); a larger percentage were female (56.9% versus 47.8%, $\chi^2 = 11.6$, p = .001); a larger proportion had been chased by the wave (36.0% versus 25.8%, $\chi^2 = 8.1$, p = .005); and the participants had higher mean levels of posttraumatic stress reactions than did the excluded participants (Paper IV).

It is likely that the participants in the present study were not a representative sample of the Norwegian population. An evaluation found that adult participants in the tsunami project were similar to the age- and gender-adjusted Norwegian population with regard to employment and marital status (Heir, Piatigorsky, et al., 2009), though they had an above-average education level. Likewise, the present study found that only 1.5% of the caregivers of the children included in Papers I and V did not complete secondary education, compared to 31.3% of the Norwegian population (SSB, 2011).

Table 1 Characteristics of Study Design and Participants Included in the Five Papers

	Design	*Data*	*Inclusion criteria*[a]	*N*	*Age at tsunami (SD)*	*Gender*
Paper I	Longitudinal	Child and parent interviews concerning the children at 10 months and 2 ½ years[b]	Exposed and experienced immediate subjective distress (criteria A1 and A2)	133 children and 104 children	12.9 (3.4) 12.9 (3.4)	45.9% male 45.2% male
Paper II	Cross-sectional	Parents' questionnaire responses at six months concerning themselves and their children	Exposed (criterion A1)	319 children and 183 parents	12.2 (3.5) 42.6 (6.4)	47.9% male 31.3% male
Paper III	Cross-sectional	Child interviews at 10 months[b]	Exposed and experienced immediate subjective distress (criteria A1 and A2), at least two siblings living in same household participating in study	76 children (38 pairs of siblings)	12.9 (3.2)	44.7% male
Paper IV	Longitudinal	Adults' responses to	Known address, responded to	641 adults	43.4 (12.9)	44.9% male

		questionnaires at six months and two years	both assessments			
Paper V	Longitudinal	Child interviews at 10 months and 2 ½ years[b]	Exposed and experienced immediate subjective distress (criteria A1 and A2)	133 children and 104 children	12.9 (3.4) 12.9 (3.4)	45.9% male 45.2% male

Note.

[a] "Exposed and experienced immediate subjective distress" means a score above zero on the respective sum variable.

[b] Information about exposure was gathered from parents' answers concerning their children on the questionnaire six months post-tsunami.

3.3 Measures

3.3.1 Family aspects

Two subscales of the *Family Environment Scale* (Moos & Moos, 1994) were used in Paper I to measure children's cohesion and expressiveness within their families at the times of the interviews. Each subscale consists of nine statements with yes/no response categories. In 92 cases, the children replied *both yes and no*, which was coded as 0.5. Seven negatively phrased statements were coded 0 for *yes* and 1 for *no*, and 11 positively phrased statements were coded with 1 for *yes* and 0 for *no*. Thus, the two summed scores represent the number of positive replies (possible range of 0-9). The internal consistency has been reported to average .77 and .62 for cohesion and expressiveness, respectively. The test-retest correlation varies from .73 to .86. The scale has been found to have acceptable content, construct, concurrent, and predictive validity (Moos, 1990), but it has been criticized for having lower internal consistency than originally thought (Roosa & Beals, 1990). In the present study, the internal consistency was not satisfactory (see Discussion, chapter 5.2.2), with a Cronbach's α of .59 for cohesion and .35 for expressiveness. Exploratory factor analyses did not reveal stable factors across sample sizes. No items were negatively correlated with the other items of the same subscale.

Parents in Paper I reported whether they had taken tsunami-related sick leave during the interview at 10 months post-tsunami (0 = *yes*, 1 = *no*). Parents' sick leave was thought to be an aspect of how the parents coped with the tsunami, and it was found to be significantly related to parents' posttraumatic stress reactions as measured by IES-R (Paper I). Children reported whether they felt that their mother, father, siblings, other close relatives, or friends understood them (0 = *yes*, 1 = *no*) at the interview at 10 months (Paper I). The responses regarding parents' sick leave and children's feelings of being understood were skewed in that few parents had taken tsunami-related sick leave (n = 15) and few children felt that they had not been understood (n = 16).

Multilevel analyses were used in Paper II to determine whether variance in the children's posttraumatic stress reactions was related to differences between families or between individuals within families. Thus, the family aspect of having one or more children as participants was investigated. In total, 76 families had one child included in the study, 81 families had two children, 23 families had three children, and three families had four children who participated in the questionnaire study at six months post-tsunami.

Papers I and II and the present thesis inaccurately use the term "parent" for all adult responders in families with children. At the first assessment (questionnaire at six months post-tsunami), parental informants (N = 183) included 110 mothers (60.1%), 53 fathers (29.0%), and 20 stepparents or close relatives who lived with the children (10.9%) (Paper II). We have no information about the biological relationships between the parents and children. In some cases, the included parent did not live with the child on a daily basis (i.e., the child had travelled with a parent who did not have daily care of the child). We also have assessments from only one of the caregivers of each child. These factors indicate that caution must be used when interpreting the relationships between what we call "parents" and children.

Paper III investigated the similarity between siblings' posttraumatic stress reactions. The family variable was whether the children were siblings. No other aspect of the family was investigated. Similar results are reported in Paper V.

In Norway, a high proportion of unmarried people live together as couples. Thus, live-in partners and married partners were combined into one marital status group in Paper IV. Single participants were divided into two groups that differed in marriage history.

In Paper IV, parenthood was defined as being the parent of one or more children under the age of 18 at the time of the first questionnaire, six months post-tsunami. There was an overlap between being a parent after the tsunami, traveling with children, and having responsibility for children during the tsunami. Of the 247 (38.5%) participants who had children at six months post-tsunami, 213 traveled with their children, and 193 had responsibility for their children at the time of the tsunami. Thus, it is difficult to separate the consequences of the acute experiences of being a parent during the tsunami from those of later family processes.

The third family perspective analyzed in Paper IV was the effect of sharing a residence on the similarity of posttraumatic stress reactions. We had no information about the relationships between the adult participants. However, respondents with the same address were assumed to live together. While 420 (65.5%) respondents were considered to live alone, 196 (30.6%) shared an address with one other participant. An additional 21 (3.3%) participants shared an address with two other participants, and four (0.6%) participants shared a single address. A total of 23 (10.4%) of the participants from households with multiple participants did not travel with another participant of the opposite gender who was within 20 years of their age.

3.3.2 General mental health

The *Strengths and Difficulties Questionnaire* (Goodman, 1997) was used as a measure of general mental health (Paper V) and was completed by adolescents over 10 years of age in the interviews conducted at 10 months and 2 ½ years post-tsunami. The questionnaire included 30 statements that measured six sub-factors: emotional symptoms, conduct problems, hyperactivity, peer problems, prosocial behavior, and impact. Each statement was answered *not true*, *somewhat true*, or *certainly true* and was rated 0-2 for the negatively worded items and 2-0 for the five positively worded statements. The total self-reported difficulty scores based on the 20 statements included in the four problem-oriented sub-factors were summed to obtain a total score (possible range 0-40). The questionnaire is a widely used self-report instrument and has been translated and used in Norway in large community screening programs (Heiervang et al., 2007; Van Roy, Grøholt, Heyerdahl, & Clench-Aas, 2006). The questionnaire has been found to discriminate satisfactorily between psychiatric and non-psychiatric samples. Additionally, this questionnaire has a specificity of .94 and a sensitivity of .23 when using the 10th percentile as a cutoff, high correlations with other measures of similar mental health problems of .88-.92, a test-retest reliability of .62 after four to six months, and a cross-informant correlation of between .33 and .62 (Goodman, 1997, 2001; Van Roy, Groholt, Heyerdahl, & Clench-Aas, 2010). In the present study, the items had low but acceptable internal consistency, with a Cronbach's α between .61 and .76 (Paper V). Only one item was negatively correlated with the other items in any assessment ("has at least one good friend" 2 ½ years after the tsunami, with a corrected item total correlation of -.11), and all items were kept in the sum variable.

3.3.3 Exposure

To assess the exposure (A1) criterion for PTSD in the DSM-IV-TR (APA, 2000), questions concerning the adults' and the children's objective exposure were constructed based on information about potentially traumatizing experiences that tourists may have had during the tsunami. The way in which this information was used varied according to the aims of the different studies. The interviews with the children included standardized questions about their exposure in addition to open-ended questions that facilitated an in-depth description of their disaster experiences. Due to possible misunderstandings about the interview guide, the children's replies to the standardized questions on exposure were not reliable across informants within the same family, and there were numerous missing replies. Thus, parents' reports on their children's exposure were used in Papers I, II, III, and V.

Ten questions concerning the children's exposure were presented to the parents in the questionnaire at six months post-tsunami. These questions asked whether each child was in the area when the tsunami struck; in physical danger due to the wave; caught by the water; physically injured; separated from parents; exposed to dead bodies; witness to others' serious physical injuries; experienced the death of a close friend or family member during the tsunami; exposed to other dangers; or suffered from a lack of water, food or medication. All items were rated yes or no (*no* = 0 and *yes* = 1).

The loss of a caregiver or sibling often has multiple lasting effects on families and children, and it is difficult to separate the effects of the disaster experience from the continued effects of the loss of a family member (Kristensen, Weisaeth, & Heir, 2009; Kristensen, Weisæth, & Heir, 2010). Thus, the loss of a family member (n = 4) was extracted as a separate exposure variable in Paper I and was not included in the sum variable of disaster exposure in Paper V. Paper III did not include any children who experienced the loss of a family member. Paper II included loss (n = 12) in the sum variable of exposure. The adult sample in Paper IV included 19 adults who had lost a family member.

The 10 remaining exposure variables for children were evaluated for the number of concepts they included (i.e., one or multiple separate exposure variables). Examples of such divisions include the level of threat to the child's life (life-threatening versus less dangerous exposure) and the qualities of the experiences (witnessing others' experiences versus threat to own life versus threat to life of family member). Results from unpublished exploratory factor analyses were not stable across the different samples used in the different articles. However, the items were sufficiently related to warrant combining them into a total score of children's exposure (possible range 1-10 after exclusion of children with no exposure), with Cronbach's α in the range of .61 to .68 for the different articles (Papers I, II, III, and V). All 10 items were positively correlated to each other.

The adult questionnaire at six months post-tsunami asked 48 questions concerning the adults' exposure during the tsunami, including 10 questions similar to those used to assess the children's exposure. Participants' yes/no responses to these 10 questions (*no* = 0 and *yes* = 1) were summed to a total score of adults' exposure in Paper II (possible range 0-10). The 10 items for the adults had an acceptable level of internal consistency (Cronbach's α = .75).

Paper IV only included adults and did not include exposure among the major variables. However, it was important to control for exposure in some of the analyses. Four specific exposure items that are known to be closely related to adults' mental health after the

tsunami (Heir & Weisæth, 2008) were used in the paper: witnessed abandoned children; witnessed multiple dead bodies; caught/touched/chased by the waves; and experienced the death of a family member or friend. These four adult exposure variables were retained as dichotomous variables in Paper IV (*no* = 0 and *yes* = 1).

3.3.4 Immediate subjective distress

Two internationally well-known instruments were used to assess the children's immediate subjective distress. Adults' immediate subjective distress was measured by questions designed by NKVTS for the purpose of the study. These measures were interpreted to assess criterion A2 for PTSD in the DSM-IV-TR (APA, 2000).

The *University of California, Los Angeles Posttraumatic Stress Disorder Reaction Index* (PTSD-RI) (Steinberg, Brymer, Decker, & Pynoos, 2004) was used to measure the children's levels of subjective distress during or immediately following the tsunami and their posttraumatic stress reactions. The PTSD-RI is often used as a self-report instrument, but in the present study, it was used in face-to-face interviews to ensure valid replies from the children at 10 months and 2 ½ years post-tsunami (Papers I, III, and V). To further ensure validity, the PTSD-RI was translated to Norwegian and back-translated to English. No specific procedures were used to ensure the cultural validity of the assessment.

The first part of the PTSD-RI includes nine items that ask participants to retrospectively describe their subjective distress during or immediately following the tsunami. These nine items include four items concerning threat to life (fear that they would die; fear that they would be hurt badly; fear that family members or friends would die; and fear that family members or friends would be hurt badly) and five items describing other immediate emotional responses (experiencing extreme fear, as in this was one of the scariest experiences that they had ever had; feeling that they could not stop what was occurring or that they needed help; feeling that the experience was disgusting or gross; running around or acting very upset; and feeling confused). The items were scored as present or absent and were summed into a total score of immediate subjective distress (possible range of 1-9 after exclusion of children without immediate subjective distress). The items had an acceptable level of internal consistency in the different samples, with Cronbach's α ranging from .66 to .72 (Papers I, III, and V).

The Child Stress Disorder Checklist (CSDC) (Saxe et al., 2003) was used retrospectively to measure the children's immediate subjective distress and posttraumatic stress reactions in the

questionnaire given at six months (Paper II). The CSDC was translated from English into Norwegian by a licensed translator, and two qualified researchers evaluated the translated instrument.

The first part of the CSDC includes five items based on the DSM-IV-TR criterion A2 for PTSD and describes subjective distress during or immediately after the tsunami: extreme anxiety or fear; feelings of disgust or shame; helplessness; agitation; and disorganized behavior. The items were coded from 0 (*not true*) to 2 (*very true*) and had an acceptable level of internal consistency (Cronbach's $\alpha = .74$). The items were summed to obtain a total score of children's immediate distress (possible range of 0-10) in Paper II.

The adults' immediate subjective distress was measured retrospectively by 19 items in the questionnaire given at six months post-tsunami, which asked participants to describe fear, helplessness, and horror during or immediately after the tsunami. The items were answered using a 5-point scale (0 = *not at all*; 1 = *a little bit*; 2 = *partly*; 3 = *much*; 4 = *very much*). The items had a high level of internal consistency (Cronbach's $\alpha = .90$) and were summed to obtain a total score of parents' immediate subjective distress (possible range of 0-76) in Paper II.

In Paper IV, immediate subjective distress was not a central focus of the analyses, though it was important to control. Based on earlier studies on the adult sample of Norwegian tourists who had experienced the tsunami (Heir, Piatigorsky, et al., 2009), two of the 19 items from the 6-month post-tsunami adult questionnaire that measured fear and feelings of helplessness during the tsunami were used as measures of subjective distress. The items were not added together in Paper IV.

3.3.5 Posttraumatic stress reactions

Three different internationally well-known measurements were used to assess levels of posttraumatic stress reactions, the dependent variable in all papers: the PTSD-RI for children's self-reports, the CSDC for parents' reports of children, and the *Impact of Event Scale – Revised* (IES-R) for parents' self-reports. None of the measurements are diagnostic instruments; therefore, it is difficult to assess the number of participants who fulfilled the diagnostic requirements for PTSD. Rather, the instruments were used to measure levels of posttraumatic stress reactions on a continuous scale.

The second part of the PTSD-RI was used to measure self-reported posttraumatic stress reactions in children for Papers I, III, and V. The PTSD-RI includes 20 items that

measure posttraumatic stress reactions during the two weeks prior to the interview. Responses are given on a 5-point scale ranging from 0 (*none of the time*) to 4 (*most of the time*). Three of the stress reactions have two alternative formulations, and the item with the higher reported frequency score was used for each. The remaining 17 scores corresponded to the 17 DSM-IV-TR PTSD symptom criteria (APA, 2000) and were summed to obtain a total symptom score (possible range of 0-68). The PTSD-RI is one of the most widely used instruments for the assessment of posttraumatic stress reactions in children and adolescents (Steinberg, et al., 2004) and was developed for use in children aged seven or older (Steinberg, et al., 2004). The total score has been reported to have a sensitivity of .93 and a specificity of .87 when using a cutoff score of 38 (Steinberg, et al., 2004) and a test-retest reliability of .84 (Roussos, et al., 2005). In the present studies, we found the items to have an acceptable level of internal consistency, with Cronbach's α ranging from .81 to .87 (Papers I, III, and V).

Because the items on the PTSD-RI correspond to the criteria for PTSD in the DSM-IV-TR, responses to the PTSD-RI were used to validate the factor structure of PTSD in the present sample of children and to validate the concept of PTSD in relation to the children's general mental health in Paper V. The 17 items were clustered into four factors: intrusion (5 items); avoidance (2 items); numbing (5 items); and arousal (5 items). Confirmatory factor analysis indicated that all but one of the items loaded on the expected factor (Paper V). Item 15 (corresponding to the diagnostic criterion C3), "I have trouble remembering important parts of what happened," had low loadings on its expected factor of numbing at the interviews at both 10 months and at 2 ½ years. Modification indices indicated that the item was more closely related to avoidance at 10 months than it was to numbing. To facilitate comparability across studies, the item was kept as part of its expected factor in all analyses (Paper V).

The second part of the CSDC that was completed by parents at six months post-tsunami included 30 items measuring children's posttraumatic stress reactions during the month prior to the assessments. The items were based on the DSM-IV-TR criteria for PTSD (criteria B, C, D, and F) and acute stress disorder (criterion B). The items were recorded on a 3-point scale (0 = *not true*; 1 = *somewhat true*; 2 = *very true or often true*). The instrument can be used to assess the total level of posttraumatic stress reactions by adding the individual responses to obtain a total score (possible range of 0-60). Alternatively, the items can be summed to obtain five sub-scores: re-experiencing (7 items); avoidance (5 items); numbing and dissociation (8 items); increased arousal (6 items); and impairment in functioning (4 items). Validation studies have found a 2-day test-retest reliability of .84, an inter-rater

reliability of .44, and a correlation with other measurements of posttraumatic stress reactions of between .26 and .59 (Saxe, et al., 2003). In the present study, internal consistency between items was good, with a Cronbach's α of .91 for all items and between .64 and .83 for each subscale (Paper II).

Children's posttraumatic stress reactions reported by parents in the questionnaire given at six months and self-reported in the interview conducted at 10 months post-tsunami were significantly but moderately correlated (r = .23, 95% CI = 0.00 to 0.45, p = .01, N = 131). The correlation was weaker than that between the reactions reported by children at 10 months and 2 ½ years post-tsunami (r = 0.56, 95% CI = 0.37 to 0.71, $p \leq .001$, N = 104) (r_{diff} = 0.33, 95% CI_{diff} = 0.06 to 0.64, p = .03).

The IES-R (Weiss & Marmar, 1997) was used to measure the adults' levels of posttraumatic stress reactions. The IES-R is a 22-item self-report measure of posttraumatic stress reactions. The items can be combined into a total score or split into the three sub-scores of intrusion (8 items), avoidance (8 items), and hyperarousal (6 items). The IES-R is one of the most commonly used instruments for measuring posttraumatic stress reactions (Weiss, 2004), and its psychometric properties have been extensively investigated. Internal consistency within subscales ranges from .81 to .91. The test-retest reliability is between .52 and .86, and correlations with other measures of posttraumatic stress reactions are between .53 and .84 (Creamer, Bell, & Failla, 2003; Weiss, 2004). Similar acceptable measures and reliability have been found in a Norwegian non-clinical sample (Eid et al., 2009). Although the authors of the scale have advised against the use of a cutoff (Weiss, 2004), the IES-R has been reported to have a sensitivity of .91 and a specificity of .82 (Creamer, et al., 2003). In the present samples, internal consistency was high between all 22 items (Cronbach's α between .93 and .96) (Papers I, II, and IV) and within subscales (Cronbach's α between .84 and .93) (Paper II).

An earlier version of the Impact of Event Scale (IES) (Horowitz, Wilner, & Alvarez, 1979) contained 15 items that measured intrusion and avoidance and used four possible responses indicating frequency (0 = *not at all*; 1 = *seldom*; 3 = *sometimes*; 5 = *often*). The scores were added to give a total score. The revised version (IES-R) included six additional items to measure hyperarousal and one additional item to measure intrusion. The IES-R uses response categories to measure severity on a 5-point scale (0 = *not at all*; 1 = *a little bit*; 2 = *moderately*; 3 = *quite a bit*: 4 = *extremely*). Normally, the mean score is presented either across all 22 items or for each of the three subscores. Thus, the revised version was amended to encompass the factor of PTSD that was missing from the earlier IES and changed the

response categories. Although the 22 items from the IES-R were used in all assessments in the present papers to measure the adults' levels of posttraumatic stress reactions, the assessments differed in the response categories used. The new 5-point response categories of event severity were used in the questionnaires given at six months and at two years post-tsunami. However, the 4-point response categories of frequency were used in the interviews at 10 months and 2 ½ years post-tsunami. Thus, the IES-R results from the questionnaires (Papers II and IV) are not comparable to the results from the interviews (Paper I).

3.4 Statistical Procedures

All analyses were based on raw data that were originally stored in SPSS version 16.0, and most analyses used SPSS (or PASW, as it was called from version 17.0.3 until version 19.0). However, Paper V also used the statistical add-on tool AMOS version 16.0, and Papers IV and V also used the statistical package R version 2.10.1. A significance level of .05 was used in all papers.

There were missing replies for the dependent variable "level of posttraumatic stress reactions" (CSDC, PTSD-RI, or IES-R) in all papers. Preliminary frequency analysis revealed that no participants had between four and nine missing responses on any of these measures. Nine or more missing responses would reduce the validity of the sum variables, so more than four missing responses on measurements of posttraumatic stress reactions was used as an exclusion criterion in the papers. Papers I, III, and V replaced missing answers with the respondent's mean score for the other questions within the same suggested factor of posttraumatic stress reaction when calculating sum scores. Papers II and IV used expectation maximization algorithms to replace missing values. This method takes into account the respondent's scores on other items, the scores of the other respondents, and the correlations between items. The change in the method of replacing missing values reflects the learning process during the project.

More than one participant from the same family or household appeared in all of the papers. Family members' responses were expected to be dependent on and related to each other. This multilevel effect was not taken into account in the analyses in Paper I. Papers II, IV, and V used mixed-effect models (a procedure allowing multilevel analysis). Again, the change in the method reflects the learning process during the project. The mixed-effect models account for the facts that participants within families/households have shared variance and that the regression model has error terms at two levels (the individual and the

family/household level). Intra-class correlations (ICC) were defined as the proportion of unexplained variance between families/households and were calculated by dividing the unexplained variance between families/households by the total unexplained variance. Thus, ICC can vary between 0 and 1, where an ICC close to 0 indicates unrelated scores within families and an ICC of 1 indicates identical scores within families.

In all samples, many participants were more likely to have levels of posttraumatic stress reactions close to 0 than they were to have high levels of stress reactions, although a few participants had high levels of stress reactions. Thus, there was a tendency toward non-normality. All papers included the participants with outlying levels of posttraumatic stress reactions to keep participants with clinically important levels of symptoms in the analyzed sample. Skewness or kurtosis above 2 in absolute value, a proportion of outliers more than 3 standard deviations from the mean, and subjective evaluation of histograms were used as signals of non-normality. In the samples of children in Papers I and V, the distributions of posttraumatic stress reactions based on interviews conducted at 10 months were close to being normally distributed, with low levels of skewness and kurtosis. However, one participant (0.8%) had an outlying score 3.4 standard deviations above the mean. Posttraumatic stress reaction scores at 2 ½ years were not perfectly normally distributed, with a kurtosis of 2.2 and two outliers (1.9%) that were 3.4 standard deviations above the mean. The child sample in Paper II did not have normally distributed levels of posttraumatic stress reactions (skewness = 2.4, kurtosis = 7.7). Six children (1.9%) had scores more than 3 standard deviations above the mean, four (1.3%) of whom had scores more than 4 standard deviations above the mean. The sample of siblings used in Paper III had a distribution of posttraumatic stress reactions that resembled a normal distribution, but one child (1.3%) scored 3.9 standard deviations above the mean. The adult sample in Paper IV had a distribution of posttraumatic stress reactions that resembled a normal distribution, with skewness and kurtosis within ±1. Only three participants (0.5%) and five participants (0.8%) had levels of posttraumatic stress reactions that were above 3 standard deviations from the mean at six months and at two years post-tsunami, respectively. Papers I, II, IV, and V used linear regression analysis, which works best on normally distributed data. Paper III used correlations based on ranked scores. Paper V used confirmatory analysis procedures that accommodated non-normality (the robust maximum likelihood estimation method and bootstrap maximum likelihood discrepancy). Analysis with log-transformed and ranked-data dependent variables was conducted in preparation for Paper I, and analyses with log-transformed dependent variables were

conducted in preparation for Paper II. Results similar to those presented in the papers were found. Thus, the conclusions do not seem to be influenced by non-normal distributions of the data.

Paper I used stepwise multiple univariate linear regression analyses to identify independent risk factors for children's posttraumatic stress reactions. Variables correlating significantly with posttraumatic stress reactions at either of the two assessments were entered into a multivariate model in four steps, with exposure on the first step, child demographics on the second step, and other preexisting characteristics on the third step. Characteristics of the post-disaster environment were entered last. The choice of statistical methods was based on the suggested theoretical model in Figure 1. Many different preliminary analyses were conducted, and different measures and combinations of measurements of parents' mental health were used to analyze the validity of parents' mental health as a risk factor for children's posttraumatic stress reactions. Theoretically sound interaction effects were analyzed, but none were found to be stable across the different models tested; thus, the interaction effects were not included in Paper I. The findings in the model presented in Paper I were stable across all analyses.

Paper II used multiple univariate mixed-effect models to analyze factors related to children's posttraumatic stress reactions. Interaction effects between age, gender, and significant main effects were analyzed, and the significant interaction effect was presented.

In Paper III, the mean difference in posttraumatic stress reactions between siblings was compared to the mean difference between randomly selected pairs of children from the same sample using bivariate analyses. Because siblings' exposures were more similar than the exposures of random pairs of children, the analyses were also conducted by controlling for exposure. Siblings were not more similar than random pairs of children in age and immediate subjective distress. Hence, these variables were not controlled for. An alternative method of analyzing this data set is by calculating the ICC using mixed-effect models. Mixed-effect models are not well known in the field, and a detailed presentation of differences between siblings was used to facilitate a more comprehensive understanding of the calculations. Results of both analyses are very similar (Donner & Koval, 1980), and the use of the mixed-effect model in Paper V resulted in a similar conclusion as those in Paper III regarding the similarity of siblings' reactions.

Paper IV used statistical analyses similar to those in Paper II. However, the R statistical package nlme was also used to calculate confidence intervals of ICC, which could

not be calculated in SPSS. A confidence interval of ICC far from zero would indicate that members of the same household tended to have more similar reactions than did members of different households. Interaction effects were not presented in depth due to a lack of significant main effects and interaction effects. For example, males and females did not differ in their relationships in terms of marital status or parental status and their levels of posttraumatic stress reactions.

Paper V used confirmatory factor analysis to test which model of posttraumatic stress reactions best fit the PTSD-RI responses at 10 months and 2 ½ years after the tsunami. Based on theory and a detailed literature review, we had an *a priori* theory of which models would be investigated. We therefore used confirmatory factor analyses rather than exploratory factor analyses. Both hierarchical and intercorrelated models were tested. However, hierarchical models were excluded from the paper because all fit indices indicated that hierarchical models were inferior to their comparative intercorrelated models. All of the presented models had unconstrained intercorrelations between all factors. Similar confirmatory analyses that included replies from both assessments in the same analysis were conducted to investigate the stability of the factor structure over time. The factor covariance matrices were not positive definite for the four-factor model at both assessments or for the combined four-factor models across time, possibly violating the conditions for the structural modeling. The factor covariance matrices in the three-factor models were positive definite at both assessments, thus indicating that the sample sizes may not be the main cause of the lack of positive definite covariance matrices. The lack of a positive definite covariance matrix at T_2 might be related to the high correlation between intrusion and avoidance and to the presence of only two indicators for avoidance in the four-factor model (Brown, 2006). Therefore, the results seem to be interpretable. Alternative interpretations (Wothke, 1993) have been investigated. There were a few missing cases, and replacing missing values did not make the factor covariance matrices positive definite. There was no negative error variance. Different starting values for the covariance matrices were tried without the matrices becoming positive definite. To analyze the changes over time in the predictive validity of exposure, immediate subjective distress, and general mental health for the factors of posttraumatic stress reactions, a multivariate mixed-effect model was used to account for the longitudinal design, the multilevel feature, and all main and interactional effects simultaneously.

3.5 Ethical Aspects

This study was approved by the Norwegian Regional Ethical Committee, and all adults and children signed a written consent form. The law requires that caregivers give informed consent for children younger than 16 years of age (Lov 20. Juni 2008 om medisinsk og helsefaglig forskning § 17), and parents signed written consent forms for all participating children. The participants were given simple and understandable information about the purpose of the questions. All children and parents were informed that they could withdraw from the study at any time. The children were also informed that the information would remain confidential and would not be shared with their parents unless serious concerns for their well-being were raised, for example, through the disclosure of suicidal thoughts or other severe symptoms.

Another ethical issue concerns potentially negative consequences for the participants. When asking about possibly traumatizing experiences, it is important to avoid enhancing the negative effects of the trauma. It has been theorized that studies of posttraumatic stress can function as a reminder to the participants and thereby enhance their negative reactions (e.g., Templeton, 1993). However, most participants do not find participation in trauma research distressing and view the experience as interesting and positive (e.g., Griffin, Resick, Waldrop, & Mechanic, 2003). This result is in accordance with theories of the treatment of posttraumatic stress reactions. Most treatments for PTSD ask patients to recall their experiences in a safe setting. Theoretically, the fear response will be less harmful when the patient subsequently thinks about the traumatic event. Learning theory and behavioral therapy suggest that the conditioned fear response will thus be extinguished (Foa, et al., 1989). According to cognitive theory, the retelling of traumatic experiences may help patients to build a coherent narrative of the traumatic event and modify their maladaptive cognitions and behavioral avoidance (Smith, et al., 2010). To prevent negative consequences from the interviews, only psychologists, psychiatrists, and educators were used as interviewers, and the interviewers were trained to consider the participants' needs during the interview, including referral to appropriate help for those who needed it. There was also a toll-free number that the participants could call if needed. The interviews were conducted in the participants' homes to ensure that the participants would feel as safe as possible. Questionnaires and interviews included some invasive questions not directly related to the tsunami, such as questions regarding other mental health problems.

An important issue for disaster research is when the investigation should be conducted. In the immediate aftermath of a disaster, children and their families are in a

vulnerable situation, and help and support are their main needs. It may be more difficult for victims to refuse to participate in a research project in the immediate aftermath of a disaster. However, conclusions about post-disaster processes may be more valid when information gathering begins shortly after the disaster. Thus, an ethical question arises regarding when disaster researchers should make contact with disaster victims, and no clear answer to this question exists. The present study contacted the participants six months after the disaster, and the participants had to participate actively (by actively agreeing and returning the questionnaire).

4 Summary of Papers

4.1 Paper I

Title: *A longitudinal study of posttraumatic stress reactions in Norwegian children and adolescents exposed to the 2004 tsunami.*

Background: Approximately 4,000 Norwegians were in the area struck by the tsunami in Southeast Asia in 2004. The present study investigated the prevalence of symptoms of posttraumatic stress reactions and the factors related to the levels of posttraumatic stress reactions in Norwegian children who experienced the catastrophe and returned to the safety of their homeland.

Method: Using a longitudinal design, face-to-face, semi-structured interviews were conducted at 10 months ($N = 133$) and 2 ½ years ($N = 104$) after the disaster. Data were analyzed using stepwise multiple univariate linear regression analysis.

Results: The majority of the children reported possibly traumatizing experiences. For example, the majority of the children were in physical danger from the wave (65%) or had witnessed others' physical injuries (59%). Most of the children also experienced fear and horror. Two children had scores indicative of PTSD at 10 months post-tsunami. There was a significant decrease in symptoms at 2 ½ years post-tsunami, and no child had a score exceeding the clinical cutoff at this time. Only the death of a family member and subjective distress were independently and significantly associated with levels of posttraumatic stress reactions at 10 months post-tsunami. Being female, using professional mental health services prior to the tsunami, experiencing the death of a family member, and having a parent who took sick leave due to the effects of the tsunami were independent risk factors for posttraumatic stress reactions at follow-up assessments. The sum score of exposure, age, other life events of children or parents, and family environment was not significantly related to children's levels of posttraumatic stress reactions at any time when other risk factors were controlled for.

Conclusions: The children in this study reported fewer symptoms of PTSD compared with children in other disaster studies. Risk factors changed from disaster-related features at first assessment to factors related to general mental health at follow up. The findings indicate the

importance of secondary adversities and pre-trauma functioning in the maintenance of posttraumatic stress reactions in children.

4.2 Paper II

Title: *Children's and parents' posttraumatic stress reactions after the 2004 tsunami*.

Background: Previous studies and theories have indicated that a comprehensive psychosocial model may be used to predict posttraumatic stress reactions in children. The model used in this part of the study includes the pre-existing characteristics of the child, the characteristics of the stressful event, and the characteristics of the post-disaster environment. Parental experiences and reactions during the event may be important features of children's experiences during the event, and parental posttraumatic stress reactions may be important features of children's post-disaster environment.

Method: Data were collected using cross-sectional questionnaires ($N = 319$) given to parents six months post-tsunami. Data were analyzed using multiple univariate mixed-effects models.

Results: Parents' posttraumatic stress reactions were closely related to the posttraumatic stress reactions of their children. The strongest relationships with children's reactions were found for parents' intrusive and hyperarousal reactions. Highly exposed children seemed to be more vulnerable to parental distress compared to children with lower levels of exposure. Age, gender, children's and parents' immediate reactions, and parents' exposure were not related to children's level of posttraumatic stress reactions when other risk factors were controlled. Parents reported more similar reactions among siblings than were found among unrelated children.

Conclusions: The study demonstrated that parental distress may be related to children's distress as reported by parents after a disaster. Assessments of trauma-related consequences in children and therapeutic work with children after traumatic events should focus on parents' posttraumatic stress reactions in addition to children's symptoms.

4.3 Paper III

Title: *Posttraumatic stress reactions in siblings after mutual disaster: Relevance of family factors.*

Background: Many studies have found that different family factors, such as family functioning and parental stress reactions, are related to children's levels of posttraumatic stress reactions. However, family members may influence each other in many ways, both directly and indirectly. Thus, it is difficult to separate the contributing factors. One way to study the impact of family factors independent of the factors or pathways that primarily influence outcomes is to investigate the differences between siblings. If family factors are important, then siblings should have more similar levels of posttraumatic stress reactions than do children from different families.

Method: Data were collected in face-to-face, semi-structured interviews conducted at 10 months post-tsunami ($N = 38$ sibling pairs).

Results: Siblings did not have more similar posttraumatic stress reactions than did random pairs of children.

Conclusions: Contrary to the anticipated results, family factors did not appear to be significantly related to child siblings' levels of posttraumatic stress reactions. Although earlier studies have found that some family factors contribute to children's levels of posttraumatic stress reactions, it is possible that other unmeasured family features may contribute in the opposite direction. These findings also suggest the importance of assessing family members individually after a mutually experienced trauma.

4.4 Paper IV

Title: *Family structure and posttraumatic stress reactions: A longitudinal study using multilevel analyses*.

Background: Theories and previous studies have suggested that family factors may be important for the development and maintenance of posttraumatic stress reactions. Discrepant results have been found for the influence of marital status and parental status, and the relevance of these family structures for adults' levels of posttraumatic stress reactions is investigated in the present paper. After disasters, family members may experience possibly traumatizing events and may influence each other's reactions to the events. Family members' posttraumatic stress reactions may thus become more similar than reactions across different families. However, disaster studies have seldom taken this complexity into account. Some studies have included participants from the same family without controlling for such overlapping information, whereas other studies have missed information by including only one participant per family. The present study investigates the influence of sharing a household on adults' posttraumatic stress reactions.

Method: A longitudinal design was used to collect data via questionnaires ($N = 641$) administered at six months and two years post-tsunami. Data were analyzed using multiple univariate mixed-effects models.

Results: Marital status and parenthood were not related to levels of posttraumatic stress reactions in adults at six months or two years after the tsunami. Parents differed from non-parents in some respects. For example, parents witnessed fewer dead bodies, were more likely to have lost family or friends in the tsunami, and reported more feelings of fear during the tsunami compared to non-parents. Intra-class correlations were significant at both assessments, indicating that adults from the same household had more similar levels of posttraumatic stress reactions than adults from different households did. The similarity between household members did not increase over time. However, tsunami-related factors were less related to the levels of posttraumatic stress reactions of individuals within families over time.

Conclusions: Marital status and parental status were not found to be related to the level of posttraumatic stress reactions. However, it is possible that these family features can be both protective features and risk factors through different causal paths. Adults within the same

household had more similar levels of posttraumatic stress reactions than did adults from different households. This result is expected; theories and prior studies of family factors have suggested such an effect, though it is in contrast to previous studies of child siblings in the same population of Norwegian tourists. It is possible that adult family members influence each other more than child siblings do.

4.5 Paper V

Title: *Stability of posttraumatic stress reaction factors and their relation to general mental health problems in children: A longitudinal study*

Background: Previous studies have not agreed upon the factorial division of posttraumatic stress reactions, especially with respect to children, and none has investigated the stability of the factors of PTSD over time. There is also debate about the specificity of the criteria of PTSD and whether items related to general mental health problems should be included in the diagnostic criteria for PTSD. The forthcoming revisions of the DSM-IV-TR and the ICD-10 diagnostic manuals make studies of these issues even more relevant.

Method: A longitudinal design was used to collect interview data at 10 months ($N = 133$) and 2 ½ years ($N = 104$) post-tsunami. Data were analyzed using confirmatory factor analysis and multivariate mixed-effects models.

Results: Results showed that a four-factor model of intrusion, avoidance, numbing, and arousal better fit the data of the current sample than the three-factor model in the present version of DSM. The factors of intrusion and avoidance were highly correlated at follow-up interviews, and a three-factor model of intrusion/avoidance, numbing, and arousal had a similar fit to the four-factor model at follow-up. Immediate subjective distress was significantly related to symptoms of intrusion and arousal 10 months post-disaster. However, subjective distress was not related to symptoms of active avoidance or numbing at 10 months post-disaster nor was it related to any of the factors of posttraumatic stress reactions at 2 ½ years post-disaster. General mental health was strongly related to levels of all factors of posttraumatic stress reactions, especially symptoms of arousal, at both assessments. The intra-class correlation was not significant, indicating that siblings did not have more similar reactions than did unrelated children.

Conclusions: The present study supports the suggested division of the diagnostic criteria for PTSD into four factors in the upcoming DSM-5. Specifically, the results suggest that avoidance and numbing may be two distinct features of posttraumatic stress reactions in children. The factors of intrusion and avoidance might be more highly correlated in some samples, perhaps as posttraumatic stress reactions diminish over time. In the present study, increased arousal was the factor most strongly related to general mental health, indicating that arousal may not be exclusive to PTSD. However, the results can also be interpreted to

suggest that increased arousal may be an important clinical feature of PTSD. Thus, the present study supports both the suggestion to remove some of the general features from the diagnostic criteria of PTSD to reduce the comorbidity between PTSD and other mental ailments and the suggestion to retain the current symptoms, which are an important part of posttraumatic stress reactions.

Table 2. Results Across Papers Concerning Similarities in Posttraumatic Stress Reactions Within Families and Households

Paper	*Sample*	*Statistical method*	*Intra-class correlations*	*Conclusion*
II	Parents' reports of 319 children's reactions at six months post-tsunami	Mixed-effects model, with exposure, demographics, and parental variables controlled	.67[a]	Parents reported siblings to have more similar reactions than those found among unrelated children
III	Self-reports from 76 child siblings at 10 months post-tsunami	Nonparametric regression with exposure controlled	n/a	Siblings reported unrelated levels of posttraumatic stress reactions
IV	Self-reports from 641 adults at six and 24 months post-tsunami	Mixed-effects model, with exposure controlled	.56 (95% CI, .42 to .69) and .35 (95% CI, .17 to .52) at six and 24 months respectively	Adults within the same household reported more similar reactions than did adults who were not living together
V	Self-reports from 133 children at 10 months post-tsunami and from 104 children at 2 ½ years post-tsunami	Mixed-effects model, with exposure, immediate subjective distress, and general mental health controlled	.10 (95% CI, .00 to .26)	Siblings reported unrelated levels of posttraumatic stress reactions

Note: Intra-class correlation (ICC) is defined as the proportion of total unexplained variance that is found between families. An ICC close to 0 indicates unrelated scores within families, while an ICC of 1 indicates perfectly related family scores.

[a] The confidence interval of ICC was not calculated in Paper II.

5 Discussion

5.1 Discussion of Main Findings

5.1.1 Level of posttraumatic stress reactions after the 2004 tsunami

There was considerable variation in reactions to the tsunami. For example, 10 months after the tsunami, 53% of the children reported that they experienced one or more reactions often or almost always (Jensen, et al., 2008). However, only two children had levels of posttraumatic stress reactions that were indicative of PTSD at 10 months post-tsunami (Paper I), and none of the children fulfilled the diagnostic criteria for PTSD at 2 ½ years post-tsunami. This rate of PTSD is lower than rates that have been previously reported among children after the tsunami of 2004 (Figure 3). A combination of factors may explain this discrepancy.

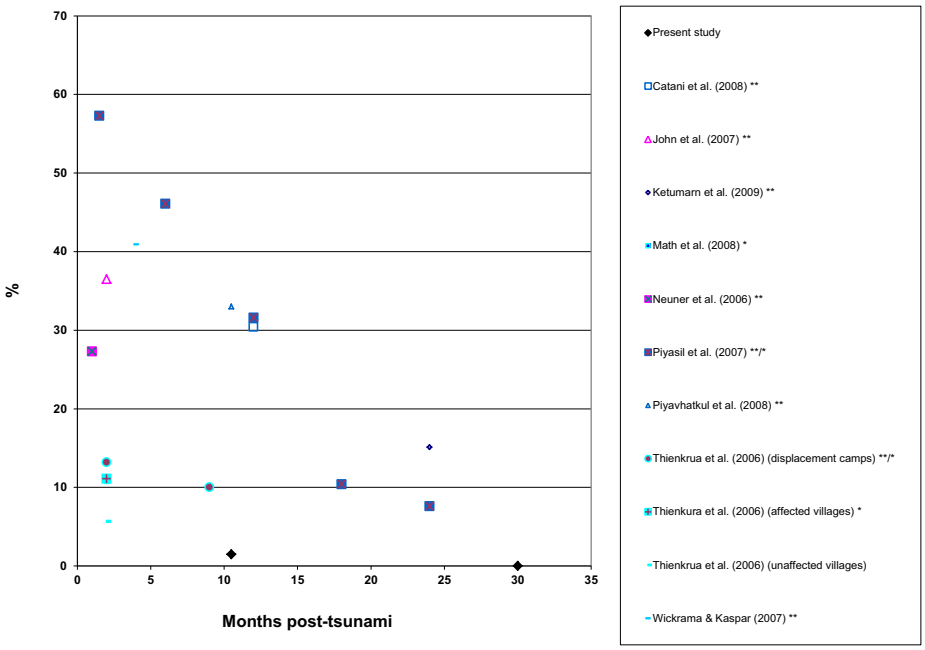

Figure 3. Percentage of participants with levels of posttraumatic stress reactions equivalent to PTSD in studies of children after the tsunami in 2004.

Note: Significance was controlled by Pearson chi-square. Piyasil et al. (2007) had significantly higher levels up to one year ($P \leq .001$) and at 1½ and two years ($P \leq .01$). Thienkrua et al. (2006) showed that displacement camps had significantly higher levels at two months ($P \leq .001$) and at nine months ($P \leq .01$).

* Significant difference compared to the present study at 10 months with $P \leq .01$.

** Significant difference compared to the present study at 10 months with $P \leq .001$.

All studies except the present study investigated children from tsunami-stricken areas, including Sri Lanka (Catani, et al., 2008; Neuner, et al., 2006; Wickrama & Kaspar, 2007), India (John, et al., 2007; Math et al., 2008), and Thailand (Ketumarn et al., 2009; Piyasil, et al., 2007; Piyavhatkul, et al., 2008; Thienkrua, et al., 2006). This important difference may explain discrepancies in the likelihood of posttraumatic stress reactions after the tsunami.

The Norwegian children had likely experienced fewer pre-tsunami traumatic events compared to the children in some of these studies. Some studies included children who had been exposed to war-related events (Catani, et al., 2008; Neuner, et al., 2006), a majority who had experienced violence in the family (Catani, et al., 2008), and/or experienced other previous traumatic events (Neuner, et al., 2006). Most or all children who experience such a combination of traumas may develop posttraumatic stress reactions (Catani, et al., 2008).

The Norwegian children had a relatively high level of exposure to potentially traumatizing experiences. The majority of children were in physical danger from the wave (65%) or had witnessed physical injuries to others (59%). Four children (3%) lost relatives in the disaster. Most children also experienced fear and horror (Paper I). However, the experiences of the children living in the area and included in the other studies may have been even worse. For example, a study in India found that more than 75% of the sample had experienced the loss of life (of a family member, friend, neighbor, or pet) or the loss of property (home, fishing boat, or farmland) (John, et al., 2007). Other studies included a high proportion of children who had lost a family member during the tsunami (Neuner, et al., 2006; Thienkrua, et al., 2006). For example, 41% of children from so-called 'unaffected villages' in Thailand lost a close family member or friend during the tsunami (Thienkrua, et al., 2006). The discrepancy between the children's prior assumptions and their disaster experiences would be even greater for children living in the affected area. Thus, it would be more difficult to integrate the traumatic experiences with their prior assumption of invulnerability and their view of the world as a meaningful and predictable place (Horowitz, 2001; Janoff-Bulman, 1985). The more extreme stress may also have overwhelmed the children, making it more difficult for them to tolerate flashbacks and integrate their appraisal of themselves during the tsunami with previous appraisals of themselves (Brewin, et al., 1996; Ehlers & Clark, 2000).

All of the previous studies on the proportion of children who developed PTSD after the tsunami investigated children who continued to live in the tsunami-stricken areas or were evacuated away from their former homes to displacement camps and were unable to return home at the time of the investigation. In comparison, the children in the present study were able to return to their intact homes and communities. These children could return to their normal lives, and their parents could return to their jobs. Thus, the children who remained in the disaster areas had much higher levels of secondary adversity than the children in the present study did.

Mounting evidence shows that secondary adversities are significant mediating factors between exposure and posttraumatic stress reactions. In a study of 427 Sri Lankan adolescents who had experienced the tsunami and war, daily deprivation (e.g., lack of clean drinking water) significantly mediated the relationship between their tsunami and war experiences and their levels of PTSD (Fernando, et al., 2010). A study of children 6-7 months after an earthquake in Athens found that 20.1% of the children who were out of town during the earthquake had levels of posttraumatic stress reactions that were similar to PTSD, and the post-disaster adversities that they encountered were strongly related to their levels of symptoms (Giannopoulou, Strouthos, et al., 2006). The importance of evacuation is also supported by Ehlers and Clark's (2000) theory regarding the risk of overgeneralized appraisals with global negative implications for the future. There is less risk of overestimating the negative personal consequences of a disaster or the risk of having a similar experience again when one is no longer in the disaster area. There may also be less of a conflict for children between prior assumptions about their own vulnerability and their experiences (Ehlers & Clark, 2000; Horowitz, 2001; Janoff-Bulman, 1985). It may have been easier to interpret the event as a rare event that probably would not happen to them again than as something that occurs more frequently in places other than Norway.

The two previous studies of children who experienced a single disaster and returned to unaffected homes and communities found higher levels of PTSD than the present study. A total of 17.5% of affected children had PTSD 5-8 years after the sinking of the "Jupiter" (Yule, et al., 2000). Approximately one-third of affected children had high levels of posttraumatic stress reactions one year after a bus accident, whereas none had clinically significant symptoms three years post-accident (Winje & Ulvik, 1998). These results suggests that features other than secondary adversities may have been important contributors to the low levels of posttraumatic stress reactions in the present study.

In addition to being protected against many secondary adversities, the Norwegian children also experienced fewer direct reminders of the tsunami in their daily lives than did children who remained in the areas affected by the tsunami. More frequent reminders of a traumatic event have been found to be related to higher levels of posttraumatic stress reactions, for example, in Bosnian adolescents who experienced war (Layne et al., 2010).

Norwegian children may have had fewer people in the community who shared their experiences and could understand what they had been through compared to children who continued to live in the disaster area. However, many of the children in the present study had family members with similar experiences, and most (88%) reported that they felt understood by family members, friends, or others (Paper I). Features specific to a tsunami may allow this event to be accepted by those who have experienced it and may increase the likelihood that survivors will speak about it, unlike survivors of other traumas, such as interpersonal violence during wars, traffic accidents, or lesser-known natural disasters. No negative stigmas were related to the event, there was widespread public interest in the disaster, and peers and adults expressed interest in the event. Many of the children were therefore able to talk openly about their experiences and their need for support (Jensen, et al., 2008). Thus, even if the community did not share their experiences, it is likely that this did not affect most children negatively.

The combination of few reminders and an openness and interest concerning their experiences may have facilitated a good recovery environment for the Norwegian children. Because they received few reminders of the traumatic event, Norwegian children probably did not experience many involuntary intrusive symptoms that they needed to suppress. Thus, they were at lower risk of using a maladaptive avoidance strategy that could prevent the integration of unconscious situational memories, conscious verbal memories, and prior fundamental assumptions about the world and themselves (Brewin, et al., 1996; Ehlers & Clark, 2000; Horowitz, 2001; Janoff-Bulman, 1985) (see Introduction chapter 1.3.1). However, a certain level of reminders may be necessary to activate cognitive processes and ensure this integration, and others' interest in and openness about the tsunami may have facilitated this. Instead of experiencing possibly overwhelming and surprising negative emotional reactions as a result of unpredictable reminders, the children experienced easily understandable reactions when others talked about the tsunami. Thus, they had more control over their emotional reactions and could more easily integrate their memories of the event, their present emotional reactions, and their assumptions about the world and themselves.

Whereas the present thesis interprets the Norwegian children as having low levels of reactions, it may be that many of the children had a premature inhibition of processing (Brewin, et al., 1996). Because of the lack of reminders, the children may have successfully avoided the unpleasant memories and thus inhibited the integration of the verbally accessible memories,

situationally accessible memories, and prior assumptions about the world and themselves. According to Brewin (1996), these children would have impaired memory of the trauma, show phobic avoidance of trauma-related situations, and show evidence of somatization. However, this finding is not supported by the low levels of general mental health problems found among the Norwegian children (Paper V). In addition, the children voluntarily participated in the study and did not avoid this trauma-related situation, and the interviews did not indicate generally impaired memory of the trauma narrative among the children (Hafstad, et al., 2011).

The Norwegian children came from a country with a higher average income than did children in the tsunami-stricken areas, and their caregivers had above-average levels of education compared to the general Norwegian population. Thus, their parents generally had a comparably high level of resources in the aftermath of the disaster.

The mental health services available in Norway were more developed than the services in most of the areas struck by the tsunami (Carballo, Daita, & Hernandez, 2005). Health care services in the area of the tsunami had to contend with a huge burden in the aftermath of the disaster. In some cases, health care services were unavailable or inadequate because facilities were decimated or health care personnel were killed, injured, or displaced (Carballo, et al., 2005). The Norwegian children would be expected to have easier access to health care services than children living in the disaster-stricken areas did.

Thus, it is not surprising that the present study found a relatively low level of posttraumatic stress reactions among the assessed Norwegian children compared to children living in the disaster-stricken areas or children who had experienced other disasters. Despite the children's horrible experiences, the present study indicates that a single traumatic disaster experience may have limited longitudinal consequences if children are protected from other adversities and receive appropriate help.

5.1.2 Factors related to levels of posttraumatic stress reactions

The degree of exposure to traumatic stressor(s) is the most consistently documented causal risk factor for PTSD (Ford, 2009). This characteristic dose-response relationship was only partially supported in the present study (Paper II). The sum variable of exposure was not related to children's reported levels of posttraumatic stress reactions (Papers I and V). The dose-response relationship between exposure to a traumatic event and stress reactions is so well documented

that the absence of this effect in the present study may be due to methodological problems, such as the lack of concurrent self-reported levels of trauma exposure by the children at 10 months (see Discussion in chapter 5.2.1). The relationship between children's self-reported immediate subjective distress and posttraumatic stress reactions at 10 months supports this conjecture. The findings also indicate that experiences during the tsunami may be more closely related to symptoms of intrusion and arousal than they are to symptoms of avoidance and numbing (Paper V). This result is in accordance with other studies of children after disasters (Dyregrov, Kuterovac, & Barath, 1996; Giannopoulou, Strouthos, et al., 2006; Goenjian, et al., 1995; Kitayama, et al., 2000; Kolaitis, et al., 2003; Lonigan, et al., 1994; Najarian, Goenjian, Pelcovitz, Mandel, & Najarian, 1996; Winje & Ulvik, 1998) and with theories of PTSD that focus on intrusive symptoms as the primary distinguishing feature of partly unconscious sensory memories of the trauma (Brewin, et al., 1996; Ehlers & Clark, 2000).

The lack of a relationship between immediate subjective distress and posttraumatic stress reactions at 2 ½ years indicates that the characteristic dose-response relationship probably disappeared over time. Whereas levels of posttraumatic stress reactions at six and 10 months post-tsunami were related to tsunami experiences, this relationship was not observed at 2 ½ years. We interpret this finding to indicate that the measured symptoms at 2 ½ years no longer reflected the tsunami experiences as much as they reflected other mental health problems (Papers I and V), as discussed in chapter 5.1.5. Thus, the results indicate that the children had integrated their different memories of the disaster at follow up (Brewin, et al., 1996; Ehlers & Clark, 2000) and had few intrusive symptoms related to the disaster (Paper V).

There was no relationship between age and levels of posttraumatic stress reactions in children in the present study (Papers I and II). Only linear relations were analyzed. Thus, there may be non-linear relations that went undetected, as found in two other studies of school-aged children (McDermott & Palmer, 2002; Piyavhatkul, et al., 2008). However, other studies of the relationship between age and posttraumatic stress reactions after disaster in school-aged children have found quite discrepant results (see Introduction chapter 1.3.2), and a meta-analysis of different traumatic event types did not find age to be related to children's levels of posttraumatic stress reactions (Alisic, et al., 2011). A qualitative analysis of the narratives of two age groups within the present sample of interviewed children also indicated few differences between children and adolescents (Hafstad, et al., 2011). This finding may be in accordance with developmental theories with contradictory suggestions on the effect of age on the level of posttraumatic stress reactions. For example,

young children's immature emotional understanding and thinking may both increase and decrease the risk of posttraumatic stress reactions (see chapter 1.3.1). The youngest children may not use appropriate coping strategies or may be unable to integrate their thoughts with conscious and unconscious emotions as well as older children can (Franks, 2011; Salmon & Bryant, 2002). However, young children may not use maladaptive coping strategies such as rumination (Salmon & Bryant, 2002). The youngest children may also be more open to influences from their caregivers, which may be both positive and negative. Young children may be more easily influenced by parental distress during and after the disaster, and they may be more open to parental support after the disaster. Thus, all in all, it is likely that age was not significantly related to levels of posttraumatic stress reactions in the Norwegian school-aged children after the tsunami.

As most studies have found (see Introduction, chapter 1.3.2), girls in the present study had more stress reactions at 2 ½ years post-tsunami than boys did. However, no significant gender differences were observed at six or 10 months (Papers I and II). It is unclear why girls had more reactions at a time when children's total distress levels were lowest. Considerable documentation shows that girls and women have more posttraumatic stress reactions than males do (Alisic, et al., 2011; Olff, et al., 2007). Thus, the discrepant results of the present study should not be interpreted as contradictory to previous reports of gender differences. Some of the gender differences may be culturally specific, with fewer gender differences in posttraumatic stress reactions in the Nordic countries compared to other countries. One theory suggests gender differences in the cognitive appraisal of a traumatic event and thus in the effect of traumatic experiences on reactions (Olff, et al., 2007). The potentially greater gender equality in roles, rights, and thoughts in Norway compared to other countries with disaster victims may minimize gender differences in the cognitive appraisal of the traumatic event. However, both Norwegian and Swedish adult females reported more reactions than males did after the tsunami (Heir & Weisæth, 2008; Wahlström, et al., 2008). The differences in previous traumas between genders may not be controlled for in disaster studies, and there may be fewer gender differences in previous traumas in the present study than there are among children in other countries. However, this type of epidemiological information is lacking.

Other potentially traumatic life events experienced by the children or adults were not found to be related to children's levels of posttraumatic stress reactions when other risk factors

were controlled for (Paper I). This result may be due to low levels of other traumatic life events in this study compared to other studies, which often included participants who had lived in areas with civil war, poverty, or higher levels of violence (e.g., Catani, et al., 2008). Norway is generally a safe place, with the United States, for example, having eight times as many homicides per capita (Olsen et al., 2010). However, comparable international epidemiological data are lacking for other traumatic experiences.

In the present study, children's view of their social support, measured by whether they felt understood by their family, friends, or others, was found to be unrelated to children's levels of posttraumatic stress reactions when other risk factors were controlled for (Paper I). Social support is strongly related to levels of posttraumatic stress reactions in adults (Brewin, et al., 2000; Ozer, et al., 2003) and children (La Greca, et al., 1996; McDermott, et al., 2010). Social support is thought to help victims to rebuild and solidify their basic assumptions about their self-esteem and self-worth (Janoff-Bulman, 1985). Parents are important communication partners who may help children to understand what occurred and their reactions during and after the disaster (Ehlers & Clark, 2000; Salmon & Bryant, 2002). Support from parents is thought to be important for the ability of children to integrate traumatic memories with their prior assumptions about the world and themselves (Franks, 2011; Horowitz, 2001). The lack of such findings in the present study may be due to methodological problems, such as a lack of variability, because this construct was assessed by only one question, and to a floor effect, with only 12% of the children reporting that they did not feel understood (Paper I). A qualitative study of the parents' interviews also revealed a high level of understanding and support from parents (Hafstad, Haavind, & Jensen, in press). The findings of earlier studies and the literature indicate the importance of parental support for children's development (Berk, 2009). Thus, social support is likely important for children's coping in the aftermath of a natural disaster.

The present study found significant relationships between parents' disaster-related health problems and children's levels of posttraumatic stress reactions (Papers I and II). This result has been identified in many other studies (see Introduction chapter 1.3.4). An interaction effect was also found in which children who had a combination of high exposure and distressed parents had higher levels of posttraumatic stress reactions than indicated by these risk factors separately (Paper II). This interaction effect was not found in a study using parental reports of preschool children's stress reactions (Cornely & Bromet, 1986). The genetic similarities in adult siblings' posttraumatic stress

reactions found in other studies (Stein, et al., 2002; True, et al., 1993) may indicate a genetic contribution to the similarities observed among parents and their children in posttraumatic stress reactions. However, most studies have interpreted similarities between parents' and children's reactions as an indication of the parents' levels of distress influencing the children (see Introduction, chapters 1.3.1 and 1.3.4). Parental distress may influence children through different processes. For example, distressed parents may avoid discussing the event with their children, either to prevent their own intrusive memories or to protect their children from what they think are unhealthy memories. Thus, the children have less opportunity to integrate conscious trauma memories, involuntary intrusive trauma memories, and pre- and post-disaster assumptions about themselves and the world (Brewin, et al., 1996; Franks, 2011; Horowitz, 2001; Salmon & Bryant, 2002). Parental distress may also influence the parents' general abilities to support their children. Parental injury and illness have been linked to developmental problems in children, such as attachment difficulties; delayed brain development; emotional dysregulation; cognitive, emotional, or developmental delays; psychological and behavior problems; and somatic health concerns (Gorman, Fitzgerald, & Blow, 2010). Thus, there is considerable support for a causal link from parents' to children's posttraumatic stress reactions.

It is also possible that parents are influenced by their children's levels of distress. In the aftermath of Hurricane Katrina, caregivers' posttraumatic stress reactions were related to their children's unmet service needs (Kilmer & Gil-Rivas, 2010), and parents' distress nine months after 9/11 was related to their children's distress three months following the event and less to their own distress (Koplewicz et al., 2002). Interestingly, a study found that parents' posttraumatic stress reactions after 9/11 were more closely related to their perception of children's distress in general (both the levels of their own children's distress and the distress of unrelated children) than to their perception of their own children's distress (Phillips, Featherman, & Jinyun, 2004).

The most plausible explanation for the relation between children's and parents' stress reactions is an interactional process within the family whereby all family members influence each other. This explanation is supported by ecological (Bronfenbrenner & Morris 2006, referenced in Berk, 2009) and dynamic interactional system-oriented developmental theories (e.g., Lerner, 2002) as well as the fundamental assumptions of family therapy (Nichols, 2010). It is overly simplistic to conclude that either the child influences the parent or the parent influences the child. There is an ongoing

process by which all family members are influenced by their internal cues and their environment. Because most studies are cross-sectional, causal pathways are difficult to investigate. Even longitudinal studies need complex statistical procedures and similar assessment tools over time to evaluate family processes. Due to the retrospective approach of most disaster research, family processes before a disaster are largely unknown.

Family functioning has been considered as a link between parents' and children's levels of posttraumatic stress reactions. Parents' inability to cope is thought to influence the family environment and family communication in particular (Gorman, et al., 2010). Studies have found that the enmeshed cohesion or rigid adaptability of families (Birmes, et al., 2009) and an irritable and depressed family atmosphere (Green, et al., 1991; McFarlane, 1987a) are related to a higher level of posttraumatic stress reactions in children after disasters. By contrast, we have found only one study suggesting that communication within families is unrelated to children's levels of reactions (McDermott, et al., 2010). Therefore, it was surprising that family cohesion and expressiveness were not related to children's levels of posttraumatic stress reactions in the present study (Paper I). Low internal consistency and a possible lack of construct validity of the assessment tool (the Family Environment Scale) may have decreased the sensitivity of this scale to relationships between the family environment and distress (see Discussion in chapter 5.2.2). It is unclear if this is a general problem with the assessment tool (Roosa & Beals, 1990), if there are cross-cultural differences in the instrument (Munet-Vilaro & Egan, 1990; Saito, Nomura, Noguchi, & Tezuka, 1996), or if there are problems with the instrument's translation.

When investigating the relationship between parents and children's distress after a disaster, the developmental level of the children must be considered (Franks, 2011; Salmon & Bryant, 2002). The interaction between children and their caregivers differs across children's lives. Therefore, it may be simplistic to reduce the interpretation of results to either the presence or absence of a relationship. We did not find age to be related to the level of posttraumatic stress reactions (Papers I and II). The present study did not include preschool children, and the literature concerning the first years of childhood will therefore not be thoroughly discussed. However, it is important to remember that most infants lack previous disaster experiences. Thus, they depend to a large degree on their interpretations of their caregivers' reactions during and after a disaster to evaluate the proper reactions to the situation. This concept is similar to "social referencing", in which

infants rely on a caregiver's emotional reactions to appraise an uncertain situation (e.g., Klinnert, et al., 1983; Mumme, Fernald, & Herrera, 1996). This interaffectivity is thought to develop at approximately 9 months of age (Stern, 1985), but the tendency to evaluate a situation and the proper emotional reactions based on other people's reactions continues throughout life (e.g., Sherif, 1936, referenced in Hogg & Vaughan, 2008; Siegel, 1999). However, this tendency may vary depending on personal characteristics, such as gender and personality, and the characteristics of the situation, such as the number of persons nearby and the relationships with these people (Hogg & Vaughan, 2008). Due to close relationships and longitudinal proximity, family members influence each other's interpretations and reactions more than strangers do (e.g., Taifel & Turner, 1979, referenced in Hogg & Vaughan, 2008; Nichols, 2010).

Marital status and parental status were found to be unrelated to posttraumatic stress reactions in adults (Paper IV). Because many studies have found social support to be an important factor in adults' recovery from posttraumatic stress reactions (Brewin, et al., 2000; Ozer, et al., 2003), the null effect of marital status was surprising. However, this finding was in accordance with the highly discrepant findings of other studies that have investigated the relationship between marital status and posttraumatic stress reactions (see Introduction, chapter 1.3.4). Additionally, the lack of difference in posttraumatic stress reactions between parents and non-parents is in accordance with the findings of other studies on reactions to the tsunami (Ranasinghe & Levy, 2007; Wahlström, et al., 2008). There may be features that both increase and decrease the risks of posttraumatic stress reactions in parents versus non-parents. Parents experienced more fear during the tsunami, which suggests that parents may feel more anxious because they are worried about the well-being of their children. The finding that parents witnessed fewer dead bodies than non-parents did indicates that parents may have protected their children, and thereby themselves, from some of the disaster experiences. It is unknown why the three studies of the aftermath of the tsunami did not find parental status to be related to posttraumatic stress reactions because this relationship has been identified after other disasters (see Introduction, chapter 1.3.4).

5.1.3 Similarities in posttraumatic stress reactions within families

As reported in Table 2, siblings differed in their posttraumatic stress reactions as much as randomly paired children did (Papers III and V), although parents reported that their children's reactions were very similar (Paper II). Adults in the same household were found to have

posttraumatic stress reactions that were more similar than the reactions of adults from different households were (Paper IV).

A previous study (Asarnow, et al., 1999) and the present study indicate that siblings' reactions are not significantly related. This result is surprising because many studies have found that a multitude of family factors are related to children's levels of posttraumatic stress reactions. Examples of these factors include parents' post-disaster coping (Bloch, et al., 1956; McFarlane, 1987b; Swenson, et al., 1996), parents' psychopathology (Green, et al., 1991; Vijayakumar, et al., 2006; Wickrama & Kaspar, 2007), parents' alcohol abuse (Wickrama & Kaspar, 2007), family violence (Catani, et al., 2008), family support (La Greca, et al., 1996), and positive family relations (Wickrama & Kaspar, 2007). A genetic susceptibility to posttraumatic stress reactions in adult twin studies has also been reported (Stein, et al., 2002; True, et al., 1993). Most of these family factors are likely to be similar for siblings. Cognitive theories of children's posttraumatic stress reactions also underline the importance of caregivers and siblings in the recovery from posttraumatic stress reactions (Brewin, et al., 1996; Ehlers & Clark, 2000; Salmon & Bryant, 2002). Why, then, are siblings' posttraumatic stress reactions as different as those of random children?

There may be at least three reasons for this phenomenon. First, siblings may be influenced by family factors in the same direction and to the same degree. Thus, if they are at increased risk due to a family risk factor, then siblings' levels of posttraumatic stress reactions can increase to the same degree. The differences in reactions between siblings would therefore not be affected, and their reactions would remain just as different as those of unrelated children. Second, some family factors may influence siblings in diverging directions, whereas other factors may influence siblings' reactions in converging directions. For example, communication within the family may help to unify the family's history of an event, whereas each individual's role in the family may influence diverging reactions. Children's irritability and negative affectivity have been found to elicit negative behavior and inhibit positive behavior both from parents and from strangers, which may increase the risk of such behavior (e.g., Deater-Deckard et al., 2001). Thus, differences between siblings in symptoms after a disaster may increase over time due to family processes. This finding is in accordance with studies suggesting that parents treat siblings quite differently and that this differential treatment increases when parents are under stress (Jenkins, Rasbash, & O'Connor, 2003). Furthermore, the relationship between children's posttraumatic stress reactions and family factors may have been overestimated in earlier studies. Publication bias is a

well-known problem, with published studies having a tendency to report significant findings, while studies with non-significant findings or findings that seem illogical may not be published (Scargle, 2000). For example, it is possible that family features that are not found to be significantly related to levels of posttraumatic stress reactions have been excluded from further analyses and published manuscripts. However, many studies have shown the expected relationship between children's symptoms and family factors (see Introduction chapter 1.3.4). It is probable that family factors are important for children's levels of posttraumatic stress reactions. An example is the relationship between parents' and children's posttraumatic stress reactions presented in Papers I and II. However, the present study indicates that siblings' reactions may differ more than previous studies of family factors have indicated.

Parents reported that their children were more similar in their reactions (Paper II) than the self-reports from the children themselves indicated (Papers III and V). No studies have previously investigated this phenomenon in regard to posttraumatic stress reactions or, as far as we know, in other mental health problems. This discrepancy is interpreted as an indication that the parents' reports did not accurately assess their children's posttraumatic stress reactions (see Discussion, chapter 5.2.1).

Adults living in the same household reported more similar levels of posttraumatic stress reactions than unrelated adults did. Although not all adults living in the same household were couples, it is likely that the majority were. The results show that couples have more similar posttraumatic stress reactions after a disaster than do random pairs of adults, as found in previous studies of general mental health, depression, and anxiety after traumatic experiences (Gleser, et al., 1981; Kristensen, et al., in press; Vila, et al., 2001). The convergence in reactions is in accordance with theories of social psychology (e.g., Sherif, 1936 and Asch, 1952 referenced in Hogg & Vaughan, 2008), family therapy (Nichols, 2010), and cognitive theories of posttraumatic stress reactions (Ehlers & Clark, 2000; Horowitz, 2001; Janoff-Bulman, 1985).

It is surprising that posttraumatic stress reactions seem to converge only among adult household members (Paper IV) and not among child siblings (Papers III and V) after a mutually experienced natural disaster. We do not know why this is so. The different results between adult household members and child siblings may be related to differences in methodology, age, and/or role. First, the children were interviewed separately, whereas the adults replied to postal

questionnaires. Thus, adult participants from the same household may have discussed the questionnaire with one another before replying, completed the questionnaire together, or compared their responses. Second, there may be an age effect, with older family members (adults) communicating in a more convergent way than younger family members (children) do. If this were a linear relationship, one would expect adolescent siblings to be more similar in their posttraumatic stress reactions than younger siblings are. However, this is the opposite of what one would expect with regard to a non-shared environment (Berk, 2009). Adolescents have a larger part of their social life outside the family and therefore have less of a shared environment with their siblings than younger children do. However, it is possible that there is a non-linear relationship with age, with siblings becoming increasingly different in early adolescence but becoming closer to each other again in middle/older adolescence, as has been found for mixed-sex siblings' intimacy (Kim, McHale, Wayne Osgood, & Crouter, 2006). Due to the small sample size of child siblings (Paper III), the interactional role of age was not analyzed in detail. Third, there may be differences in the role of couples versus siblings that influence their communication and convergence in reactions. It is possible that couples communicated more about the traumatic event and their later reactions than siblings did because of couples' cooperating roles. It may be more important for couples to agree about their interpretation of the traumatic event and reasonable reactions to it, especially if they are parents. Whereas siblings may actively disagree, parents may seek cooperation and converging interpretations from their partner and co-caregiver.

5.1.4 Clustering of symptoms of PTSD in children

In Paper V, we found that the current division of PTSD into the three factors of intrusion, avoidance/numbing, and arousal was the least well-supported model for children at both times. Instead, we found that a division of symptoms of posttraumatic stress reactions into the four factors of intrusion, avoidance, numbing, and arousal fit the data best, especially at the first assessment (10 months post-tsunami). This four-factor numbing model has been supported in other studies that compared this model to other models for children (Kassam-Adams, et al., 2010; Saul, et al., 2008; Stewart, et al., 2004) and adults (Asmundson, Wright, McCreary, & Pedlar, 2003; Elhai, Ford, Ruggiero, & Christopher Frueh, 2009; King, Leskin, King, & Weathers, 1998). The DSM-5 will probably have a similar four-factor model of intrusion, avoidance, cognitions/moods, and arousal/reactivity (APA, 2011a).

The division of symptoms of avoidance and numbing supports the distinction between avoidance as entailing active strategies intended to reduce the distress associated with memories of traumatic events and numbing as the shutting down of the affective system when avoidance strategies fail (Foa, et al., 1995). These numbing reactions may be similar to those found in studies of learned helplessness in animals that are not able to avoid a negative stimulus (Foa, et al., 1989). However, other studies have suggested that symptoms of numbing manifest deficits that arise from the depletion of biological, cognitive, and affective resources subsequent to chronic hyperarousal in patients with PTSD (Litz et al., 1997). Thus, numbing is thought to be a consequence of too much arousal rather than a failure of avoidance strategies. It is possible to link the division of avoidance and numbing to Brewin's theories of two memory systems for traumatic events and thus two paths for the retrieval of traumatic memories (Brewin, et al., 1996; Ehlers & Clark, 2000). Active avoidance may be the emotional processing of conscious, available, verbally accessible memories, whereas numbing may be the automated, unconscious reactions to involuntary and intrusive symptoms arising from situationally accessible memories. The underlying processes of the different parts of posttraumatic stress reactions remain fairly unknown in both adults and children.

While the suggested model of the DSM-5 is based on confirmatory factor analysis studies (APA, 2011a), some confirmatory factor studies of children that have evaluated similar four-factor numbing models have found other ways of clustering the symptoms to better match their data (Anthony, et al., 1999; Ford, et al., 2009; March, et al., 1997). For example, a large study after hurricane Hugo that included 5,664 children found that an alternative three-factor model of intrusion/avoidance, numbing, and arousal better described the data (Anthony, et al., 1999). In our study, we found that such a three-factor model had a degree of fit similar to that of the recommended four-factor model at 2 ½ years after the tsunami. The convergence over time of intrusive symptoms and active avoidance can be interpreted in accordance with predictions made by Brewin (1996). As unconscious, situationally accessible memories become more integrated with conscious, verbally accessible memories, intrusive symptoms become less separate from conscious avoidance processes. Emotional reactions and thought processes become more integrated over time; the memory of trauma is better integrated into its temporal and spatial context, subsequent and

previous information, and other autobiographical memories; and the memories becomes less implicitly and perceptually primed (Ehlers & Clark, 2000).

However, the children had low levels of symptoms at follow-up, and the posttraumatic stress reactions reported at this time may have been related to general mental health problems rather than to the consequences of the tsunami. Because a higher proportion of the sample fulfilled the requirements for a diagnosis of PTSD (5.5%) in the comprehensive investigation by Anthony et al. (Lonigan, Anthony, & Shannon, 1998) than in our sample, even at 10 months (1.5%), we cannot conclude that the three-factor model supported by Anthony et al.'s findings is effective exclusively in samples with low levels of posttraumatic stress reactions. Other models that incorporate the findings of comorbidity between posttraumatic stress reactions and other mental health problems have recently found support (see Discussion in chapter 5.1.5).

Therefore, although a four-factor model similar to the one evaluated in Paper V seems to be favored thus far in existing studies and in the forthcoming DSM-5, other models may also be used successfully.

5.1.5 Comorbidity

Paper V found a significant overlap between posttraumatic stress reactions and general mental health in children, especially for arousal symptoms. This result is similar to the findings of other studies: that children's anxiety is strongly related to levels of PTSD symptoms (Hensley & Varela, 2008). Additional studies have shown that depression and general mental health are significantly related to both intrusion and arousal symptoms of PTSD in children (Goenjian, et al., 1995; Hukkelberg & Jensen, 2011; Kassam-Adams, et al., 2010) and that anxiety and depression are strongly related to symptoms of arousal (Kolaitis, et al., 2003; Lonigan, et al., 1994).

Due to the overlap between symptoms of PTSD and other mental health problems, some studies have suggested the removal of non-specific symptoms from the diagnosis of PTSD (Brewin, Lanius, Novac, Schnyder, & Galea, 2009; Spitzer, et al., 2007). A model suggested by Spitzer et al. excludes two such criteria from numbing and three from arousal. The model was supported by a confirmatory factor study of posttraumatic stress reactions in adolescents (Ford, et al., 2009), but two other studies of children have found other models to fit better than the model suggested by Spitzer et al. (Hukkelberg & Jensen, 2011; Kassam-Adams, et al., 2010). However, the removal of non-specific symptoms may decrease the content and face validities of the diagnosis because these symptoms may be considered

important by patients with posttraumatic stress reactions. Although these symptoms characterize many disorders, they remain important clinical features of PTSD. Another problem is that the removal of some symptoms may not reduce comorbidity between disorders because many studies have found that the symptoms common to many disorders are also core symptoms of PTSD, both in children (Goenjian, et al., 1995; Hukkelberg & Jensen, 2011; Kassam-Adams, et al., 2010; Lonigan, et al., 1994) and in adults (e.g., Heir, Piatigorsky, & Weisæth, 2010). This result was also found in the present study. Even though general mental health was significantly more closely related to arousal than to any of the other factors, general mental health was also significantly related to all other factors of posttraumatic stress reactions.

Instead of removing these symptoms, it has been suggested that numbing (C3-C7) and some arousal (D1-D3) criteria known to overlap with other mental ailments should be clustered (Simms, et al., 2002). This reformed model has been called a dysphoria model because the clustered symptoms that are related to other mental health problems are thought to evaluate dysphoric symptoms. Several studies have investigated this model in adults (e.g., Elhai et al., 2009; Elhai, Ford, et al., 2009; Naifeh, Richardson, Del Ben, & Elhai, 2010; Palmieri, Weathers, Difede, & King, 2007; Wang et al., in press), but only one study had investigated this model in children at the time Paper V was written (Kassam-Adams, et al., 2010), and one additional paper has subsequently been accepted for publication (Hukkelberg & Jensen, 2011). Both papers found that the dysphoria model and the four-factor numbing model fit their data better than the three-factor model from the DSM-IV-TR. Whereas Kassam-Adams et al. found that the numbing model provided a slightly better fit for their data than the dysphoria model did, Hukkelberg and Jensen found that the dysphoria model was slightly more accurate than the numbing model was. Thus, both models appear to represent the data equally well for children. In addition, studies of adults have found that the dysphoria model and the numbing model are equally well suited (Elhai, Ford, et al., 2009), with some diverging preferences across samples (Wang, et al., in press).

Although studies have found an overlap between posttraumatic stress reactions and depression, anxiety, and general mental health in children (Asarnow, et al., 1999; Goenjian, et al., 1995; Hukkelberg & Jensen, 2011; Kassam-Adams, et al., 2010; Kolaitis, et al., 2003; Lonigan, et al., 1994; McDermott & Palmer, 2002; Warheit, et al., 1996), the etiology of this comorbidity is unknown. At least five different causal pathways are possible. First, there may be an overlap in the criteria between PTSD and other mental health problems

and thus a lack of discriminant validity of the diagnoses. This lack is the main reason for the suggested removal of some criteria of PTSD (Brewin, et al., 2009; Spitzer, et al., 2007). Second, the diagnoses may measure different mental health problems, with traumatic experiences as a risk factor for developing both posttraumatic stress reactions and other distinct mental health problems (O'Donnell, Creamer, & Pattison, 2004), which would indicate a shared vulnerability for different disorders after trauma. Third, pre-disaster mental health problems may be a risk factor for developing posttraumatic stress reactions (Asarnow, et al., 1999; Warheit, et al., 1996). This concept is supported by the findings of Paper I, which showed that children who used mental health services before the tsunami had higher levels of posttraumatic stress reactions. Fourth, the development of PTSD may be a risk factor for the development of other mental health problems, such as depression (Goenjian, et al., 1995; Warheit, et al., 1996). Fifth, interaction effects may exist between posttraumatic stress reactions and other concurrent health problems (Asarnow, et al., 1999). It is possible that the interactional pathways are different during the acute and developmental phases of posttraumatic stress reactions compared to the pathways of the recovery process (O'Donnell, et al., 2004).

It is difficult to separate the different causal pathways because most research involves retrospective studies that lack comparable measures for mental health problems that occur pre- and post-disaster. Although Paper I found a relationship between the pre-disaster use of mental health services and posttraumatic stress reactions, this may be a reflection of many of the aforementioned pathways. The findings in Paper V of a strong relationship between concurrent mental health problems and posttraumatic stress reactions may also be due to a combination of the aforementioned pathways.

5.2 Methodological Considerations

5.2.1 Sources of information

The present study incorporated parents' reports of their children's levels of posttraumatic stress reactions (Paper II) and the children's own self-reported stress reactions (Papers I, III, and V). It was not possible to analyze differences in the levels of reported stress reactions because the levels reported by parents and children were assessed using different assessment tools. However, children's posttraumatic stress reactions reported by parents in the questionnaire given at six months and reported by children in the interview conducted at 10 months post-tsunami were

significantly less strongly correlated ($r = 0.23$) compared to the levels reported by children at 10 months and 2 ½ years post-tsunami ($r = 0.56$). Parents also reported siblings to be more similar in their reactions (Paper II) than was found by comparing the self-report measures from the siblings themselves (Papers III and V). These discrepancies raise the question of the validity of caregiver reports about children's posttraumatic stress reactions versus children's self-reports (Nader, 2008). In children younger than eight years of age, it is common to use reports from parents (Smith, et al., 2010), though some self-report scales can be used on younger children (Nader, 2008). The use of parents' reports is understandable because of the difficulties of using written or verbal communication to ask the youngest children to present and describe their emotional reactions. For example, an association between children's level of understanding of the mind and their ability to report their own intrusive thoughts after a disaster has been found in children between five and eight years old (Sprung, 2008). Even though few original studies include reports from both parents' and children on the children's posttraumatic stress reactions, parent-child discrepancies have been found. Some studies have found that parents underreport children's posttraumatic distress after disasters or traffic accidents (Dyb, Holen, Brænne, Indredavik, & Aarseth, 2003; Handford et al., 1986; Jones & Ribbe, 1991; Nader, 2008; Reich & Earls, 1987; Yule & Williams, 1990), whereas a small study of infants found that parents overestimated some of their children's symptoms (Scheeringa, Peebles, Cook, & Zeanah, 2001). One study reported greater discrepancies between parents' and children's reports for younger children compared to older children (Dyb, et al., 2003).

There could be at least four reasons for the differences between the reports of parents and children in the present study. First, the assessment tools differed. The children's reports included 20 questions that assessed the 17 symptoms of intrusion, avoidance, numbing, and arousal, whereas the parents' reports included 30 questions that assessed these four factors as well as symptoms of dissociation and impairment in functioning. Second, the times of assessment differed. The parents' reports were given at six months post-tsunami, and the children's reports were given at 10 months and 2 ½ years after the disaster. It is surprising that the children's reports (conducted with a 20-month gap) were more closely related than the parental and child reports (conducted with a 4-month gap) were. However, several studies have found significant changes in levels of posttraumatic stress reactions between six and 12 months post-disaster (e.g., Piyasil, et al., 2007). Thus, significant changes could have occurred between the

parents' reports (at six months) and the children's reports (at 10 months). Third, parents may have had difficulty assessing their children's posttraumatic stress reactions. Mental health problems that are not apparent in children's behavior, including internalization of mental health problems, may be difficult to detect (Franks, 2011; Nader, 2008; Smith, et al., 2010). Thus, it may be more difficult for parents to assess children's intrusive symptoms than it is for them to assess symptoms of arousal. Intrusive symptoms are often not directly observable; unless the children verbalize their intrusive thoughts, dreams, or feelings, parents must interpret such symptoms through the children's play and other behaviors. Avoidance may be similarly difficult to assess because parents may not be aware that their children avoid thoughts, feelings, or activities that remind them of the disaster. The reminders of a disaster may vary significantly from person to person (Nader, 2008) and may differ by children's age (Pynoos, et al., 1995). Therefore, parents may not understand children's reactions to smells, sounds, or visions that evoke memories of the disaster. Children may also avoid disclosing their distress to their parents to protect their parents from discomfort (Yule & Williams, 1990), particularly if the parents themselves have uncomfortable posttraumatic stress reactions (Nader, 2008). Indeed, Norwegian children who experienced the tsunami often did not describe their worst experiences without being asked about them specifically (Hafstad, et al., 2011). Fourth, the parents' reports of their children may be influenced by the parents' own disaster experiences and coping mechanisms. Therefore, parents may report that their children are more similar to themselves than they actually are, which may also account for parents' reports of similarities in reactions between siblings despite self-reports suggesting that siblings did not experience similar reactions (Paper II versus Papers III and V). As stipulated in attribution and social cognition theories, one's own prior experiences are important to one's interpretation of the world (Fiske & Taylor, 1991; Janoff-Bulman, 1985); thus, parents include their own experiences and reactions during and after the disaster when interpreting their children's reactions. The degree to which parents base their understanding of their child on their own experiences differs depending on, for example, the parents' abilities to understand the child, the clarity of the signals given by the child, and the quality of the relationship between the child and the parent.

Thus, some of the relationships that were found between the children's and parents' levels of posttraumatic stress reactions at six months post-tsunami in Paper II may be related to

the use of parents' reports of children's posttraumatic stress reactions. Children's self-reports about their own posttraumatic stress reactions were found to be related to their parents' stress reactions 2 ½ years post-tsunami (Paper I). As found in other studies (see Introduction, chapter 1.3.4), the conclusion that parents' and children's levels of posttraumatic stress reactions are related seems valid. However, the lack of such a relationship at 10 months when controlling for other variables (Paper I) and the possible lack of validity of the assessment at six months makes it difficult to determine when and through what processes the relationship between the children's and parents' reactions was established.

Parents' reports at six months post-tsunami about their children's exposure were used in Papers I, II, III, and V. This procedure may have introduced a bias in which parents reported levels of exposure that were more closely related to their own interpretations and memories of the disaster experiences than what their children would have reported. The use of parents' reports of children's exposure may have led to an underreporting of the relation between exposure and the children's self-reported levels of posttraumatic stress reactions in Papers I and V. Additionally, the relationship between exposure and children's posttraumatic stress reactions as reported by parents in Paper II may be overestimated.

As is the case in most disaster research, the present study used retrospective assessments of pre-disaster characteristics, such as pre-disaster mental health, and event experiences, such as exposure and immediate subjective distress. The recollection of features assessed retrospectively in the present thesis may have changed over time. Even exposure, which is often called "objective exposure", in contrast to immediate subjective emotional distress, is not a static and exact report of what occurred during a disaster (Fivush, McDermott, Goldberg, Bahrick, & Parker, 2004; Heir, Piatigorsky, et al., 2009). For example, adults in the Norwegian tsunami research program changed their reports of perceived life threats from six to 24 months post-disaster, and increases in recalled threat intensity were related to a lack of improvement in PTSD symptoms (Heir, Piatigorsky, et al., 2009). This trend is one reason why we cannot draw conclusions about causal pathways between pre-disaster characteristics, event experiences, and posttraumatic stress reactions. Likewise, it is difficult to make conclusive statements about whether some of the relationships identified are due to the time at which features were assessed. For example, it is possible that the observed relationship between immediate subjective distress and posttraumatic stress reactions found in

Papers I and V is partly related to the simultaneous assessment of these variables. Such a relationship might not have been observed if immediate subjective distress had been assessed immediately after the tsunami.

Papers I, III, and V primarily relied on information from interviews, whereas Papers II and IV used information obtained via postal questionnaires. Although face-to-face interviews are often preferred (Nader, 2008), few studies have investigated the advantages and disadvantages of using interviews rather than questionnaires in studies of posttraumatic stress reactions in children, and these few studies are limited by the number of participants (Jones & Ribbe, 1991; Scheeringa, et al., 2001). However, research on assessments of other mental health problems in children indicates that interviews may ensure more valid assessments (Nader, 2008), partly because the interviewer can use follow-up questions to ensure that the participant has interpreted the questions as intended. Thus, it is possible that the interview data used in Papers I, III, and V more precisely measure posttraumatic stress reactions than do the questionnaire data of Papers II and IV. However, validation studies of adults indicate that even very short questionnaires may have high levels of sensitivity and specificity when screening for posttraumatic stress reactions (Brewin, 2005).

5.2.2 Internal consistency

An important aspect of a measure's reliability is the internal consistency between items grouped into one variable. The internal consistency has been represented in all papers as Cronbach's α. Cronbach's α increases as the number of items and the average correlation between items increase (Cronbach, 1951). A low Cronbach's α may suggest that the items do not measure a unidimensional concept and therefore should not be grouped together. The acceptable level of internal consistency as measured by Cronbach's α differs (Streiner, 2003); some studies define acceptable levels as above .7, while others define lower values as acceptable. Several measures in the present thesis had internal consistency below .7, such as the measures of exposure of children (.61 to .68), general mental health of children (.61 to .76), and family environment (.35 to .59). Thus, these clustered variables seem to assess broader concepts than does each separate question, and they may assess broader concepts than the name of the clustered variable indicates. For example, the sum variable of children's exposure measures both a multidimensional concept of possibly unrelated exposure experiences and dimensions outside of the concept, such as the

parents' ability to interpret and remember specific features of children's experiences. When interpreting internal consistency measures, it must be noted that perfect internal consistency between items is not the desired outcome. Perfect internal consistency would make it unnecessary to use more than one item and indicate that the items only measure one part of the broader theoretical concept.

In the present papers, for all clustered variables, items that were negatively correlated with other items were controlled. For clustered variables with low internal consistency, alternative ways of grouping were evaluated by exploratory factor analyses. The content of all items was also evaluated subjectively to assess whether they measured the same concept. Thus, although some concepts were measured by clustered variables consisting of items that were not highly correlated, we concluded that the internal consistency of the grouped items was high enough and that the construct validity good enough to be used to evaluate the desired concepts. However, it is possible that the two subscales measuring family environment in Paper I did not have adequate internal consistency. Their items may not have measured a clear and defined concept. The scales were included in the study due to the possible centrality of the family environment to children's recovery after disasters and the lack of more reliable measures of family environment.

5.2.3 Generalizability

When interpreting the results of the studies, it is important to identify the limits of generalizability to other populations. Are the present samples representative of the population from which they are drawn, and can the results from the present samples be used to draw conclusions about other populations?

The dropout analyses indicated that the children who were interviewed had greater levels of exposure to the tsunami than did the children who answered the first questionnaire. However, no indices of skewness were found in later dropout analyses of children (Papers I and V). Similarly, analyses indicated that adults who did not respond to the questionnaire at six months tended to have been in areas that were less affected by the tsunami than the responders' locations were (Hussain, et al., 2009). There was also a tendency for adults who only responded to one of the questionnaires (at six months or at two years) to have less serious experiences and posttraumatic stress reactions than did participants who responded to both assessments (Paper IV). These results

indicate that there was a tendency for people who had fewer trauma-related experiences to refuse participation in the study. This conclusion is supported by the findings that a failure to respond was related to a lack of relevant experiences among non-responding adults (Hussain, et al., 2009). In the present study, the loss of participants who experienced fewer potentially traumatizing experiences was not surprising. Anyone who arrived at Oslo Airport from airports in the tsunami-stricken area was invited to participate. Thus, people who did not personally experience the tsunami or any direct consequences of it were invited to participate. The dropping out of people who did not have potentially traumatizing experiences does not threaten the conclusions of the studies, and the participants seem to be representative of the Norwegian tourists who were exposed to the direct effects of the tsunami. On average, the participants had higher levels of education than the Norwegian population overall. Thus, care should be taken in generalizing the results of these studies to the population of Norway.

In volunteer studies, there is a tendency for self-selection bias, with females responding more often than men (e.g., Søgaard, Selmer, Bjertness, & Thelle, 2004). This trend was identified among adults in the present study (Paper IV). The interview study of children also included a larger proportion of girls than boys (Table 1). However, as indicated by the greater number of girls in the questionnaire study (which was completed by parents), more girls than boys may have been present as tourists in the area at the time of the tsunami.

An important question is whether the results from the present studies can be generalized to other populations that experience a disaster. Most studies after disasters evaluate the consequences for people who either continue to live in the disaster-stricken area or have to be evacuated away from their homes. As discussed in chapter 5.1.1, this may explain why Paper I found that Norwegian children had fewer posttraumatic stress reactions than reported in other studies of children who lived in tsunami-stricken areas. Few studies have provided insight on the consequences of such vast differences in secondary adversities. Even if the present sample of children had lower levels of posttraumatic stress reactions than did children in other samples, it is possible that the underlying mechanisms of posttraumatic stress reactions are the same across vastly different populations. The circumstances of the present sample are so different from the circumstances of people who live in the disaster-stricken areas or who were displaced that care should be taken when generalizing from the present study to other samples of disaster victims.

However, the lack of secondary adversities provided a unique opportunity to investigate posttraumatic stress reactions without the confounding features of secondary adversities.

The participants in the present thesis experienced a single acute and non-abusive disaster, and most of them were protected against long-term secondary stressors. Children who experience a single traumatic event have fewer symptoms than do children who experience chronic or abusive traumatic events, especially with respect to symptoms of avoidance/numbing and arousal (Fletcher, 2003). This result is in accordance with studies that find that children who experience multiple traumatic events have more symptoms than do children who experience one traumatic event (see Introduction, chapter 1.3.3). It is also possible that, in addition to the number and length of the traumas, interpersonal traumas have further or more serious consequences compared to natural disaster experiences. For example, a review study found that victims of mass violence had more severe levels of impairment than did victims of natural disasters (Norris, et al., 2002), and population-based studies have found that adult (Breslau et al., 1998; Creamer, et al., 2001; Resnick, Kilpatrick, Dansky, Saunders, & Best, 1993) and adolescent (Ford, et al., 2010) victims of assaultive violence have greater risks of PTSD than do victims of disasters or accidents. This result is in accordance with Janoff-Bulman's (1985) theory that victims of man-made traumatic events have more symptoms because they are "no longer able to feel secure in the world of other people" (p. 20). Their basic assumption of their own invulnerability has been shattered. It has been hypothesized that childhood posttraumatic stress reactions can be divided into two categories based on whether there is a single unanticipated event (Type I) or long-standing or repeated exposure to extreme external events (Type II) (Terr, 1991). The recent literature has used the concept of complex trauma to describe the multifaceted consequences for children who experience maltreatment, family violence, or the loss of their caregivers (Cook et al., 2005). Such experiences may have more serious consequences across multiple and broader domains, including attachment, biology, affect regulation, dissociation, behavioral control, cognition, and self-concept, than do single traumas. Thus, caution must be used when generalizing from studies of natural disaster victims to victims of chronic or abusive traumatic events.

Bereavement after disaster may also have more serious and longer-lasting consequences than single traumas do. In support of this hypothesis, children who lose family members have more posttraumatic stress reactions than non-bereaved disaster victims do (Bhushan & Kumar, 2007; Catani, et al., 2010; Gleser, et al., 1981; Goenjian, et al., 1995; Green, et al., 1994; Hsu, et al., 2002; Neuner, et al., 2006; Parvaresh & Bahramnezhad,

2009; Stoppelbein & Greening, 2000; Wickrama & Kaspar, 2007). Due to the small subsample of bereaved children in the present study and the possible differences between bereaved and non-bereaved individuals, care should be taken when applying the findings of the present study to groups of children or families who lose family members in a disaster.

5.2.4 Posttraumatic stress reactions versus PTSD

An important question is whether the findings in studies of posttraumatic stress reactions can be generalized to people with PTSD. Inherent in this question is the debate regarding the criteria for and diagnostic validity of diagnoses of PTSD in children. Here, criterion validity refers to the accuracy of assessing the threshold that must be reached for the diagnosis of PTSD to be made. Diagnostic validity refers to the current description of PTSD and its accuracy in describing clinically important symptoms after a trauma.

As in most diagnoses of mental health problems, the diagnosis of PTSD is dichotomous. Such a clear demarcation may be difficult in many mental illnesses, though surprisingly little literature has discussed the dichotomous definition of PTSD. Much discussion has focused on whether children should be evaluated using child-specific criteria rather than the criteria that are used for diagnosing adults (e.g., Scheeringa, Zeanah, Myers, & Putman, 2003). Additionally, there is ongoing debate about whether children can experience fewer symptoms and still fulfill the criteria for PTSD (APA, 2011a; Scheeringa, et al., 2003). It has also been debated whether impairment should be a criterion for diagnosis. A major difference between the DSM-III-R (APA, 1987) and the DSM-IV (APA, 1994) was that the former did not include a criterion that explicitly required impairment in functioning. The inclusion of this criterion decreased the number of people who fulfilled the criteria for the diagnosis of PTSD, for example, among American Vietnam War veterans (Dohrenwend et al., 2006; McNally, 2007). The use of the expression "partial PTSD" (Ketumarn, et al., 2009; McNally, 2007; Stein, Walker, Hazen, & Forde, 1997) has expanded the dichotomous definition of PTSD to include people who have clinically significant symptoms but do not fulfill all requirements for the full diagnosis of PTSD. However, this discussion often focuses on the distinction between people who fall within versus outside the definition of PTSD. Thus, there is a considerable lack of discussion on whether findings from research including participants with subclinical levels of symptoms can be generalized to populations with PTSD. The expression "spectrum PTSD illnesses" was used in a study that investigated posttraumatic stress reactions in preschool

children on a continuous scale (Linares & Cloitre, 2004). Unfortunately, the consequences of using this concept have not been extensively explored.

The question remains of whether the conclusions from studies of participants who do not fulfill all diagnostic requirements for PTSD can be generalized to people diagnosed with PTSD. The answer may be found among studies comparing samples with different levels of symptoms, such as studies of factor structure or etiological studies.

To our knowledge, no studies have investigated the difference in the factor structure of PTSD between samples with low and high levels of symptoms after experiencing the same disaster. However, one study found that the factor structure of posttraumatic stress reactions varied across adult samples with and without previous traumatic experiences (Elhai, Engdahl, et al., 2009). The results from another study indicate that the four-factor numbing model did not fit as well for a sample of adults who had experienced violent riots as it did for a sample of adults who had experienced an earthquake and who displayed higher levels of posttraumatic stress reactions (Wang, et al., in press). Two studies have found that adults with low levels of posttraumatic stress reactions have a different symptom configuration than do adults with higher levels of reactions (Breslau, Reboussin, Anthony, & Storr, 2005; Naifeh, et al., 2010). In Paper V, we identified a change in factor structure between the first and second interviews. We suggest that this change may be due to lower levels of posttraumatic stress reactions at the second interview. Thus, it is possible that differences exist in the factor structure of posttraumatic stress reactions between groups with low and high levels of distress.

Although many studies have evaluated the risk and protective factors for posttraumatic stress reactions, no studies directly assess differences between groups with high and low levels of symptoms. However, some hypotheses may be drawn from one longitudinal study of children whose symptom levels decreased over time. This study reported on risk factors related to the levels of symptoms at two or more time points (La Greca, et al., 1996; La Greca, et al., 1998). In this study of schoolchildren at three, seven, and 10 months after Hurricane Andrew, the authors found almost identical factors to be related to levels of posttraumatic stress reactions over time, even though the levels of distress declined. This result indicates that the components of risk and protective factors may be stable across different levels of posttraumatic stress reactions. However, in Paper I, we identified a change over time. Whereas factors related to the tsunami experience were

related to symptom levels at 10 months, pre-tsunami use of mental health services, parental health, and gender were related to levels of symptoms at 2 ½ years. It is impossible to determine why La Greca et al. found stability in risk factors across time while we found a change in risk factors over time related to levels of posttraumatic stress reactions. However, there may be stability in the factors related to posttraumatic stress reactions as long as children have significant levels of symptoms. When the children recover—for example, when the children display as few symptoms as seen in our study at follow-up—the factors related to their symptoms may change from disaster-related factors to factors related to general mental health.

It is unclear if the results from samples with posttraumatic stress reactions can be generalized to people who fulfill the criteria for PTSD, but research on subclinical levels of symptoms is nevertheless important. People who do not fulfill all requirements for PTSD may still have troublesome symptoms. Some symptoms may impair a child's quality of life even if the child does not fulfill all of the criteria for PTSD (Carrion, Weems, Ray, & Reiss, 2002). For example, difficulty falling or staying asleep may itself be detrimental to mental and somatic health. Thus, research on samples that do not fulfill all criteria for PTSD is clinically valuable.

5.3 Implications

5.3.1 Implications for clinicians

Most children do not have longitudinal and significant posttraumatic stress reactions after a single natural disaster if they are protected against other traumas and secondary adversities. However, many children require help in the first year after a disaster. Obtaining help is especially important for children who experienced extreme situations during a disaster and whose parents were seriously and negatively influenced by the disaster. Longitudinal vulnerability factors are also significant, such as children's previous mental health problems and parents' mental health problems in the aftermath of the disaster. Children who lose either a parent or a sibling may be especially vulnerable in both the short term and the long term. The low levels of longitudinal posttraumatic stress reactions in the present sample indicate the importance of minimizing secondary adversities in the aftermath of natural disasters.

Although it is often difficult to assess young children, the present study suggests that it is important to ask children about their own experiences and reactions whenever possible. Parents

may not be aware of their children's symptoms because of the internalization of several posttraumatic stress reactions, among other reasons.

Child siblings are often as different in their posttraumatic stress reactions as unrelated children are. Thus, children of the same family often require individually customized help. Because children's reactions are often related to their parents' reactions, it is important to incorporate parents into the treatment of each individual child and to ensure that parents receive appropriate help.

The similarities between the posttraumatic stress reactions of adult household members indicate that family-centered care and post-disaster intervention from an ecologically grounded perspective may be warranted to understand and treat adults with posttraumatic stress reactions.

The discussion of what constitutes PTSD continues, and it is important for clinicians to remember that there is a great degree of overlap between posttraumatic stress reactions and other mental health problems. This overlap can have two consequences: it may be difficult to correctly diagnose patients with symptoms that are common to many disorders, and patients may not obtain optimal treatment due to inaccurate diagnoses. It may be especially difficult to understand symptoms of hyperarousal long after the experience of a disaster; concentration problems, for example, may indicate posttraumatic stress reactions, general anxiety unrelated to the trauma, depression, hyperactivity, or general mental health problems not specified in the diagnostic manual. There may also be a real overlap between the problems, and patients with one health problem may also have other mental ailments. Because there are specific and efficient treatment methods for PTSD, such as trauma-focused cognitive behavior therapy or eye movement desensitization and reprocessing therapy, it is important to screen specifically for PTSD after known traumas in children with mental health problems.

5.3.2 Implications for future research

In contrast to many previous studies, the children in the present study were found to have low levels of posttraumatic stress reactions at 10 months and 2 ½ years after the tsunami disaster. We propose that these low levels result from the children's protection from secondary adversities and from exposure to a single, well-known traumatic event lacking associated interpersonal violence. This finding indicates that the traumatic event itself may not be the most important risk factor for longitudinal stress reactions in children after natural disasters; what occurs before

and, especially, after the trauma may be at least as important. However, there is a need for longitudinal disaster research that includes participants who were protected and participants who were not protected from secondary adversities.

The present study found a correlation between parents' and children's posttraumatic stress reactions after the disaster. However, we cannot identify the causal mechanisms that underlie this finding. Furthermore, the present study is one of the first studies to investigate differences in reactions between family members. Therefore, we do not know why siblings' posttraumatic stress reactions differ as much as randomly paired children's do whereas adults within the same household have more similar stress reactions than adults who do not live in the same household. Thus, there is a need for research on family processes that investigates how family members are influenced differently by disasters. How does the appraisal of the traumatic event change over time for fathers, mothers, adolescents, and younger children in families? Is there room for only one child with posttraumatic stress reactions in a family? If one sibling develops PTSD, will his/her sibling be more likely to develop similar symptoms? How do children and adults in a family influence each other? Is there a reciprocal process in which all members of a family influence each other? Are there differences between how fathers' and mothers' stress reactions relate to those of their children? How does communication about the disaster differ in families with young children versus families with adolescents?

It is important for studies after natural disasters to consider that multiple family members may have been exposed to the disaster. Mixed-effect models may provide valuable information and may account for the multileveled information.

Many studies that have investigated emotional reactions after a disaster have included participants with subclinical levels of posttraumatic stress reactions, including the present study. However, it is uncertain whether the findings from these samples can be generalized to clinical samples with PTSD. Thus, research that distinguishes the findings from samples of low versus high levels of posttraumatic stress reactions is needed.

As indicated by the short historical review at the beginning of this thesis, the concept of PTSD has a long history, and it is likely that the DSM-5 will not end the controversy over which symptoms constitute stress reactions after trauma. As indicated in Paper V, one continuing controversy is the overlap between posttraumatic stress reactions and other mental ailments.

Will the future diagnosis of PTSD be more or less restrictive? Should the diagnosis prioritize a more discriminant, valid, and narrow diagnosis, or should it include a broad spectrum of clinically important symptoms after traumatic experiences despite their overlap with other mental ailments? The current diagnosis is a compromise between the two objectives. More research is needed to define diagnostic criteria that better discriminate between diagnoses and, at the same time, do not exclude important clinical features of problematic posttraumatic stress reactions.

6 Conclusions

Compared to children in other studies after disasters, the children in the current study had low levels of posttraumatic stress reactions 10 months after the tsunami and even lower levels at 2 ½ years post-tsunami. This result may reflect the sample's experience of a single traumatic event that was not related to interpersonal violence, their protection from most secondary adversities, and the availability of necessary support. The findings indicate that the post-disaster environment is a fundamental factor in recovery after trauma.

The development of posttraumatic stress reactions in children shortly after the tsunami seems to be related to the severity of exposure and emotional reactions experienced during the disaster. Longitudinal posttraumatic stress reactions, as measured at 2 ½ years post-tsunami, seem to be more closely related to features of general mental health, such as prior need for mental health services, parents' posttraumatic stress reactions, experiencing the death of a family member, and being female.

Parents' and children's levels of posttraumatic stress reactions were found to be related. However, the causal mechanisms and underlying family processes that account for this relationship are unclear.

Parents reported that child siblings have more similar posttraumatic stress reactions than the self-reports of the siblings indicated.

Although the self-reported posttraumatic stress reactions of siblings were not significantly related, the posttraumatic stress reactions of adults within the same household were more similar than were those of randomly paired adults.

The 17 criteria for symptoms of PTSD as specified in the DSM-IV-TR may better represent the different aspects of posttraumatic stress reactions if they are clustered into the four factors of intrusion, avoidance, numbing, and arousal rather than the current three factors. This proposed format is similar to the clusters suggested in the new DSM-5.

Posttraumatic stress reactions and, especially, symptoms of arousal overlap considerably with general mental health problems in children.

Care should be taken when generalizing from the present study of survivors of a single natural disaster to victims of interpersonal or chronic trauma.

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I

II

III

IV

Family Structure and Posttraumatic Stress Reactions: A Longitudinal Study Using Multilevel Analyses

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Abstract

Background

There is limited research on the relevance of family structures to the development and maintenance of posttraumatic stress following disasters. We longitudinally studied the effects of marital and parental statuses on posttraumatic stress reactions after the 2004 Southeast Asian tsunami and whether persons in the same households had more shared stress reactions than others.

Method

The study included a tourist population of 641 Norwegian adult citizens, many of them from families with children. We measured posttraumatic stress symptoms with the Impact of Event Scale-Revised at 6 months and 2 years post-disaster. Analyses included multilevel methods with mixed effects models.

Results

Results showed that neither marital nor parental status was significantly related to posttraumatic stress. At both assessments, adults living in the same household reported levels of posttraumatic stress that were more similar to one another than adults who were not living together. Between households, disaster experiences were closely related to the variance in posttraumatic stress symptom levels at both assessments. Within households, however, disaster experiences were less related to the variance in symptom level at 2 years than at 6 months.

Conclusions

These results indicate that adult household members may influence one another's posttraumatic stress reactions as well as their interpretations of the disaster experiences over

time. Our findings suggest that multilevel methods may provide important information about family processes after disasters.

Keywords: family structure, multilevel analyses, posttraumatic stress reactions, PTSD, tsunami

Family Structure and Posttraumatic Stress Reactions: A Longitudinal Study Using Multilevel Analyses

Background

There has been increasing interest in the relevance of family factors to the development of posttraumatic stress disorder (PTSD). In particular, family functioning and intrafamily support have been considered important [1-7]. Singles may receive less family support than married persons due to lack of partner [8]. However, the impact of marital status on posttraumatic stress is ambiguous. Some studies have found married individuals to have less posttraumatic stress reactions than unmarried individuals [4, 9, 10], while others have found the opposite effect [11] or no relationship between the variables [12-14]. Whereas one study found that divorced, separated, or widowed adults are at higher risk for PTSD than people who are presently married [15], another study found that this risk disappeared when controlling for other sociodemographic factors and trauma categories [16].

Few post-disaster studies have examined the effect of parental status on the development of PTSD. Parenthood may influence the risk of developing posttraumatic stress reactions through processes occurring both in the acute disaster situation [17] and post-disaster. Such an effect would be in accordance with classical developmental theories of bidirectional processes between parents and children [18, 19] as well as with more contemporary developmental theories [20, 21]. However, whereas several studies have found parental factors to be related to children's development of PTSD after disasters [22-25], relatively few longitudinal studies have investigated how parents are influenced by their children's level of posttraumatic stress reactions, and these studies have yielded discrepant results [26-29]. Furthermore, few studies have investigated whether having children relates to levels of posttraumatic stress. Studies have found that parents had higher levels of

posttraumatic stress than nonparents after the Chernobyl disaster [30], after floods [8, 14], and after the 9/11 attacks [31]. The effect was particularly pronounced for single parents impacted by the 9/11 attacks [32]. However, other work suggest that parenthood or being in the company of children were not risk factors for posttraumatic stress reactions after the 2004 tsunami [10, 12].

An alternative method of investigating the relevance of family factors to posttraumatic stress reactions is by examining similarities in reactions within the family. We found only three studies that looked at the similarities of couples' reactions to disasters [14, 33, 34]. All three studies found general mental health or depression to be more similar within couples than for non-related adults but did not measure specific posttraumatic stress reactions. Two other studies found child siblings' posttraumatic stress reactions not to be more similar than other children's reactions [35, 36], thus it is unclear if family members do actually have more similar reactions after disaster than other disaster victims. If more than one person from a family is included in a study, the participants' responses are not independent of each other. Such grouping effects may influence results [37]; therefore, it has been suggested that disaster research should take grouping into account [38]. Multilevel analysis, including mixed effect models, is such a statistical method. It takes into account that some participants come from same subgroup, and thus for example analyze both the variability between individuals and between families [37]. However, very few disaster studies have taken into account the mutual experiences and shared reactions of families when analyzing predictors of posttraumatic stress reactions [10, 14, 39, 40]. Some resolve the problem by investigating only one participant from each household [7, 31] or by using sampling weights to correct for selection bias related to number of household members [32]. Others make no adjustments to account for participants from the same household [12, 33]. Thus, the question remains to what extent adult participants living in same household do have

more similar reactions than other participants, and thereby are not independent observations, and how such possible grouping effects should be taken into account. This is important because the assumption of independent observations is one of the basic assumptions in standard statistical analyses.

Present Study

This longitudinal study investigated posttraumatic stress reactions in Norwegian adults who experienced the tsunami as tourists in Southeast Asia on December 26, 2004. To our knowledge, this is the first longitudinal study of posttraumatic stress reactions to account for the multilevel effect of mutual households or families within the sample. We aimed to examine the relevance of family structures for adults' risk of posttraumatic stress reactions using two strategies: (1) by analyzing family structures as predictors for posttraumatic stress reactions and (2) by investigating possible similarities in reactions within families. The specific aims of the study were as follows:

- To investigate differences in posttraumatic stress reactions between married participants and non-married participants
- To investigate differences in posttraumatic stress reactions between parents and adults without children
- To investigate, via multilevel analyses, whether adults within shared households had more similar posttraumatic stress reactions than adults from different households

Methods

Procedure

Shortly after the 2004 tsunami in Southeast Asia, Norwegian nationals who were evacuated from the disaster-stricken area were registered upon arrival in Norway. A postal questionnaire was sent to all registered persons 18 years or older ($N = 2468$) at 6 (T_1) and 24

(T_2) months post-tsunami. The questionnaire at T_1 included questions concerning exposure, posttraumatic stress reactions, marital and parental status, and other background variables [41]. The questionnaire at T_2 included questions about posttraumatic stress reactions [42]. Participants with the same address were assumed to be living in a common household. The study was approved by the Norwegian Social Science Data Services and The Regional Committee for Medical Research Ethics.

Participants

While 868 and 1170 responded at T_1 or T_2 respectively, we received questionnaires for both T_1 and T_2 from 657 respondents. Five of these were excluded due to high levels of missing data on measures of posttraumatic stress reactions, and eleven more were excluded due to missing addresses. Therefore, the final sample included 641 participants.

At T_1, 61.8% of the participants had more than 12 years of education, and 75.5% were employed. There were multiple participants from the same household in 221 cases (35.5%). A total of 48.4% of the participants reported that they had traveled with a spouse or cohabitating partner, and 48.4% of the participants reported that they had traveled with their children, stepchildren or foster children. A total of 247 (38.5%) participants reported having children under the age of 18 years at T_1; 240 participants (40.7%) reported to have responsibility for a child at time of the disaster, including 25 (4.2%) who had sole responsibility; and 310 (48.4%) reported to have traveled together with their own child, stepchild or foster child. At T_1, 70.5% were married or cohabitating, 9.4% were no longer married and 20.1% were single. A total of 50 participants changed marital status from T_1 to T_2, 27 of which were no longer married or cohabitating, and 23 participants became married/cohabiter. More descriptive information about the participants is included in Table 1.

Table 1 about here

Non-responders at T_1 were more likely than responders to have resided in less severely affected locations in Southeast Asia [41] and were more often men; however, they were similar in age to responders [43]. The most frequently reported reasons for not participating were lack of interest or time, followed by lack of relevant experiences [44]. The final sample did not differ from responders who were excluded from the analyses in family features (marital status, proportion who had children at T_1, or proportion of participants from same household) or posttraumatic stress reactions at T_1. However, the excluded responders reported a lower average level of posttraumatic stress reactions at T_2 than the analyzed sample ($M_{excluded} = 0.85$, $M_{included} = 1.05$, $t(1396) = 2.89$, $p = .004$).

Measures

Exposure and immediate response to the disaster. Based on earlier work [45], questions regarding a broad spectrum of tsunami experiences were assessed in the questionnaire 6-months post-tsunami. Based on earlier evaluations of the exposure experiences as risk factors [41], four questions were included in the present study to measure exposure: whether a participant had witnessed multiple dead bodies, had witnessed abandoned children, had been caught, touched or chased by waves, or had experienced the death of a family member or friend. Each question was answered *no* (0) or *yes* (1). Two questions were used to assess immediate subjective response to the disaster: fear, and feelings of helplessness, with both items rated on a five-point scale (0 = *not at all*, 1 = *little*, 2 = *moderate*, 3 = *intense*, 4 = *extreme*). These two items represented immediate response to the disaster, corresponding to the A2 criterion for PTSD from the DSM-IV [46].

Posttraumatic stress reactions. The Impact of Event Scale – Revised (IES−R) [47] was included at both assessments to measure the level of posttraumatic stress reactions during the previous two weeks. The IES−R includes 22 items with five response alternatives (0 = *not at all*, 1 = *little*, 2 = *moderately*, 3 = *quite a bit*, 4 = *extremely*). Total mean scores were based on all items. The psychometric properties of the IES−R have been extensively evaluated and deemed acceptable, with internal consistency within subscales reported to be between .81 and .91, test-retest reliability to be between .52 and .86, and correlation with other measures of posttraumatic stress reactions to be between .53 and .57 [48]. Similar acceptable measures or reliability have been found in a Norwegian non-clinical sample [49]. The internal consistency was high in the present sample (Cronbach's α = .96 and .95 at T_1 and T_2, respectively).

Data Analysis

We excluded participants who were missing more than four replies to questions about posttraumatic stress reactions. For the remaining participants, missing values for these variables were replaced using expectation maximization algorithms (EM algorithms), which took into account a participant's scores on items within the same symptom cluster, the scores of the other respondents, and the correlations between items [50]. Dropout analyses were done using χ^2-tests for categorical data and student t-tests for continuous data.

Chi-square tests were used for bivariate analyses of grouped variables. The effects of marital status and parental status on posttraumatic stress reactions were first tested with univariate mixed effects models adjusted for exposure and immediate subjective distress during the disaster. The effect of single parenthood was tested with a mixed effects model with both marital status and parental status as independent variables and adjusted for exposure and immediate subjective distress during the disaster. The effect of household was tested with mixed effects models, first with an unadjusted model without predictors and next with a model adjusted for exposure and immediate subjective distress during the disaster. In

this way, all models controlled for participants who lived in the same household. This multilevel approach means that the regression model has error terms at two levels, the individual level and the household level.

Similarity between household members is presented by intra-class correlations (ICC). ICC was calculated by dividing unexplained variance between households by the sum of unexplained variance between households and between individuals within same household. ICC can vary between 0 and 1. An ICC close to 0 indicates that household members are no more similar than other participants, whereas an ICC of 1 indicates that household members have identical responses. Confidence intervals for ICC were based on parametric bootstrapping and computed as bootstrap percentile intervals using 10,000 bootstrap replications. Bootstrapping is a general procedure that e.g. makes it possible to compute confidence intervals in cases where other methods are not easily available [51].

All tests were two-tailed, with a significance level of $p \leq .05$. Statistical analyses were performed using PASW Statistics, version 18, and R, version 2.10.1, with packages nlme and boot.

Results

Marital Status and Parenthood

Marital status at T_1 was not related to the level of posttraumatic stress reactions at T_1 or at T_2. The mean values (*SD*) of IES−R at T_1 and T_2, respectively, were 1.1 (0.8) and 1.0 (0.8) for married/cohabiters, 1.1 (0.8) and 1.1 (1.0) for single persons who had been previously married, and 1.1 (0.9) and 1.0 (0.8) for single persons who had not been previously married, corresponding to an average response close to *little* on the 0 – 4 scale ($F(2, 515.2) = 0.02$, $p = .98$ at T_1 and $F(2, 512.5) = 1.74$, $p = .18$ at T_2).

Furthermore, parents at T_1 did not differ from non-parents in their level of posttraumatic stress reactions at T_1 or at T_2. The mean values (*SD*) of IES−R at T_1 and T_2, respectively, were 1.2 (0.9) and 1.1 (0.8) for non-parents and 1.1 (0.8) and 1.0 (0.8) for parents ($t(503.8) = 1.77$, $p = .08$, b(95% CI) = 0.10 (-0.01, 0.22) at T_1 and $t(469.4) = 0.91$, $p = .36$, b(95% CI) = -0.06 (-0.07, 0.18) at T_2).

To examine whether posttraumatic stress reactions differed between single parents and couples with children, marital status (single versus couple) and parenthood (having a child versus not having a child) were entered simultaneously into mixed effects models. No significant main effects or interaction effects on posttraumatic stress reactions were found at either of the two study times.

Further analyses were conducted to investigate whether parents and non-parents differed in their exposure or immediate emotional reactions during the tsunami. Compared to non-parents, parents did not witness more abandoned children, were not taken more often by the waves, and did not feel more helplessness during the tsunami. However, parents were less likely to have witnessed multiple dead bodies ($\chi^2(1, N = 587) = 5.38$, $p = .02$), were more likely to have lost family or friends in the tsunami ($\chi^2(1, N = 641) = 8.97$, $p = .003$), and felt more fear during the tsunami (t(505.2) = 2.39, p = .02, b(95% CI) = 0.28 (0.05, 0.52)).

Mutual Household

At both time points, adults from the same household reported more similar levels of posttraumatic stress reactions than adults from different households. The unadjusted intra-class correlation (ICC) for posttraumatic stress reactions in the mixed effects model was .53 at T_1 and .47 at T_2 (Table 2). The confidence intervals for ICC at both times were sufficiently far from zero to indicate a considerable effect of mutual household. To examine whether similarities between members of the same household could be due to a greater number of shared experiences during the tsunami, we performed mixed effects models adjusted for

exposure and immediate emotional responses. Similar results were found, with ICC of .56 and .35 at T_1 and T_2, respectively (Table 2).

Table 2 about here

The decrease in unadjusted and adjusted ICC from T_1 to T_2 was not significant. However, the decrease in adjusted ICC was close to significant (Table 2). This decrease was related to changes in how much tsunami experiences explained variance in posttraumatic stress reactions between individuals within families. Taking into account the disaster experiences, the unexplained variances at T_1 were reduced both at the individual level (36.0%) and at the household level (44.8%). At T_2, unexplained variance between households had decreased (48.4%), whereas unexplained variance between individuals within the same household had decreased less when taking into account the disaster experiences (9.0%) (Table 2). Thus, tsunami experiences were still related to posttraumatic stress reactions of families at T_2, but not as much to the reactions of individuals within families.

Discussion

In the present study, neither marital status nor parental status was related to the level of posttraumatic stress. Adults living in the same household had more similar levels of posttraumatic stress than adults not living together. The association between household members with regard to posttraumatic stress did not change from T_1 to T_2. Disaster experiences were associated with posttraumatic stress of individuals within families at T_1, but there was almost no such association at T_2. Thus, the impact of each family member's original disaster experiences on the level of posttraumatic stress decreased over time.

Neither single nor married parents had higher levels of posttraumatic stress reactions than adults without children. This is in accordance with findings in a similar study of Swedish tourists during the tsunami [10] and a study of Sri Lankan adults who were displaced after the tsunami [12]. However, other studies have found parenthood to be related to higher levels of reactions after a nuclear accident [30], floods [8, 14], and the 9/11 attack [31]. One possible reason for the discrepant findings is that our study, like the Swedish tsunami study, examined disaster survivors who were repatriated to stable home societies; thus, parents had fewer post-tsunami worries about their children's wellbeing and future. The fact that parents experienced both more fear than nonparents and were less likely to have witnessed dead bodies may have influenced our results as well. While the parents may have been more anxious because they worried about the wellbeing of their children, they may also have protected their children and thus also themselves from witness experiences. Thus, the findings indicate that it is possible that having children may both be related to factors enhancing and factors decreasing the risk of posttraumatic stress reactions [17], with such effects possibly nullifying each other.

Marital status was not related to an elevated or reduced level of posttraumatic stress reactions. However, adults living in the same household had more similar levels of posttraumatic stress reactions than adults not living in the same household, with ICC indicating that approximately half of the variation in posttraumatic stress reactions was related to differences between adults within the same household. This is consistent with theories indicating that humans in relationships influence each other and often have converging interpretations of mutual experiences [52-54]. In most natural disasters, all members of a family are exposed, and in most instances, the members of the family live together after the disaster. Therefore, not only do family members have more resemblance in their disaster experiences than unrelated people, but they will also influence each other's recollections, interpretations and post-disaster reactions. However, child siblings have been

found to have unrelated posttraumatic stress reactions, both in the same population as the present sample and after common disaster experiences during an earthquake [35, 36]. It is unclear why adult family members' reactions should be more similar than the reactions of child siblings. The difference between couples and child siblings may be age related and/or role related. Children are developmentally different from adults in how they are aware of their surroundings and their internal experiences [55]. It is also possible that couples communicate more and listen more to each other about the traumatic event and later reactions than siblings because of their cooperating role, especially their parental role. Whereas siblings may actively disagree, parents may seek cooperation and converging interpretation with their partner and co-caregiver.

We did not find any increase in household concordance of posttraumatic stress reactions from T_1 to T_2. This indicates that most of the family converging processes happened within six months of the disaster. However, the experiences during the disaster were less related to the posttraumatic stress reactions of the individuals within households at follow up than at the first assessment. These results indicate that family members influence each other's interpretations of the disaster over time. Thus, individual differences in interpretation of and reaction to the disaster diminish over time. The results thus indicate that over time, an individual's posttraumatic stress reactions may be influenced more by family members' interpretations and memories of the trauma than by actual exposure during the disaster.

Methodological Considerations

This study had some methodological advantages. Almost all Norwegians who were tourists in the disaster area were invited to participate, reducing sample selection bias. The participants experienced a single, easily identifiable trauma and were largely protected from secondary adversities because they were able to quickly return to unaffected home

communities. The tsunami-related processes between the persons in the household should therefore be less influenced by processes outside the household.

There was a relatively low response rate. However, due to the directionality of the dropout bias, the included participants seem to represent most of the heavily exposed Norwegian tourists in the tsunami-stricken areas [44].

The information was gathered by the use of postal questionnaires. Thus, participants from same household may have interacted during the filling out process. This may have influenced the results.

The present article has evaluated marital status at first assessment as a risk factor for later posttraumatic stress reactions. Additional analyses indicated that change in marital status was not related to level of posttraumatic stress reactions (results not shown). Additional analyses (not shown) did also find that neither traveling with children nor having responsibility for children during the tsunami were related to level of posttraumatic stress reactions.

Conclusions

Adults living in the same household reported similar posttraumatic stress reactions. In addition, family members' interpretations of the disaster seemed to merge over time. This may be positive if the family moves in a favorable direction, but it indicates that for individuals who are not improving from posttraumatic stress reactions, it is important to investigate how their family interprets and perhaps contributes to the non-improving mental health. This study emphasizes the importance of a family-centered care that takes on an ecological grounded perspective when treating adults with posttraumatic stress reactions after common disaster experiences.

Methods of analysis that take into account the grouping of stress reactions within households provided valuable information about possible family processes. The study thus supports the importance of taking group levels into account when analyzing and discussing findings from studies including more than one participant from same household [38].

Competing interests

The authors declare that they have no competing interests

Authors contributions

EN performed the statistical analysis and drafted the manuscript. TWL performed the statistical analysis and was involved in the revision of the manuscript. AH collected data and revised the manuscript. TH participated in the conception, design, and revision of the manuscript and was the general supervisor for the project. All authors read and approved the final manuscript.

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Table 1

Descriptive Statistics of the Major Study Variables (N = 641)

Variable	*n (%) / M (SD)*
Number of participants from household at T_1	
One	420 (65.5%)
Two	196 (30.6%)
Three	21 (3.3%)
Four	4 (0.6%)
Mean age at time of tsunami (*SD*)	43.4 (12.9)
Sex	
Men	288 (44.9%)
Women	353 (55.1%)
Marital status at T_1	
Married or cohabitating	434 (70.5%)
Divorced, separated, or widowed	58 (9.4%)
Single	124 (20.1%)
Missing	25
Had children under 18 years of age at T_1	
No	394 (61.5%)
Yes	247 (38.5%)
Witnessed abandoned children	
No	415 (70.2%)
Yes	176 (29.8%)
Missing	50

Witnessed multiple dead bodies	
No	463 (78.9%)
Yes	124 (21.1%)
Missing	54
Caught, touched or chased by waves	
No	404 (64.0%)
Yes	227 (36.0%)
Missing	10
Death of family member or friend	
No	585 (91.3%)
Yes	56 (8.7%)
Mean immediate response of fear during tsunami (*SD*)	2.5 (1.4) [a]
Mean immediate response of helplessness during tsunami (*SD*)	2.6 (1.4) [b]
Mean posttraumatic stress reactions at T_1 (*SD*)	1.1 (0.8)
Mean posttraumatic stress reactions at T_2 (*SD*)	1.0 (0.8)

[a] $n = 596$. [b] $n = 597$.

Table 2

Intra-class Correlations for Posttraumatic Stress Reactions, with and without Adjustments for Predictors at 6 (T_1) and 24 (T_2) Months Post-tsunami, and Differences between These Times

	Without adjusting for predictors (95% CI)[a]			*Adjusting for predictors (95% CI)*[b]		
	T_1	T_2	Difference (T_2-T_1)	T_1	T_2	Difference (T_2-T_1)
Unexplained variance between households	0.38	0.33	-0.05	0.23	0.17	-0.06
Unexplained variance between individuals within households	0.33	0.37	0.04	0.18	0.32	0.14
Intra-class correlation	.53 (.36, .62)	.47 (.45, .68)	-.06 (-.24, .10)	.56 (.42, .69)	.35 (.17, .52)	-.21 (-.43, .005)
Change in unexplained variance between				-44.8%	-48.4%	

households when including predictors		
Change in unexplained variance between individuals within households when including predictors	-36.0%	-9.0%
Total change in unexplained variance when including predictors	-41.3%	-28.2%

Note. Adjustment for mutual household is done by mixed method with mutual household as intercept. Dependent variable is mean posttraumatic stress reactions (IES). Intra-class correlation (ICC) is defined as the proportion of unexplained variance that is between groups (possible range 0–1). It is calculated as unexplained variance between households divided by the sum of unexplained variance between and within households. Predictors controlled for include witnessed abandoned children, witnessed multiple dead bodies, caught or chased by waves, death of family member or friend, immediate response of fear, and immediate response of helplessness.

Difference (T_2-T_1) is the difference between the two assessment points in unexplained variance and intra-class correlation.

Change in variance in analyses adjusted for predictors is the change in unexplained variance when taking into account the predictors in percentage of unexplained variance before taking into account any predictors. The percentages are different from what can be calculated from the first part of the table because the change in unexplained variance is based on models excluding participants with missing data on predictor variables (N = 550).

[a] N = 641. [b] N = 550.

Running head: FACTORS OF PTSD IN CHILDREN: A LONGITUDINAL STUDY

Stability of Posttraumatic Stress Reaction Factors and Their Relation to General Mental Health Problems in Children: A Longitudinal Study

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Abstract

The aim of this study was to evaluate the structure of posttraumatic stress reaction factors and their relation to general mental health problems in Norwegian children exposed to the tsunami on December 26, 2004. A total of 133 children were interviewed 10 months post-tsunami using the UCLA PTSD Reaction Index, and 104 were interviewed again 2.5 years after the tsunami. Confirmatory factor analyses supported the theory of a four-factor model of intrusion, active avoidance, numbing, and arousal as a better division than the three-factor model in the present diagnose. The factors of intrusion and active avoidance were highly correlated 2.5 years post-tsunami. This may be due to nonspecificity in these trauma related factors as posttraumatic stress reaction levels diminish over time. General mental health problems were highly related to arousal at both assessments, supporting the theory that some symptoms of posttraumatic stress reactions overlap with other, concurrent mental problems.

Keywords: children, factor structure, posttraumatic stress reactions, PTSD, general mental health, tsunami

Stability of Posttraumatic Stress Reaction Factors and Their Relation to General Mental Health Problems in Children: A Longitudinal Study

Most research on posttraumatic stress disorder (PTSD) in children has focused on increasing our understanding of what contributes to the development and maintenance of PTSD, as defined in the present diagnostic and statistical manual of mental disorders (DSM-IV) (APA, 2000). However, a number of studies have raised concerns that the current definition of PTSD does not adequately describe important elements of the concept (Anthony, Lonigan, & Hecht, 1999; Kassam-Adams, Marsac, & Cirilli, 2010; Spitzer, First, & Wakefield, 2007). In addition, results from studies of child trauma victims strongly suggest that child reactions may differ in important ways from adult reactions (Carrion, Weems, Ray, & Reiss, 2002; Fletcher, 2003; Scheeringa, Zeanah, Myers, & Putman, 2003). Therefore, many researchers welcome the debate about how to define PTSD in the forthcoming DSM-5.

In the DSM-IV, PTSD refers to a set of 17 symptoms that develop after exposure to an unusually severe stressor or event. Three symptom clusters are defined: intrusion (e.g., flashbacks, nightmares), avoidance/numbing (e.g., trying not to talk about the event, restricted range of affect), and hyper-arousal (e.g., difficulty concentrating, exaggerated startle response). The current clustering of symptoms is a major concern in the ongoing debate about how to redefine PTSD. How well do the clusters differentiate between features of posttraumatic stress? More specifically, questions have been raised about whether actively avoiding stimuli associated with the trauma is part of the same PTSD features as other symptoms (e.g., intrusion or numbing) or whether active avoidance should be viewed as a separate cluster (Anthony et al., 1999; King, Leskin, King, & Weathers, 1998; Saul, Grant, & Carter, 2008).

Most studies of post-trauma stress reactions have been conducted on adult survivors of trauma. Although children demonstrate many of the same PTSD reactions as adults (Fletcher,

2003), there are developmentally related differences (Salmon & Bryant, 2002). However, studies of childhood PTSD have so far been diverse and non-conclusive. For instance, differences have been reported in factor structure between younger and older adolescents (Saul et al., 2008), while others have found the same factor structure across age groups (Anthony et al., 1999). Another debate about diagnostic validity has been whether different diagnostic criteria are needed for children of different age groups (Carrion et al., 2002). Scheeringa and colleagues (e.g., Scheeringa et al., 2003) have argued for the need to have specific criteria for preschool children. Others have found that todays diagnostic criteria may be too rigid for children (Carrion et al., 2002; Lonigan, Anthony, & Shannon, 1998). This indicates the need for more studies not only on adults, but also on children.

A literature search revealed 29 studies of PTSD's factor structure in children or adolescents, of which 12 used confirmatory methods, 13 used exploratory methods, and four used a combination of methods (an overview of the studies is available at request). All studies comparing the present DSM-IV three-factor model to other models find that alternative ways of clustering symptoms are just as well or better suited than the three-factor model in DSM-IV (Anthony et al., 1999; Elhai, Ford, Ruggiero, & Christopher Frueh, 2009; Ford, Elhai, Ruggiero, & Frueh, 2009; Hukkelberg & Jensen, in press; Kassam-Adams et al., 2010; Saul et al., 2008; Stewart et al., 2004). Whereas, absence of confirmatory comparisons of alternative models are a methodological shortcoming in most factor studies confirming the validity of the DSM-IV model (Bal & Jensen, 2007; Bean, Derluyn, Eureling-Bontekoe, Broekaert, & Spinhoven, 2006; Foy, Wood, King, King, & Resnick, 1997; Hamada, Kameoka, Yanagida, & Chemtob, 2003; Wu, Chan, Hung, & Cho, 2008).

The most comprehensive study of PTSD diagnostic models in children was presented by Anthony et al. (1999). They found that an alternative three-factor model of intrusion/active avoidance, numbing, and arousal provided the best fit for their data related to

PTSD in 5,664 children exposed to Hurricane Hugo. These findings were replicated in a study of 396 children who experienced hurricanes (Anthony et al., 2005). However, Anthony's conclusions have been challenged by more recent studies of a four-factor model that separates active avoidance from numbing (hereafter called the numbing model). This four-factor model of intrusion, active avoidance, numbing and arousal has gained support from several studies (Ford et al., 2009; Kassam-Adams et al., 2010; Saul et al., 2008; Stewart et al., 2004).

Another concern in the debate about how to define PTSD is the high comorbidity between PTSD and other mental health problems. Some features of PTSD may represent a nonspecific syndrome of psychiatric distress rather than a distinct syndrome linked to trauma exposure (Spitzer et al., 2007). For instance, recurrent and intrusive distressing recollections of the traumatic event relates more directly to the traumatic incident. In fact, some studies of children exposed to a range of possibly traumatic events have found the magnitude of the traumatic experience to be more related to symptoms of intrusion than to other PTSD symptoms (Dyregrov, Kuterovac, & Barath, 1996; Giannopoulou et al., 2006; Lonigan, Shannon, Taylor, Finch, & Salle, 1994; Najarian, Goenjian, Pelcovitz, Mandel, & Najarian, 1996). Other studies support the notion that PTSD measures nonspecific psychopathology. Some have found that symptoms of arousal are difficult to distinguish from anxiety and depression (Kolaitis et al., 2003; Lonigan et al., 1994) and others that symptoms of both intrusion and arousal are closely related to depression and general mental health problems (Goenjian et al., 1995; Kassam-Adams et al., 2010). Therefore, it has been suggested that symptom criteria that are less trauma-specific should be removed from the DSM diagnosis (Ford et al., 2009; Spitzer et al., 2007). Spitzer et al. (2007), for instance, suggest removing some of the numbing and arousal criteria that overlap with major depression and general anxiety disorder (e.g., loss of interest, difficulty sleeping, irritability, and concentration

problems) in addition to one item thought to have questionable clinical validity ("Inability to recall an important aspect of the trauma"). This suggestion is supported by findings in a study by Ford et al. (2009). Others have suggested a dysphoria model, with a separate factor that includes numbing and arousal criteria that are related to depression and general anxiety in both adults (Simms, Watson, & Doebbelling, 2002) and children (Elhai, Ford, et al., 2009; Hukkelberg & Jensen, in press; Kassam-Adams et al., 2010). In conclusion, some posttraumatic stress reaction symptoms, particularly within the increased arousal factor, may substantially overlap with other psychiatric disorders, such as depression, anxiety, and general mental health problems. Such nonspecificity may decrease the criteria's validity and their ability to help clinicians to select proper treatment (Spitzer et al., 2007).

Because most studies have found that the level of posttrauma reactions diminish over time (Kronenberg et al., 2010; Silverman & La Greca, 2002), it may be reasonable to assume that the structure of reactions may also change over time, warranting studies that assess such changes. However, to our knowledge, no studies have investigated whether the factor structure of posttraumatic stress reactions in children is stable over time. In addition, clusters of symptoms may relate to trauma exposure and nonspecific psychopathology differently in the immediate aftermath of the traumatic event than in later, recovery phases. The lack of knowledge about these issues may result in incorrect diagnosis and suboptimal treatment of children with posttraumatic stress reactions. Therefore, there is a need for additional research, particularly longitudinal studies, examining the expression of posttraumatic distress.

Present Study: Context and Aims

The tsunami in Southeast Asia on December 26, 2004 was the deadliest in recorded history, with a death toll of approximately 230,000 people (NGDC, 2010). It is estimated that 4,000 Norwegian citizens were in the affected areas during the tsunami, most of them as tourists on Christmas vacation. The Norwegian death toll included 58 adults and 26 children.

The surviving Norwegian children and families were evacuated back to their homes and communities soon after the disaster. This situation thereby provides a unique vantage point for assessing the effects of trauma after a disaster when the post-disaster environment included a minimum of secondary stressors.

After the tsunami, the Norwegian authorities initiated a research program that included the present study. One of the main findings was that the Norwegian children had relatively low levels of posttraumatic stress reactions, possibly because the secondary stressors that normally play an important role in maintaining posttrauma reactions were minimal (Jensen, Dyb, & Nygaard, 2009). The level of stress reactions also decreased over time. While the initial levels of posttraumatic stress reactions were related to the magnitude of the trauma experiences, the traumatic stress reactions measured 2.5 years after the disaster were more clearly related to the children's prior mental health problems. This interesting shift in what seemed to be important predictors for recovery from posttraumatic stress symptoms led us to examine how children's trauma experiences and general mental health problems may be involved in posttrauma functioning and how children's symptom patterns may change over time.

The aim of the study was twofold. The first aim was to compare the factor structure of posttraumatic stress reactions as defined by the DSM-IV to two other models in a longitudinal perspective. The two alternative models used were those found to be most relevant from the review of studies of children. These were a three-factor model of intrusion/active avoidance, numbing, and arousal (Anthony et al., 1999), and a four-factor model of intrusion, active avoidance, numbing, and arousal (numbing model). The alternative models were expected to be superior to the DSM-IV model. However, we did not have any preconceptions as to which one of the alternative models would be best and whether there would be differences over time.

The second aim of the study was to understand more about the relationship between factors of posttraumatic stress reactions, the levels of trauma exposure, and general mental health problems. Do some criteria measure specific trauma related reactions, while other criteria are nonspecific and measure general mental health problems? We hypothesized that intrusion and active avoidance symptoms would be more closely related to the magnitude of the trauma experiences than numbing and arousal, and that numbing and arousal would be more related to earlier or concurrent general mental health problems.

Method

Participants

This longitudinal study recruited children and their parents who responded to a questionnaire study conducted 6 to 8 months after the tsunami (Dyb, Jensen, & Nygaard, in press). The questionnaire was sent to parents traveling with children aged 6 to 17 years who arrived at Oslo International Airport from one of the tsunami-affected countries in the first days after the disaster (N = 781 children).

The children and a parent were interviewed 10 to 11 months (T_1) and 2.5 years (T_2) after the tsunami. Eighty-seven parents and 142 children participated at T_1, and 68 parents and 107 children participated at T_2. Five of the children were excluded from the analyses due to extensive missing information about posttraumatic stress reactions, and four were excluded because they did not fulfill the exposure requirements for PTSD (diagnostic criteria A1 and A2). Hence, 133 and 104 (78.2%) children were available for analyses at T_1 and T_2, respectively. The mean age at T_1 was 12.9 years (SD = 3.4) (range 6.5 to 17.5 years), and there were 72 (54.1%) girls and 61 (45.9%) boys. There was no significant age difference between genders. In 41 families, only one child participated in the study; in 35 families, two children participated; in six families, three children participated; and in one family, four children participated. Of the 84 parents participating in the interviews at T_1, 75% were

mothers. Parents reported that, on average, the children were exposed to more than three of 10 exposure variables (Table 1). Most children had been in an area exposed to the tsunami (99%), had been in physical danger because of the wave (65%), or witnessed the physical injuries of others (59%). Four children (3%) had friends who died in the tsunami, and four children (3%) had family members who died. Most of the children reported that they experienced the tsunami as very frightening, with a mean above five on the nine items that asked about immediate subjective distress (Table 1). Many of the children reported that this was one of the most frightening experiences they had ever had (83%), that they were afraid that friends or someone in their family would die (77%), or that they were afraid that friends or someone in their family would get seriously injured (71%). Even though the children had high levels of exposure and immediate subjective distress (Table 1), only two children had scores of posttraumatic stress reactions above clinical cutoff indicative of PTSD at T_1, , and none did at T_2. The children reported on average no more general mental health problems than what has been found in a population-based study of adolescents in Norway (Table 1 and Van Roy, Grøholt, Heyerdahl, & Clench-Aas, 2006). Analyses of the dropout group compared to participants at T_2 revealed no significant differences in age, gender, exposure, immediate subjective distress, general mental health problems or total level of posttraumatic stress reactions at T_1.

Table 1 about here

Procedure

At 10 to 11 months after the tsunami (T_1) and 2.5 years after the tsunami (T_2), the children were interviewed face-to-face and alone in their homes. The interviews were semistructured and conducted by psychologists, psychiatrists, and educators trained and

supervised by a doctoral-level psychologist. Children answered questions about their immediate subjective distress at T_1 and about their general mental health and posttraumatic stress reactions at both T_1 and T_2. Information about the children's exposure and background was gathered from the parents in a questionnaire study conducted 6 to 8 months post-tsunami. The Norwegian Regional Ethical Committee approved the study. All parents and children signed a written consent form. More comprehensive information about the study population has been previously published (Jensen et al., 2009).

Measures

Tsunami exposure. An exposure scale was developed based on information about the critical events experienced during the tsunami. The scale included the following 10 items: present in the area where the tsunami hit; in physical danger because of the wave; caught by the water; physically injured; separated from parents; witnessed injuries of others; exposed to dead bodies; exposed to other dangers; suffered from lack of water, food, or medication; and death of a close friend during the tsunami. All items were rated as yes or no (yes = 1 and no = 0). The 10 exposure items were added to produce a total score of objective exposure (possible range = 1–10) (Table 1).

Immediate subjective distress and posttraumatic stress reactions. Children's immediate subjective distress was systematically evaluated using nine items from the first portion of the University of California, Los Angeles PTSD Reaction Index (PTSD-RI) (Pynoos, Rodriguez, Steinberg, Stuber, & Frederick, 1998; Steinberg, Brymer, Decker, & Pynoos, 2004). These items examine life threat (e.g., the children's fear that they would die) and emotional reactions experienced during or immediately after the tsunami (e.g., the feeling that this was one of the most frightening experiences they had ever had). The replies were scored as present or absent and were added to produce a total score of immediate subjective

distress (possible range = 1–9). Further, the immediate subjective distress items displayed an acceptable level of internal consistency (Table 1).

The second part of the PTSD-RI is a self-reported 20-item scale assessing posttraumatic stress reactions in the past month. Responses are recorded on a 5-point Likert scale ranging from 0 (*none of the time*) to 4 (*most of the time*). Three of the items have two alternative formulations, with the higher frequency scores used to calculate the total score. Hence, 17 scores (corresponding to the 17 DSM–IV PTSD symptom criteria) comprise the total symptom scale score (possible range = 0–68). The PTSD-RI index is one of the most widely used instruments for assessing traumatized children and adolescents. The index has been reported to have a sensitivity of .93 and a specificity of .87, with a cut-off score of 38 (Rodriguez, Steinberg, Saltzman, & Pynoos, 2001), and the 17 scores had good internal consistency in the present sample (Table 1). The PTSD-RI was translated into Norwegian and back-translated, according to recommendations, with permission from the authors.

General mental health problems. The Strengths and Difficulties Questionnaire (SDQ) is widely used to screen mental health in children and adolescents (Goodman, 1997). It includes 30 statements measuring six subfactors: emotional symptoms, conduct problems, hyperactivity, peer problems, prosocial behavior, and impact. Each statement can be answered with *not true*, *somewhat true*, or *certainly true*, rated 0–2 for negatively worded items and 2–0 for the five positively worded statements. The total self-reported difficulty scores, based on 20 statements in the four problem-oriented subfactors (possible range = 0–40) had an acceptable level of internal consistency (Table 1) and were used as the measure of general mental health problems. Only children > 10 years of age completed the SDQ. The SDQ was previously translated and used in a comprehensive, population-based study of adolescents in Norway (Van Roy et al., 2006).

Statistical Procedures

Frequencies, means, and standard deviations were calculated for the descriptive data, whereas Pearson correlations were used for bivariate analyses. Histograms and normality statistics demonstrated that the variables were often positively skewed, with outliers consisting of children with the most severe symptoms. The outliers were included to represent the full range of posttraumatic stress reactions. Non-normality was taken into account using robust maximum likelihood (ML) estimation and bootstrap ML discrepancy. Missing answers on the PTSD-RI and SDQ were replaced with the person's mean score for the other questions within the same factor when calculating mean or sum scores.

Factor structure was evaluated using confirmatory factor analyses with ML estimates. Goodness of fit indices included the comparative fit index (CFI), Tucker-Lewis index (TLI) and root-mean-square error of approximation (RMSEA). The Akaike information criterion (AIC) and chi-square statistic (χ^2) were used to compare models without taking into account non-normality, whereas bootstrapped ML discrepancy was used to account for non-normality. AIC and ML discrepancy considers both the fit and the complexity of the models, whereas χ^2 only considers the models' fit. The significance of differences in χ^2 is presented. The best fit for AIC, χ^2 and ML discrepancy (lowest figure) was considered to indicate the superior model. All presented models (Table 2) had unconstrained inter-correlations between all factors.

Confirmatory factor analyses were conducted in two steps. First, the three models were tested separately for T_1 and T_2 to determine which model best represented the data. The second step was to compare the factor structure across time. Three confirmatory factor analyses, using all items from T_1 and T_2 in the same model, were performed. In all models, eight factors were included and intercorrelated, and error terms in the 17 items from T_1 were correlated with similar terms from T_2. In the first analysis, all factor loadings were unconstrained; in the second analysis, each of the 17 factor loadings was constrained to be

equal across T_1 and T_2; and in the third analysis, the covariance between the factors was also constrained to be equal at T_1 and T_2. Stability across time was inferred if the constrained models did not have worse fit indices (AIC, χ^2 and ML discrepancy) than the unconstrained model (Brown, 2006; Elhai, Palmieri, Biehn, Frueh, & Magruder, 2010).

To analyze whether the factors of posttraumatic stress reactions were related to facets of the disaster experiences or to the children's general mental health problems, multivariate mixed effect models were used. The dependent variables were mean scores within each of the four PTSD factors (possible range = 0–4) at T_1 and T_2. Exposure, immediate subjective distress and general mental health problems measured at T_1 were standardized and simultaneously entered as independent variables. The model was retested, using general mental health problems measured at T_2 instead of at T_1, to analyze concurrent comorbidity between general mental health problems and posttraumatic stress reactions at T_2. Time and the independent variables were entered as fixed effects, whereas there were random effects for the family and individual levels. The possible clustering effects of including several children from the same families were thereby taken into account.

Intra-class correlation (ICC) was defined as the proportion of unexplained variance found between families. ICC was calculated by dividing unexplained variance between families by the sum of unexplained variance between families, between individuals and between individuals within the same family. A confidence interval for ICC was calculated by parametric bootstrapping, with 10,000 replications.

A significance level of .05 was used for all statistical tests. Descriptive and bivariate analyses were conducted using PASW/SPSS Version 18.0. Confirmatory factor analyses were performed using AMOS Version 18.0. Mixed effects models were analyzed using R Version 2.12.0 with the nlme and boot packages.

Results

Factor Structure of Posttraumatic Stress Reactions over Time

Based on our literature review, three models were tested (Table 2): a three-factor model of intrusion, avoidance/numbing, and arousal (DSM–IV); a three-factor model of intrusion/active avoidance, numbing, and arousal (Anthony et al., 1999); and a four-factor model of intrusion, active avoidance, numbing, and arousal (numbing model).

Table 2 about here

The first step of the confirmatory factor analyses, testing the three models for T_1 and T_2 separately, revealed the DSM-IV three-factor model to be the least supported model at both assessments (Table 3). The four-factor numbing model represented the data best at 10 months (T_1), whereas the four-factor numbing model and the three-factor model proposed by Anthony et al. (1999) had similar fits to the data at 2.5 years (T_2). While the AIC and ML discrepancy found that the three-factor model fit the data best at T_2, χ^2 was slightly better for the four-factor numbing model (Table 3). All model fit indices (CFI, TLI and RMSEA) were worse for all of the models at T_2 than at T_1 (Table 3). Arousal was highly correlated with intrusion (r = .84) and numbing (r = .89) at T_1 in the four-factor model, and symptoms of active avoidance were increasingly more correlated with intrusive symptoms over time (r = .82 and r = .95 at T_1 and T_2, respectively), thus supporting the merging of these factors at T_2. None of the other factors were correlated above .70 at either of the assessments.

The second step of the confirmatory analyses was to analyze changes in the preferred four-factor structure across time, using models that included items from both assessments. Invariance testing compared an unconstrained model across time with two increasingly constrained models (Table 3). However, this invariance testing across time had diverging results pertaining invariance in factor loadings. Although the AIC and ML discrepancy

indicated stability in the model factor loadings across time, χ^2 indicated that the models were not stable across time. Thus, it is unclear from the invariance testing if the factor structure changed significantly from T_1 to T_2.

Table 3 about here

To evaluate whether questions were clustered together with other items measuring related features, factor loadings in the four factor numbing model were evaluated. Loadings were significant ($p \leq .05$) for all items at both time intervals. However, Item 15 (C3) "I have trouble remembering important parts of what happened" had factor loadings of 0.23 at T_1 and 0.33 at T_2 (both with $p = .02$). Modification indices suggest that this item was related to active avoidance at T_1 ($\Delta\chi^2 = 6.6$), whereas there were no suggested modification indices for this item at T_2 (table with factor loadings for the four-factor models is available from authors).

Child-reported posttraumatic stress reaction levels at T_1 and T_2 were significantly correlated ($n = 104$, $r = .55$, $p < .001$). All correlations between corresponding factors at T_1 and T_2 were > .40 (intrusion, avoidance, numbing, and arousal, with $r = .43$, .46, .53, and .41, respectively; all with $p < .001$).

Factors of Posttraumatic Stress Reactions in Relation to the Levels of Traumatic Experiences and General Mental Health Problems

In accordance with the second aim of the study, the relationships between each of the four posttraumatic stress reaction factors in the preferred numbing model to the level of exposure, immediate subjective distress, and general mental health problems (SDQ) were investigated using multivariate mixed-effect models (Table 4). Posttraumatic stress reaction levels decreased for all factors over time ($\Delta B_{\text{intrusion}} = -0.33$, $p < .001$; $\Delta B_{\text{active avoidance}} = -0.38$,

$p < .001$; $\Delta B_{numbing} = -0.24$, $p = .001$; and $\Delta B_{arousal} = -0.22$, $p = .003$). However, there were no significant differences in the degree to which each factor decreased, indicating that the factor scores tended to decrease between T_1 and T_2 at the same rates.

Table 4 about here

The level of exposure was not significantly related to any posttraumatic stress reaction factor at T_1 or at T_2 (Table 4), though the association between exposure and intrusion at T_2 proved to be stronger than the association between exposure and numbing. The immediate subjective distress level was significantly related to intrusion and arousal at T_1 but not related to any of the symptom clusters at T_2. At T_1, immediate subjective distress was related more significantly to intrusion and arousal than numbing. Exposure and immediate subjective distress were not significantly different in their relationship to any of the posttraumatic stress reaction factors at T_2 compared to T_1 (Table 4). Thus, the hypothesis that intrusion and active avoidance symptoms would be more related to trauma experiences than numbing and arousal was partly supported for intrusion but not for active avoidance.

General mental health problems at T_1 was highly related to all posttraumatic stress reaction factors at T_1 but was significantly more related to arousal than any of the other factors (Table 4). In addition, general mental health problems at T_2 was significantly related to all posttraumatic stress factors at T_2 but more strongly related to arousal than any of the other factors (Table 4).Using general mental health problems as a predictor of later posttraumatic stress reactions was also assessed, and general mental health problems at T_1 significantly predicted levels of arousal, but not any of the other three factors, at T_2 (Table 4). Thus, general mental health problems was highly related to concurrent posttraumatic stress reactions at both assessments, but did not predict later posttraumatic stress reactions as well.

The ICC was .10 (95% CI, .00 to .26), indicating that the effect of being from the same family was minute.

Discussion

The aim of the present study was to investigate the factor structure of posttraumatic stress reactions in children, as well as the symptoms' relation to trauma exposure and general mental health problems, from a longitudinal perspective. There were three main findings: 1) the DSM–IV model was the least supported model at both time points, whereas a four-factor numbing model of intrusion, active avoidance, numbing and arousal described the data slightly better than the other models at T_1; 2) the factors of intrusion and active avoidance, merged as time passed; and 3) general mental health problems were highly related to concurrent posttraumatic stress reactions, particularly arousal symptoms, at both time points.

The first finding showing a preference for a four-factor structure with intrusion, active avoidance, numbing and arousal over other models, particularly the DSM-IV model, is supported by several studies of both children (Kassam-Adams et al., 2010; Sack, Seeley, & Clarke, 1997; Saul et al., 2008; Stewart et al., 2004; Wolfe, Gentile, Michienzi, Sas, & Wolfe, 1991) and adults (Asmundson, Wright, McCreary, & Pedlar, 2003; King et al., 1998). This also lends support to a conceptual distinction between active avoidance and passive numbing. Foa, Riggs, and Gershuny (1995) suggest that victims of trauma mobilize active cognitive avoidance strategies aimed at reducing the distress associated with memories of the trauma. When such strategies fail, the affective system shuts down through a primarily automatic process, resulting in symptoms of numbing. Another explanation, which has found support in studies of adults and starting to find support in children, is that numbing symptoms are dysphoric and related to general mental distress, and thus should not be clustered together with symptoms of active avoidance (Elhai, Ford, et al., 2009; Hukkelberg & Jensen, in press; Simms et al., 2002). These hypotheses and the empirical findings indicate that dividing

symptoms of active avoidance and numbing may be helpful when trying to understand traumatized children's needs.

The second finding was that reactions of intrusion and active avoidance appeared to merge into one factor 2.5 years posttrauma. During the follow-up period from 10 months post-tsunami to 2.5 years posttrauma, the posttraumatic stress reactions of the children in this study had diminished significantly, as expected from prior studies (Kronenberg et al., 2010; Silverman & La Greca, 2002). However, the patterns of healing from posttraumatic stress reactions may differ in regard to symptom clusters. Symptoms of intrusion and active avoidance that are more directly associated with the traumatic incident may become less pronounced and distinct over time. It is possible that the trauma victims no longer distinguish between intrusive symptoms and their strategies to actively avoid such symptoms as time pass and their level of symptoms decline. This could explain why intrusion and active avoidance merged when there were low levels of posttraumatic stress reactions at T_2. This is also supported by the findings of worse fit indices at T_2 than at T_1 (Table 3), indicating that the models of posttraumatic stress disorder do not represent the symptoms at 2.5 years after the disaster as well as at 10 to 11 months after the disaster. However, it is important to remember that the large study by Anthony et al. (1999) three months after Hurricane Hugo also found symptoms of intrusion and avoidance to be highly correlated in a sample which included a higher proportion of children with PTSD than in the present sample. This indicate that the three factor model of intrusion/active avoidance, numbing and arousal may also describe samples with higher levels of reactions than found at T_2 in the present sample.

Another reason for the changes in structure across time might be that the different PTSD symptoms measure different features of mental health. Thus, their relative importance may change as time passes. As suggested by Spitzer et al. (2007) and others (Simms et al., 2002), some numbing and arousal symptoms may be nonspecific and common with other

mental disorders. This hypothesis was partially supported in the present study by its third finding. General mental health problems were highly related to concurrent symptoms of arousal, significantly more so than to any of the other factors. This supports the notion that arousal may not be a distinct feature of posttraumatic stress reactions (Ford et al., 2009; Kassam-Adams et al., 2010) and is similar to other studies' findings that other mental health problems (e.g., trait anxiety and depression) are more related to arousal than to other factors (Kolaitis et al., 2003; Lonigan et al., 1994). As reported in other studies, characteristics of the trauma, such as immediate subjective distress, were significantly related to intrusion symptoms and also to symptoms of arousal (Dyregrov et al., 1996; Giannopoulou et al., 2006; Goenjian et al., 1995; Kitayama et al., 2000; Kolaitis et al., 2003; Lonigan et al., 1994; Najarian et al., 1996; Winje & Ulvik, 1998). Thus, our findings support the hypothesis that intrusion symptoms in children are related to trauma experiences, such as immediate subjective distress, whereas arousal symptoms may overlap with symptoms of other mental ailments. However, no clear results were found for active avoidance or numbing.

There may be at least two reasons for the third finding that trauma characteristics were related to intrusion, while general mental health problems were related to arousal. First, the differences may reflect different psychological processes in which intrusive symptoms and active avoidance reflect consequences of the specific trauma, whereas numbing and arousal symptoms also are mediated through and/or reflect other mental health problems. Other mental health problems, for example depression and anxiety, may be both a pre-disaster vulnerability factor for the development of PTSD (Asarnow et al., 1999; Warheit, Zimmerman, Khoury, Vega, & et al., 1996), and/or be concurrent consequences of a disaster (O'Donnell, Creamer, & Pattison, 2004). Other mental health problems may also share some symptoms with PTSD, thus indicating a nonspecificity of the PTSD criteria (Simms et al., 2002; Spitzer et al., 2007). Low levels of posttraumatic stress reactions combined with the

high correlation to general mental health problems at T_2, indicate a low specificity of the diagnostic criteria. Second, the differences may reflect that the items targeting intrusion and active avoidance are phrased in relation to the traumatic incident, whereas those related to numbing and arousal are not primed to a specific event. An exception is the item "I have trouble remembering important parts of what happened" (C3), which refers directly to the possibly traumatic incident but is grouped together with items not related to the event. Other studies have defined the item as active avoidance (Sack et al., 1997) or numbing (Kassam-Adams et al., 2010; Saul et al., 2008; Stewart et al., 2004), or have excluded the item altogether (Anthony et al., 1999). It is difficult to determine if the phrasing contributes to the unclear grouping of this item, both in the present and earlier studies (Kassam-Adams et al., 2010). Few studied have studied the possible influence of differences in phrasing on the factor structure of PTSD. In a study of adults, findings were inconclusive in regard to the impact of event primers when assessing PTSD symptoms (Elhai, Engdahl, et al., 2009). To separate the effects of the psychological process from the difference in phrasing, one would need to conduct further studies using two different measurement tools on the same sample at the same time.

Limitations

This study has several limitations that must be considered when interpreting the results. First, compared to some studies of the factor structure of PTSD, we included only a small number of children. It is possible that a larger sample would have yielded more consistent results. Second, it is possible that the posttraumatic stress reaction level was too low at follow up to provide statistical validity to the factor structure. Analyses indicated that the low level of reactions at T_2 was not due to dropout. This is also supported by earlier representativeness analyses of adult participants in the Norwegian tsunami research program (Hussain, Weisaeth, & Heir, 2009). Third, the study included children from the same family.

Thus, clustering effects may have influenced the results from the confirmatory analyses. However, both the low ICC in the multilevel analyses and earlier findings within the present sample that siblings' total posttraumatic stress reaction levels were unrelated (Nygaard, Jensen, & Dyb, 2010) indicate a low risk for errors due to the inclusion of more than one child per family in the present study. Fourth, victims of single traumatic events may have fewer arousal and numbing symptoms than victims of chronic or abusive stressors (Fletcher, 2003). Therefore, arousal may be more related to the trauma and thereby relatively less related to general health in children with more chronic or abusive stressors than those the children in the present study experienced. Fifth, the included children were protected against secondary adversities in a way seldom found in trauma studies, such as loss of home, schooling, displacement, and possible unemployment of parents. They probably also experienced less reminders of the disaster than children living in a disaster area. Secondary adversities (Fernando, Miller, & Berger, 2010) and reminders (Layne et al., 2010) have been found to moderate levels of posttraumatic stress reactions. It is therefore important to use caution when generalizing results from the present study to other samples.

Implications for Research, Policy, and Practice

The present study supports dividing PTSD symptoms according to a four-factor numbing model consisting of intrusion, active avoidance, numbing, and arousal, indicating that active avoidance and numbing may be two distinct features of posttraumatic stress reactions in children. This is similar to the division suggested for the DSM-5 (APA, 2011). Intrusion and active avoidance may be more highly correlated in samples with low posttraumatic stress reaction levels or as time passes after the trauma. Future research should separate the effect of time vs. the effect of changes in the level of posttraumatic stress reactions.

Further research is required to examine the effects of phrasing and other priming of responders. It may be that children and adults respond differently to priming, and the effect of priming may differ depending on whether the priming occurs before all questions or as part of each question. This indicates a need for studies that examine the effect of priming on both children and adults.

Posttraumatic stress reactions, particularly arousal symptoms, were highly related to children's concurrent general mental health problems. This finding can suggest consequences in two opposite directions. First, these results can be thought of as supporting the removal of some of the general features, particularly arousal symptoms, from the PTSD diagnostic criteria to reduce the overlap between PTSD and other mental ailments. However, general emotional problems may be an important clinical feature of PTSD and not primarily part of other affective disorders. Thus, instead of removing overlapping symptoms, it may be appropriate to include symptoms of general mental health problems as part of posttraumatic stress reactions, as in the current diagnostic system. Clinicians must be aware that, at present, it may be difficult to differentiate between PTSD, other diagnosable mental ailments (such as depression), and general mental health problems not specified in a diagnostic manual. Further, it may be especially difficult to understand the origin of symptoms of arousal and what they represent in children long after they have experienced a trauma. In such cases, a broader clinical assessment including an evaluation of the onset of symptoms may help differentiate between posttraumatic stress reactions and mental health problems that are not related to the traumatic experiences.

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Table 1. Descriptive and Psychometric Properties of the Major Study Variables at T_1 and T_2.

	T_1 (N = 133)					*T_2 (N = 104)*				
	n (%)	*M*	*SD*	*Range*	*α*	*n (%)*	*M*	*SD*	*Range*	*α*
Age at time of tsunami	133	12.9	(3.4)	(6.5–17.5)		104	12.9	(3.4)	(6.5–17.5)	
Gender										
Male	61 (45.9%)					47 (45.2%)				
Female	72 (54.1%)					57 (54.8%)				
Exposure	133	3.7	(2.0)	(1–9)	.66	104	3.8	(1.9)	(1–9)	.61
Immediate subjective distress	133	5.5	(2.2)	(1–9)	.69	104	5.5	(2.2)	(1–9)	.66
Posttraumatic stress reactions	133	14.6	(10.1)	(0–51)	.87	104	8.8	(7.1)	(0–33)	.82
General mental health problems	95	10.2	(5.0)	(0–23)	.76	85	8.9	(5.1)	(0–31)	.61
Number of parents	84					68				

Note. Exposure was reported by the parents in the questionnaire 6 to 8 months post-tsunami. Immediate subjective distress was reported by the children at T_1. Posttraumatic stress reactions were measured by the total scores from children's reports on the PTSD-RI at T_1 and T_2. General mental health problems reflects the adolescents' answers to the Strength and Difficulty Questionnaire at T_1 and T_2.

Table 2. Posttraumatic Stress Reaction Symptoms with Hypothesized Factor Loading for Each Model Tested.

DSM-IV criterion (item no.) PTSD-RI item	*Three-factor model (DSM-IV)*	*Three-factor model (Anthony et al., 1999)*	*Four-factor model (Numbing model)*
B1 (3) Upsetting thoughts, pictures or sounds of what happened	I	I/AA	I
B2 (5) Bad dreams about what happened or other bad dreams	I	I/AA	I
B3 (6) Living through it again	I	I/AA	I
B4 (2) Upset, afraid or sad in response to reminders	I	I/AA	I
B5 (18) Physiological reactions to reminders	I	I/AA	I
C1 (9) Avoiding talking, thinking or feeling about the event	AV	I/AA	AA
C2 (17) Staying away from people, places or things that arouse recollections of what happened	AV	I/AA	AA
C3 (15) Trouble remembering important parts of what happened	AV	N	N
C4 (7) Staying alone and not being with friends	AV	N	N
C5 (8) Feeling alone inside and not close to other people	AV	N	N
C6 (10/11) Trouble feeling happiness, love, sadness or anger	AV	N	N

C7 (19/21) Thinking I will not live a long life, feeling pessimistic or negative about future	AV	N	N
D1 (13) Trouble going to sleep, or waking up often during the night	AR	AR	AR
D2 (4/20) Feeling grouchy, angry, mad, or having arguments or physical fights	AR	AR	AR
D3 (16) Trouble concentrating or paying attention	AR	AR	AR
D4 (1) Watching out for danger or things that I am afraid of	AR	AR	AR
D5 (12) Feeling jumpy or startling easily	AR	AR	AR

Note. AA = Active avoidance; AR = Arousal; AV = Avoidance; I = Intrusion; N = Numbing.

Table 3. Goodness-of-Fit of Three Models at Two Assessment Points.

Sample	*Model*	*Corr range*	*df*	*CFI*[a]	*TLI*[a]	*RMSEA*[a]	*AIC*[a]	χ^{2a}	χ^2 *difference*[b]	*ML discrepancy*[c]
Interviews at T_1 (*N* = 133)	Three-factor (DSM-IV)	.71–.88	116	.82	0.77	.09	342.4	234.4	29.8***	326.1
	Three-factor (Anthony et al.)	.50–.87	116	.86	0.81	.08	321.6	213.6	9.0*	305.6
	Four-factor numbing model	.50–.92	113	.86	**0.82**	.08	**318.6**	**204.6**		**303.0**
Interviews at T_2 (*N* = 104)	Three-factor (DSM-IV)	.59–.89	116	.68	.58	.12	386.6	278.6	54.4***	453.8
	Three-factor (Anthony et al.)	.22–.67	116	.78	**.71**	.10	**336.8**	228.8	4.6	**392.1**
	Four-factor numbing model	.19–.95[d]	113	.78	.70	.10	338.2	**224.2**		409.7
Interviews at T_1 and T_2 combined (*N* = 104)[e]	All factors unconstrained		482	**.76**	.70	.08	1088.4	**794.4**		1218.8
	All factor loadings constrained		495	.75	.70	.08	**1083.4**	815.4	21.0	**1196.0**
	All factor loadings and covariance between factors constrained		501	.73	.68	.08	1098.0	842.0	47.6***	1209.6

Note. All factors were intercorrelated in all models. Chi-square was significant, with $p \leq .001$ for all models, indicating that the models did not fit the population perfectly. The factor covariance matrices were not positively definite for the four-factor numbing model at T_1 and T_2 or for the combined models across both assessments. Bold figures represent the models with the best fit indices.

CFI = comparative fit index; TLI = Tucker-Lewis index; RMSE = root-mean-square error of approximation; AIC = The Akaike information criterion; χ^2 = chi-squared statistic; ML discrepancy = bootstrapped maximum likelihood discrepancy.

[a] Fit indices that do not account for non-normality.

[b] Compares a model's χ^2 with the χ^2 of the four-factor model from same dataset.

[c] Fit indices that account for non-normality. ML is the discrepancy between implied and population estimates. The bootstrap analyses were based on 2,000 bootstrap samples when separately analyzing models at each assessment and on 200 bootstrap samples when analyzing items from both assessments in the same model.

[d] The correlation between intrusion and active avoidance at T_2 was not possible to calculate because the factor covariance matrix was not positively definite. Correlations between intrusion and active avoidance were .82 and .95 at T_1 and T_2, respectively, when defining the item "I have trouble remembering important parts of what happened" (C3) as part of active avoidance instead of numbing.

[e] Confirmatory factor analyses of similarity over time, analyzing 34 items (17 items from each assessment). The 34 items were divided into eight factors (four factors from each interview). Similar questions across time could have intercorrelated error terms. Factor loadings were

unconstrained in the first analyses. In the second analyses, factor loadings were constrained to be equal at T_1 and T_2. In the third analysis, factor covariance was also constrained to be equal across time.

* $p \leq .05$ and *** $p \leq .001$.

Table 4. Regression Coefficients (*SE*) for Predictors of Posttraumatic Stress Reaction Factors Across Time, Using Multivariate Mixed Effect Models.

Sample	*Posttraumatic stress reaction factors*	*Exposure*	*Immediate subjective distress*	*General mental health problems*[a]
Interview at T_1	Intrusion	0.09 (0.07)	0.22 (0.07)**	0.35 (0.06)***
	Active avoidance	0.09 (0.07)	0.12 (0.07)	0.26 (0.06)***
	Numbing	-0.04 (0.07)	0.01 (0.07)	0.28 (0.06)***
	Arousal	0.06 (0.07)	0.16 (0.07)*	0.51 (0.06)***
Significant difference between factors at T_1		None	I vs. N** N vs. Ar*	I vs. Ar* AA vs. Ar*** N vs. Ar***
Interview at T_2	Intrusion	0.12 (0.08)	0.07 (0.08)	0.11 (0.07) / 0.20 (0.07)**
	Active avoidance	0.07 (0.08)	0.03 (0.08)	0.13 (0.07) / 0.22 (0.07)**
	Numbing	-0.10 (0.08)	0.11 (0.08)	0.11 (0.07) / 0.14 (0.07)*
	Arousal	0.01 (0.08)	0.11 (0.08)	0.18 (0.07)* / 0.44 (0.07)***
Significant difference between factors at T_2		I vs. N*	None	/ I vs. Ar**; / AA vs. Ar**; / N vs. Ar***
Significant difference within factors across time		None	None	I**; N*; Ar***

Note. Dependent variables were mean scores (possible range = 0–4) within the four factors of posttraumatic stress reactions at the two assessments. Independent variables, exposure, immediate subjective distress and general mental health problems were standardized before

being simultaneously entered. Time and these independent variables were entered as fixed effects, whereas there were random effects for the family and individual levels. The figures in this table are estimates of non-standardized regression coefficients (*B*) (*SE* in parentheses) of the predictors.

I = Intrusion; AA = Active avoidance; N = Numbing; Ar = Arousal.

[a] General mental health problems was based on the children's reports at T_1 (*n* = 95) or at T_2 (after slash) (*n* = 85).

* $p \leq .05$; ** $p \leq .01$; and *** $p \leq .001$.

Appendix

Supplemental Tables Referenced in Paper V

Table S1

Published Studies on the Factor Structure of Children's Posttraumatic Stress Reactions

Description of trauma	*N*	*Age (y)*	*Time after trauma*	*Measure*	*Type of analysis*	*Best-fitting model*	*Other models tested*
Hurricane Hugo (Anthony, et al., 1999)	5,664	9-19 (mean 14.0)	Three months	Modified version of the Frederick Reaction Index for Children (RI)	Confirmatory	Three-factor with intrusion/active avoidance, numbing/passive avoidance, and arousal	Nine other models were tested
Hurricane Andrew or Hurricane Hugo, two datasets (Anthony et al., 2005)	198 + 198	Fifth-grade students (mean 10.6 and 10.3)	Three months	Modified version of the Frederick Reaction Index for Children (RI)	Confirmatory	Three-factor with intrusion/active avoidance, numbing/passive avoidance, and arousal	No other models were tested
Marmara	293	8-15	Three years	Post-Traumatic	Confirmatory	Three-factor DSM-IV	No other models

earthquake (Bal & Jensen, 2007)		(mean 11.2)		Stress Disorder Reaction Index for Children (CPTSD-RI)			were tested
Refugees, immigrants, and native Dutch and Belgian adolescents (Bean, Derluyn, Eurelings-Bontekoe, Broekaert, & Spinhoven, 2006)	3,096	8-26 (mean 15.7)	Unknown	Reactions of Adolescents to Traumatic Stress questionnaire (RATS)	Confirmatory	Three-factor DSM-IV	No other models were tested
Oklahoma tornado (Bulut, 2004)	152	6-18 (mean 9.7)	11 months	Sefa Bulut Child Post Traumatic Stress Disorder Inventory (SBC-PTSDI)	Exploratory	Five-factor with blocking/vigilance, affective/adjustment difficulties, intrusion/intrusion, somatic/attachment, and sense of foreshortened future	No other models were tested
War in Croatia (Dyregrov, et al., 1996)	1,787	6-15 years (mean	11-18 months, November	Modified version of the Impact of Event Scale (IES)	Exploratory	Two-factor with intrusion and avoidance, but also some indication of a factor of numbing	No other models were tested

		10.7)	and December 1992				
Nationally representative sample (Elhai, Ford, et al., 2009)	4023	12-17 years	Unknown	NWS PTSD module	Confirmatory	Three-factor with dysphoria symptoms removed from the model, retaining intrusion, effortful avoidance, and arousal	Three-factor DSM-IV, four-factor with intrusion, active avoidance, numbing, and hyper-arousal, and four-factor dysphoria model
Tornadoes (Evans & Oehler Stinnett, 2006)	152	6-12 (mean 9.5)	One year	OSU PTSD Scale-CF	Exploratory	Six-factor with avoidance, intrusion, interpersonal alienation, interference with daily functioning, physical symptoms/anxiety, and foreshortened future	No other models were tested
Trauma-exposed children from	3,351	12-17	Unknown	Diagnostic Interview Schedule	Confirmatory	Two-factor with intrusion and avoidance/hyper-arousal, based on 12 symptoms	Three-factor DSM-IV and four-factor with

the National Survey of Adolescents (Ford, et al., 2009)							intrusion, active avoidance, numbing, and hyper-arousal
Community violence among a representative group of urban students (Foy, Wood, King, King, & Resnick, 1997)	639	High-school students (mean 16.9)	Unknown	Los Angeles Symptom Checklist (LASC)	Confirmatory	Three-factor DSM-IV; all factors were highly correlated	No other models were tested
Earthquake in Athens (Giannopoulou, Smith, et al., 2006)	2,037	9-17	Six-seven months	Children's Revised Impact of Event Scale (CRIES)	Confirmatory	Hierarchical three-factor model, DSM-IV	Five other two- and three-factor models
Hurricane Iniki in Hawaii (Hamada, Kameoka, Yanagida, & Chemtob, 2003)	3,732	6-15 (mean 9.5)	26 months	24-item Kauai Recovery Index (KRI)	Exploratory	Four-factor with intrusion, arousal, avoidance, and a fourth idiosyncratic factor	No other models were tested

Traumatized children from child guidance clinics in Norway (Hukkelberg & Jensen, 2011)	312	10-18 years (mean 14.3)	Unknown	Child PTSD Symptom Scale (CPSS)	Confirmatory	Four-factor dysphoria model with intrusion, active avoidance, dysphoria, and arousal	One general factor, two-factor with five items removed (as suggested by Simms et al.), three-factor (DSM-IV), three-factor with intrusion/active avoidance, numbing, and arousal, and four-factor with intrusion, active avoidance, numbing, and arousal
Unintentional physical injury, two datasets	479 + 204	8-17 years (mean 11.9	Four-six months	Child PTSD Symptom Scale (CPSS) and Clinical-	Confirmatory	Four-factor with intrusion, active avoidance, numbing, and arousal	One and two factors (12 items), three-factor DSM-IV,

(Kassam-Adams, et al., 2010)		and 11.0)		Administered PTSD Scale for Children and Adolescents (CAPS-CA)			three-factor hierarchical, and dysphoria model
Physical and psychological maltreatment in schools (Lambert, 1990)	336	High-school students	Unknown	School Survey-Student Form	Exploratory	Four-factor with intrusion, arousal, school problems, and other stress symptoms	No other models were tested
Marmara Earthquake, two samples (Laor et al., 2002)	202 + 101	School-aged children (mean 8.2 and 8.8)	Four months	Post-Traumatic Stress Disorder Reaction Index for Children (CPTSD-RI)	Exploratory	Three-factor with avoidance/numbing/concentration problems/somatization, intrusion/hypervigilance, and sleep/concentration/numbing	No other models were tested
Industrial fire in North Carolina (March, et al., 1997)	1,019	Fourth-to ninth-grade student	Nine months	Self-Reported Post-Traumatic Symptomatology (SRPTS)	Exploratory	Three-factor with intrusion/numbing, active avoidance, and hyper-arousal	Four-factor with intrusion and numbing separated

		s					
Community study, individuals exposed to assault, motor vehicle accident, or injuries (Meiser-Stedman et al., 2009)	233 + 138 + 209	6-18 (mean 14.6, 12.8 and 11.4)	Two months, at least six months, and one month, respectively	Post-Traumatic Cognitions Inventory – child version (CPTCI)	Exploratory and confirmatory	Two factors of negative trauma-related cognitions; one corresponded to permanent and disturbing change, and the second corresponded to a fragile person in a scary world	No other models were tested
Schoolchildren in the Eastern Democratic Republic of Congo (Mels, Derluyn, Broekaert, & Rosseel, 2010)	1,046	Second- and third-grade students (mean age 15.8)	Diverse, population-based study	Impact of Event Scale Revised (IES-R)	Exploratory	Three factors, where two factors included a mixture of intrusion and arousal items and one factor included items of avoidance	No other models were tested
Refugee children from the Middle	311	3-15 (mean	Unknown, but interviewed	Parental report on 14 items from the basic	Exploratory and	Exploratory gave a five-factor model without PTSD-specific pattern. Confirmatory gave no	One-factor, two-factor, three-

East in Denmark (Montgomery & Foldspang, 2006)		7.5)	shortly after arrival in Denmark	elements of PTSD	confirmatory	satisfactory fit	factor DSM-IV
Earthquake (Paganucci, Primi, & Gianetti, 2007)	239	(mean 10.3)	Six months	Children's Post-Traumatic Stress Disorder – Reaction Index (CPTSD-RI)	Exploratory and confirmatory	Two-factor with intrusion and avoidance based on 12 of the 20 items from CPTSD-RI	No other models were tested
Sniper attack (Pynoos, et al., 1987)	159	5-13 (mean 9.2)	One month	PTSD Reaction Index	Exploratory	Three-factor with intrusion/numbing/avoidance, fear/anxiety, and concentration/sleep disturbances	No other models were tested
Khmer refugees (Sack, Seeley, & Clarke, 1997)	194	13-25	13 years after	Diagnostic Interview for Children and Adolescents (DICA)	Exploratory	Four-factor with intrusion, active avoidance, numbing, and arousal	No other models were tested
Trauma-exposed individuals	1,581	12-17	Unknown	Diagnostic Interview Schedule	Confirmatory	Four-factor with intrusion, active avoidance, numbing, and arousal	Three-factor DSM-IV and three-factor

from the National Survey of Adolescents (Saul, et al., 2008)							found by Anthony et al. (1999)
War in Bosnia (Smith, Perrin, Dyregrov, & Yule, 2003)	2,976	9-14 (mean 12.1)	Two years after peace agreement	Impact of Event Scale (IES)	Exploratory	Three-factor with intrusion, avoidance, and arousal	Two-factor model with avoidance and intrusion/arousal
Homelessness (Stewart, et al., 2004)	374	13-21 (mean 17.1)	Unknown	17 questions corresponding to DSM-IV PTSD symptoms	Confirmatory	Four-factor with intrusion, active avoidance, numbing, and arousal	Three-factor DSM-IV
Sexual abuse, two datasets (Wolfe, Gentile, Michienzi, Sas, & Wolfe, 1991)	61 + 76	8-16 (mean 11.6) and 8-17 (mean 12.5)	1-91 months (mean 15.6 months)	Children's Impact of Traumatic Events Scale (CITES)	Exploratory	10 subscales, including three PTSD factors: intrusion, avoidance, and sexual anxiety	No other models were tested

Road traffic accidents (Wu, Chan, Hung, & Cho, 2008)	61	8-17 (mean 12.5)	One month	Children's Impact of Event Scale – Revised (CHIES-R)	Exploratory and confirmatory	Three-factor DSM-IV	No other models were tested
Jupiter cruise ship disaster (Yule, Bruggencate, & Joseph, 1994)	334	11-18 (mean 14.8)	Five-nine months	Impact of Event Scale (IES)	Exploratory	Three-factor with intrusion, avoidance, and numbing	No other models were tested

Note. The literature search was performed on 11 databases: EMBASE, ERIC, Ovid MEDLINE(R), PsycINFO, and all EBM reviews (ACP Journal Club, CCTR, CDSR, CLCMR, CLHTA, CLEED, and Dare), using a combination of four phrases for PTSD, six phrases for factor analysis, and three phrases for children/adolescent. All hits from the data search (N = 142) were reviewed. In addition, some studies found through reference lists were included.

Table S2.

Standardized Factor Loadings for the Four-Factor Model at 10 Months and 2 ½ Years Post-Tsunami

DSM-IV criterion (item no.) PTSD-RI item	*Intrusion*	*Active avoidance*	*Numbing*	*Arousal*
B1 (3) Upsetting thoughts, pictures or sounds of what happened	.78 / .77			
B2 (5) Bad dreams about what happened or other bad dreams	.62 / .60			
B3 (6) Living through it again	.67 / .53			
B4 (2) Upset, afraid, or sad at reminders	.79 / .86			
B5 (18) Physiological reactions to reminders	.72 / .78			
C1 (9) Avoid talking, thinking, or feelings about event		.51 / .56		
C2 (17) Staying away from people, places, or things that arouse recollection of what happened		.55 / .62		
C3 (15) Trouble remembering important parts of what happened			.23 / .33	
C4 (7) Staying by myself and not being with friends			.54 / .43	
C5 (8) Feeling alone inside and not close to other people			.59 / .67	
C6 (10/11) Trouble feeling happiness, love, sadness, or anger			.43 / .60	

C7 (19/21) Thinking that I will not live a long life; feeling pessimistic or negative about the future	.56 / .44	
D1 (13) Trouble going to sleep, or waking up often during the night		.63 / .55
D2 (4/20) Feeling grouchy, angry, mad, or having arguments or physical fights		.58 / .38
D3 (16) Trouble concentrating or paying attention		.60 / .77
D4 (1) Watching out for danger or things that I am afraid of		.64 / .47
D5 (12) Feeling jumpy or startling easily		.59 / .46

Note. Coefficients at 10 months are shown first (*N* = 133*)*, while coefficients at 2 ½ years post-tsunami are shown after the slash (*N* = 104). All factor loadings were significant with $p \leq .01$, except Item C3 at T_1 and T_2 ($p = .02$).

Erratas

Page 8: Article II: Dyb, G., Jensen, T. K., & Nygaard, E. (in press) was published in 2011, and the reference has been updated.

Page 8: Article IV: Nygaard, E., Wentzel-Larsen, T., Hussain, A., & Heir, T. (Submitted) has been accepted for publication, and the reference is updated.

Page 8, note 1 and 2: Has been included to specify the change in progress for article II and IV since the thesis was presented to the commission.

Pages 13, 23, 24, 25, 26, 31, 78, 79, 80, 81 and 91: The reference to Franks in press has been updated to Franks 2011.

Page 34: Reference Liu 2010 has been changed to Liu et al 2009.

Reference list:

Dyb, G., Jensen, T. K., & Nygaard, E. (in press) has been updated to the final reference.

Franks (in press) has been updated to the final reference.

Nygaard, E., Wentzel-Larsen, T., Hussain, A., & Heir, T. (Submitted) has been updated with the name of the journal that has accepted the article.

Liu, R. T. (2010). Early life stressors and genetic influences on the development of bipolar disorder: The roles of childhood abuse and brain-derived neurotrophic factor. *Child Abuse & Neglect, 34*, 516-522. doi: DOI: 10.1016/j.chiabu.2009.10.009

has been changed to:

Liu, X.-X., Xiong, G.-Y., Ma, D.-C., Dong, Y.-Q., Ye, Y.-L., Zhang, X., . . . Yauan, P. (2009). Relationship between post-traumatic stress disorder and perceived social support among middle school students in Wenchuan earthquake-stricken. *Chung-Hua Liu Hsing Ping Hsueh Tsa Chih Chinese Journal of Epidemiology, 30*, 1017-1020.