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1 **Title page**

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4 **Six years after the wave. Trajectories of posttraumatic stress following a natural**
5 **disaster.**
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Abstract

Background

The characteristics of long-term trajectories of distress after disasters are unclear, since few studies include a comparison group. This study examines trajectories of recovery among survivors in comparison to individuals with indirect exposure.

Methods

Postal surveys were sent to Swedish tourists, repatriated from the 2004 Indian Ocean tsunami (n=2268), at 1, 3, and 6 years after the tsunami to assess posttraumatic stress (PTS) and poor mental health. Items were used to ascertain high and moderate disaster exposure groups and an indirect exposure comparison group.

Results

Long-term PTS trajectories were best characterized by a resilient (72.3%), a severe chronic (4.6%), a moderate chronic (11.2%) and a recovering (11.9%) trajectory. Trajectories reported higher levels of PTS than the comparison group. Exposure severity and bereavement were highly influential risk factors.

Conclusions

These findings have implications regarding anticipation of long-term psychological adjustment after natural disasters and need for interventions after a single traumatic event with few secondary stressors.

Key words: Posttraumatic stress; PTSD; trajectories; natural disaster; longitudinal study; recovery; general mental health

1 Highlights

- 2 • Exposure severity and bereavement are powerful determinants for long-term
3 posttraumatic stress.
- 4 • The resilient trajectory, which comprised a majority of the survivors, reported higher
5 levels of long-term posttraumatic stress than a comparison group.
- 6 • Among those who recover, the recovery process still persists after several years.
- 7 • A substantial proportion of survivors (16 %) display chronic symptoms.

8

1. Introduction

Long-term effects of disasters on mental health have been the focus of increasing interest in recent years. The majority of disaster survivors do not develop chronic reactions of distress and do not need professional help, whereas a sizeable minority may suffer for a prolonged period of time (Norris, Murphy, Baker, & Perilla, 2004; North, Kawasaki, Spitznagel, & Hong, 2004). Distressing psychological reactions are often most distinct during the first weeks after a traumatic event and gradually decrease during the following two years (Connor, Foa, & Davidson, 2006; Ford, Adams, & Dailey, 2007; Meewisse, Olff, Kleber, Kitchiner, & Gersons, 2011; Piyasil et al., 2007).

Remission from posttraumatic stress disorder (PTSD; APA, 2000) after traumatic events can take as long as six years or more, and spontaneous recovery thereafter seems improbable (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Nevertheless, apart from the work by Green et al. (Green, Lindy, Grace, & Leonard, 1992) there are few prospective empirical studies of long-term posttraumatic stress in civilians after disasters (Norris, 2006). Concerning the levels of posttraumatic stress, 10% of exposed persons reported symptoms six years after the 9/11 terror attack in New York (Brackbill et al., 2009), whereas smaller studies report significant posttraumatic stress or PTSD in one-fourth to one-fifth of survivors after 7 to 27 years (Arnberg, Eriksson, Hultman, & Lundin, 2011; Boe, Holgersen, & Holen, 2011; Hull, Alexander, & Klein, 2002; North, Pfefferbaum, Kawasaki, Lee, & Spitznagel, 2011).

Importantly, and in line with theoretical accounts of how PTSD is maintained (Brewin & Holmes, 2003), studies indicate that the burden of posttraumatic stress does not change markedly after the first years following the traumatic event (Arnberg, Bergh Johannesson, & Michel, 2013; Arnberg et al., 2011; Boe et al., 2011; Kessler et al., 1995). In other words, survivors for whom PTSD symptoms do not resolve over the course of the first one or two years face substantial risk of longstanding distress (Bui et al., 2010). In addition, whereas

1 PTSD onset is related to a range of factors that occur before, during, and after the traumatic
2 event, maintenance of PTSD symptoms seems to be related primarily to factors occurring
3 during and after the event (Schnurr, Lunney, & Sengupta, 2004). Secondary stressors such as
4 loss of property or unemployment may prolong or worsen the distress (Galea et al., 2007; Hull
5 et al., 2002; Tracy, Norris, & Galea, 2011).

6 Forms of distress other than posttraumatic stress are clinically relevant when considering
7 long-term effects, particularly depression and suicidal ideation (Cougle, Resnick, &
8 Kilpatrick, 2009; Tracy et al., 2011). Depression and anxiety are common among disaster
9 survivors (Hussain, Weisaeth, & Heir, 2011; Tracy et al., 2011) and, interestingly, seem to be
10 influenced by secondary stressors rather than by the trauma exposure itself (Kessler et al.,
11 2012; Tracy et al., 2011). These findings suggest that disaster survivors with few secondary
12 stressors would have a corresponding small increase in general psychopathology.

13 A limitation of previous studies is that they have mainly analyzed average levels of
14 continuous measures of trauma-related adjustment. These approaches do not consider
15 different pathways (Bonanno, Westphal, & Mancini, 2011), thereby failing to capture the
16 heterogeneity of trauma reactions over time (Orcutt, Bonanno, Hannan, & Miron, 2014).
17 Latent Growth Mixture Modeling (LGMM) offers a possibility to identify heterogeneous
18 subpopulations that comprise different response patterns across time. Capitalizing on
19 longitudinal data, these models provide patterns of responses that are relatively more robust
20 and flexible than cross-sectional methods and population-average slopes (Bonanno &
21 Diminich, 2013). Efforts have been made to elucidate trajectories of posttraumatic stress in
22 the short term (Sveen, Ekselius, Gerdin, & Willebrand, 2011) and recently also in the long
23 term (Bonanno et al., 2011; Bryant et al., 2015; Pietrzak et al., 2013; Karstoft, Armour, Elklit,
24 & Solomon, 2013 ; Maslow et al., 2015). Four trajectories of posttraumatic stress symptoms
25 are commonly suggested: resistance or resilience (i.e. minimal to no symptoms at any time

1 after the event), chronic (i.e. persistently elevated symptoms), delayed dysfunction (i.e.
2 initially low symptom levels followed by increasing symptoms later on), and recovery (i.e.
3 initially moderate or high symptom levels followed by a distinct decline) (Bonanno, 2004;
4 Bonanno & Diminich, 2013; Norris, Tracy, & Galea, 2009; Pietrzak, Feder, et al., 2013). A
5 limitation in the literature on potential trajectories of distress, also reflected in this field at
6 large, is the scarcity of studies with clearly defined comparison groups with little or no
7 exposure. Thus, it is still an open question as to whether trajectories of recovery and resilience
8 lead to distress comparable to no exposure or if individuals in these trajectories have
9 remaining elevated levels of distress.

10 Disaster exposure severity, including threat to life and injury, is an important determinant for
11 event-related psychopathology (Norris & Wind, 2009), thus detailed exposure categorization
12 is important after large-scale disasters. However, as noted by several authors sampling
13 methods in surveys of affected populations often do not include indirectly exposed ((Galea &
14 Maxwell, 2009); Norris & Wind, 2009). Additionally, large disasters produce substantial
15 variation in exposure severity among those directly exposed, which is an important
16 determinant for the development of posttraumatic stress (Norris & Wind, 2009). It is less clear
17 how the severity of direct exposure influences trajectories of distress over time.

18 In 2004, the earthquake in the Indian Ocean and the following tsunamis devastated coastal
19 regions in Southeast Asia, and more than 227,000 people perished (Telford & Cosgrave,
20 2007). Approximately 19,000 Swedish citizens were travelling in Southeast Asia at that time
21 and 7000 were estimated to have been in the most affected areas. Previous studies have
22 demonstrated a pattern of resilience and recovery among Swedish survivors at one year
23 through three years post-disaster (Johannesson, Lundin, Frojd, Hultman, & Michel, 2011).
24 Severe disaster exposure, physical injury (Dyster-Aas et al., 2012) and traumatic bereavement

(Johannesson, Lundin, Hultman, Frojd, & Michel, 2011) had a considerable impact on psychological distress and appeared to slow down the recovery process.

The present study is a six-year follow-up of a national cohort of Swedish survivors from the disaster. The aim of this study was twofold. First, we wanted to examine the course of symptoms of long-term distress. We expected that the burden of significant post-traumatic stress reactions and poor mental health would have decreased further as compared with one and three years, but would still be evident among those who had been exposed to life threat and those who were bereaved (Hypothesis 1). Second, we aimed to examine whether previously reported trajectories of posttraumatic stress would be possible to detect and, in line with other studies, that resilience would be the most common pattern (Hypothesis 2). We assessed whether the trajectories were related to higher levels of distress than in a group of individuals with indirect exposure. We anticipated that pre-trauma determinants such as gender, education, and pre-trauma adverse events would be related to symptomatic trajectories but also that exposure to life threat and loss of loved ones would predict chronic distress patterns (Hypothesis 3).

2. Material and methods

2.1. Procedure

The Swedish authorities established receptions at national airports and registered all Swedish citizens repatriated from destinations in Southeast Asia during the first three weeks after the disaster. Individuals from 16 years of age ($n = 10\,501$; 77% of those registered) were invited to participate in the survey. A postal survey was sent out 14 months post-disaster (T1) (Johannesson et al., 2009). The respondents at T1 were then invited to participate in a second survey three years after the disaster (T2) (Johannesson, Lundin, Frojd, et al., 2011). Six years after the disaster (T3), respondents at T1 were asked to participate in a third survey. The study was conducted in collaboration with the Centre for Family and Community Medicine,

Karolinska Institute, and the Institution for Medical Epidemiology and Biostatistics at the Karolinska Institute, Stockholm. The Regional Ethical Vetting Board in Uppsala, Sweden, approved the study.

2.2. Sample

At T1, 4932 (49%) of the participants responded; at T2, 3457 (70%) responded; and at T3, 2643 (53%) responded. There were 2268 participants (46%; 59% women) who responded to all surveys. The mean age at T1 was 49.5 years (SD = 14.0). Nearly every other participant (46%) had more than 12 years of education (50% of the women; 42% of the men). More than two thirds (78%) were married/cohabiting, and 71% were employed. The majority of the respondents (96%) had been visiting Southeast Asia for pleasure or business.

2.3. Assessments

2.3.1. Independent variables

The surveys included questions about the participants' demographics, disaster exposure and bereavement, and about their lives before and after the disaster (e.g. adverse events in childhood, adulthood and post-tsunami; use of health services; social support). The participants' ages (at T1) were categorized as 16-24 years, 25-40 years, 41-60 years, and 61+ years of age. Gender, family situation (*married/partner* or *no partner*) and educational attainment (≤ 12 or >12 years) were coded as binary variables.

Disaster exposure severity was categorized into two direct exposure groups; high and moderate exposure, and one indirect exposure group according to a set of 30 items in the T1-survey. The items included commonly used exposure criteria but were tailored to the tsunami according to outcome, type of event, place, culture, appraisal or significance of the disaster. The high exposure group included participants who indicated that they had been exposed to life threat, being caught by or had been close to being caught by the tsunami. The moderate exposure group included participants who indicated "No, I was not in the neighborhood of being caught by the

tsunami wave”, but who indicated one or more of the following: witnessing corpses, others suffering, or forlorn children, had helped other victims,, subjectively felt a threat to life, physical injury to themselves or others, loss of relatives or being worried about the fate of their family/relatives. The indirect exposure group included those participants who were passengers repatriated back to Sweden in the same aircrafts and who could have been indirectly exposed, e.g. by being in close vicinity or by talking to survivors during transportations. The traumatic bereavement group included participants who reported losing relatives (i.e. partner, children, parents, siblings, grandparents, or parents-in-law) in the tsunami (yes/no).

Adverse events were assessed with a checklist of 13 items (Bergsten Brucefors, Sidén Silfver, & Schulman, 2001). The respondents were asked to indicate if they had experienced pre-disaster events in childhood (0-16 years of age) and/or as adults (>16 years of age), and/or if they had experienced post-disaster events. The events included accidents, disasters, war/terror, violence/abuse, severe illness/injury to self or relatives, severe family conflicts/divorce, parents’ divorce, and death of a significant other. Because of a substantial positive skew of the response distribution they were coded into three categories (0, 1-2, and ≥ 3 events).

A proxy measure for pre-disaster psychiatric problems included two items: (a) *Have you ever in life, before the tsunami disaster, felt depressed or in a low mood, or had feelings of hopelessness, for more than two weeks?* (b) *Have you ever in life, before the tsunami disaster, had problems with panic reactions or persistent anxiety or anguish for more than four weeks?*

The participants were asked to report whether (a) or (b) impacted their work or social functioning, or if (a) or (b) had led to their receiving psychological or pharmacological treatment. It was seen as indicative of pre-disaster psychopathology if the participant endorsed either functional impairment or treatment for depressive or anxiety problems.

Utilization of mental health services was measured by one question: *Have you had therapy due to the tsunami disaster provided by any of the following professional categories: general practitioner, primary care counselor/psychologist, private psychotherapist, public psychiatric health professional, priest or deacon, occupational health service professional?* The response categories were *no* or *yes* at T1. At T2 and T3 the response categories were *no*, *1–2 occasions*, or ≥ 3 *occasions* at T2 and T3 (i.e., indicating treatment rather than assessment).

Satisfaction with social support was measured by one item from the Crisis Support Scale (Joseph et al., 1992): *“Are you, on the whole, pleased with the social support you have received after the tsunami?”* The respondents rated their overall satisfaction on a seven-point Likert scale, ranging from 1 (*never*) to 7 (*always*). The responses were coded as *low* (1-2), *moderate* (3-5) and *high* (6-7) levels of satisfaction.

2.3.2. Dependent variables

The Impact of Event Scale-Revised (IES-R; Weiss, 2004) was included in all surveys. The IES-R is a widely used self-rating scale to assess posttraumatic stress and includes eight items of intrusion, eight of avoidance, and six of hyperarousal reactions. The respondents rate how distressing the reactions have been during the past seven days on a five-point Likert scale ranging from 0 (*not at all*) to 4 (*extremely*), yielding a total score of 0-88. The psychometric properties of the IES-R, and its screening properties as compared to a structured clinical interview, were examined in a randomly selected subset of participants who had been exposed to the tsunami (Arnberg, Michel, & Johannesson, 2014). According to this study, the IES-R demonstrated excellent psychometric properties as evidenced in longitudinal stability in both its subscales and the screening threshold. A total score of > 30 on the IES-R yielded maximum sensitivity and specificity for detecting cases of PTSD at all assessments with a sensitivity that ranged from 0.80-1.0 at T1-T3 and a specificity that ranged from 0.75-0.93. The Cronbach’s alpha was 0.95 at T1.

The 12-item General Health Questionnaire (GHQ-12; Goldberg et al., 1997) is a widely used self-rating scale for evaluating the respondents' general mental health and has been validated in different cultures and languages. The GHQ reflects a decreased ability to undertake normal functions and the appearance of new and distressing phenomena. The GHQ scoring method was used in which the two first response alternatives are scored 0 whereas the third and fourth are scored 1. A summary index (0-12) is calculated. GHQ-12 has an internationally accepted cut-off score of ≥ 3 , indicating poor mental health (Connor et al., 2006). The Cronbach's alpha was 0.92 at T1.

2.4. Data Analysis

Demographic and outcome variables were checked for anomalies such as outliers, points of high influence, and non-random missing data. To test Hypothesis 1 we used a repeated-measures ANOVA to evaluate changes over time in posttraumatic reactions from T1 to T2, T2 to T3, and T1 to T3. The McNemar test was used for GHQ-12 to compare similar longitudinal changes in proportions of participants with poor general mental health. For the ANOVA and McNemar analyses we used data only from completers.

To test Hypothesis 2 we employed a latent growth mixture model (LGMM) using MPlus software (Muthen & Muthen, 2002) to identify longitudinal trajectories of posttraumatic stress symptoms among the directly exposed participants (high and moderate exposure groups) and to test predictors of class membership (Hypothesis 3). The LGMM utilizes a robust full information maximum-likelihood (FIML) estimation procedure and under the assumption that missing data are missing at random, it provides unbiased estimates using all available observations. Thus, the total number of observations in the high and moderate exposure groups with at least one measure of IES-R available for the MPlus analyses was $n = 3518$.

LGMM-analyses with one to six classes were estimated and compared based on the interpretability of the model, the number of participants in the classes, and a set of fit indices

(Muthen, 2004): Akaike's Information Criterion (AIC), the Bayesian Information Criterion (BIC), the sample size adjusted BIC (SSA-BIC), the Lo-Mendell-Rubin likelihood ratio test (LMR LRT). After determining the best-fitting model, posterior class assignments were used to test Hypothesis 3 in multinomial logistic regression analysis. The resilient trajectory was the reference category in the first analysis. In the second analysis, of post-disaster associated features, the indirect exposure group was the reference category. The analyses were based on participants with complete data from all predictors. The p -level was set to 0.05 (two-tailed). The regression analyses were performed in SPSS v.21 (IBM, Chicago, IL, USA).

3. Results

3.1. Analysis of attrition

At the six-year survey (T3) a higher response rate was found among women vs. men (60% vs. 54%; $p < 0.001$), among people with higher vs. lower educational attainment (61% vs. 54%, $p < 0.001$), and among people with high (61%) vs. moderate (57%), but not vs. low exposure severity (61%). Respondents were also somewhat older than non-respondents (mean age = 49 vs. 44 years; $p < 0.001$). No differences related to non-response at T3 could be discerned for T1 posttraumatic stress or poor general mental health.

3.2. Overall changes in event-specific and general distress

The proportion of participants that indicated severe posttraumatic stress reactions (IES-R >30), was 21% at T1, 12% at T2, and 11% at T3. Participants in the high exposure group had a higher level of long-term posttraumatic stress reactions at T3 as compared to those in the moderate and indirect exposure groups (Table 1). Whereas posttraumatic stress reactions decreased from T1 to T2, decreases from T2 to T3 were seen mainly in the high exposure group.

1 -----

2 Table 1 about here

3 -----

4

5 There were few changes across assessments in the proportion of participants with poor
6 general mental health, although the proportions decreased further from T2 to T3 among
7 bereaved participants (Table 2).

8 -----

9 Table 2 about here

10 -----

11 3.3 Trajectories of posttraumatic stress

12 The fits for three- and four-class solutions were relatively similar with a slight advantage for
13 the four-class solution (Table 3). The solutions with five and six classes demonstrated
14 somewhat better fit according to AIC, BIC, and SSA-BIC than solutions with fewer classes.
15 The results for the five-class solution yielded a very small class with only 1.1% of the sample.
16 For BIC and SSA-BIC the largest difference compared with a subsequent model were
17 between the four and three- trajectory solution (except for two trajectory solution compared to
18 one-trajectory solution). Accordingly, the four-class solution emerged as the optimal model
19 based on interpretability and parsimony.

20 -----

21 Table 3 about here

22 -----

The four-class unconditional solution identified four distinct trajectories of long-term posttraumatic stress symptoms from T1 to T3 (Fig. 1). A majority of the sample ($n = 2545$; 72.3%) was characterized by a *resilient class* with low levels of posttraumatic stress at each time point, intercept = 16.2, linear slope $B (s.e.) = -2.27 (0.33)$, $p < .001$, but not as low as the low-exposure reference group: $F=290.82$, $p<0.001$. *Recovery* ($n = 419$; 11.9%) was characterized by a trajectory with high levels of PTS at T1 but a gradual decrease in symptoms thereafter, intercept = -64.78, $B (s.e.) = -16.19 (0.46)$, $p < .001$. *Moderate chronic* ($n = 393$; 11.2%) was characterized by moderately high PTS at each time point with a slight increase in symptoms from T2 to T3, intercept = 29.51, $B (s.e.) = 1.10 (0.41)$, $p < .01$. Finally, *severe chronic* ($n = 161$; 4.6%) was characterized by a trajectory of a high level of PTS at each time point, intercept = 68.0, $B (s.e.) = -4.99 (0.70)$, $p < .001$. In comparison, for the indirect exposure group the intercept was 10.3 and the slope ($s.e.$) was $-2.06 (0.24)$, $p < 0.001$.

Fig 1 about here

Figure 1. Trajectories of posttraumatic stress among 3518 directly exposed survivors (solid lines) from the 2004 tsunami. The dashed line denotes an indirectly exposed comparison group ($n = 509$). Posttraumatic stress was assessed at 1 to 6 years after the event with the Impact of Event Scale–Revised (IES-R).

3.4. Predictors of the trajectory groups

A multinomial regression analysis with pre- and peri-traumatic variables as predictors of the trajectory groups is shown in Table 4. In comparison with the resilient group, the participants

of the three symptomatic groups were more likely to be female and to have been exposed to life threat during the tsunami. The recovery group was more likely to be of young age and to have suffered from previous psychiatric illness. Similar to the severe chronic group, the participants in the recovery group were more likely to have suffered loss of relatives in the disaster. Both the severe chronic group and the moderate chronic group were associated with lower educational attainment. The moderate chronic group was more likely to be middle-aged (41–60 years) at the time of the disaster. The moderate chronic group, but not the recovery or chronic groups, were more likely to have experienced more than three adverse pre-tsunami events in adulthood. As for the predictors with a putative influence during the first year post-disaster, participants in the symptomatic trajectories were more likely to have utilized disaster-related mental health services and less likely to be satisfied with social support during the first year after the disaster.

Table 4 about here

3.5 Long-term development

To examine the characteristics of the trajectories in greater detail, the trajectory groups were compared to the low exposure group with regard to post-disaster adverse events, mental health services, and satisfaction with support (Table 5). The exposed groups were more likely to have experienced post-disaster adverse events. Similarly, participants in all trajectories were more likely to have used mental health services. Low satisfaction with support characterized the two chronic groups, whereas satisfaction with support increased from T1 to T3 in the recovery group.

Table 5 about here

Finally, to shed light on the potential differences between the trajectories with severe and moderate levels of chronic posttraumatic stress, we repeated the multinomial regression analysis comparing the severe and moderate chronic groups. The analysis suggested that the severe chronic group was less likely to have a university education (OR = 0.43, 95% C.I. 0.20-0.94), more likely to report utilization of treatment at T2 (OR = 1.69, 95% C.I. 1.06-2.69), less likely to be satisfied with social support at T3 (OR = 0.55, 95% C.I. 0.31-0.98), and more likely to report additional adverse events after the tsunami (OR = 1.84, 95% C.I. 1.08-3.14).

4. Discussion

This study examined the long-term course of posttraumatic symptoms and signs of poor general mental health in a civilian Swedish population after a natural disaster. Stress symptoms were manifest but decreased during the follow-up, although not as markedly between three and six years post-disaster. Four distinct trajectories of long-term posttraumatic stress were identified: resilient, recovery, moderate chronic and severe chronic. The majority of participants were characterized as resilient, although they had higher levels of posttraumatic stress than a comparison group up to six years post-disaster. Severe disaster exposure and bereavement were associated with long-term distress.

In summary, the findings indicate that severe exposure causes broad and prolonged psychological disturbance. In spite of the character of the traumatic event, with limited risk for secondary stressors as the survivors could return to an intact society, distress was

expressed not only as elevated posttraumatic stress reactions but also as affected general mental health.

To our knowledge there are few studies of such a large civilian sample, with such a long follow-up, that report on trajectories of posttraumatic stress. Consistent with previous studies with a similar length of follow-up (Bryant et al., 2015; Pietrzak, Feder, et al., 2013), more than two thirds of the survivors demonstrated a resilient pattern. The present study extends prior research by including a comparison group, showing that despite the indicated robustness that characterizes the resilient group, that group reported higher levels of posttraumatic stress as compared to those with indirect exposure. The characteristics of low levels of posttraumatic stress are not well explored, and it may be that such reactions are better understood as aspects of adaptation rather than as being on the same continuum as severe and pathological reactions. However, those in the resilient group were more likely than those in the comparison group to receive disaster-related treatment in the long term, indicating a distressing quality even in low levels of posttraumatic stress. Clearly, further studies that compare trajectories among exposed survivors with those in unexposed controls are needed in order to understand fully the trajectories of distress after traumatic events.

The proportion of those categorized as recovered approximately corresponded to an Australian sample of patients with traumatic injuries (Bryant et al., 2015). The recovering group seemed to be somewhat younger than the resilient group and had a higher likelihood for female gender. The recovering group was more likely to report previous psychiatric illness: it may be that a higher prevalence of previous illness prolonged significant posttraumatic stress reactions and delayed recovery in this group as compared to the resilient group, although the lack of data from the first year prevent further clarifications of this issue. Similar to the severe chronic group, the participants in the recovering group were more likely to have suffered a loss of relatives. However, the distinct decrease in posttraumatic stress from three to six years

1 is worth noting, as it underscores the possibility of further long-term recovery and raises
2 optimistic expectations of long-term progress in some individuals. Besides being younger, the
3 recovering group was more likely to have a higher educational attainment and to be more
4 satisfied with social support in the long term, factors that have been associated with lower risk
5 and a more benign development (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, &
6 Weiss, 2003).

7 Consistent with previous studies concerning non-traditional World Trade Center responders
8 (Pietrzak, Feder, et al., 2013) and deployed US military service members (Bonanno et al.,
9 2012), a moderate chronic class appeared in our analyses and was almost as large as the
10 recovery group. Compared to the resilient group, the moderate chronic group was more likely
11 to be middle-aged, to have a lower educational attainment and, in contrast to the other
12 trajectories, to be more likely to report several pre-disaster adverse events during adulthood,
13 with the last two factors being noted as risk factors for PTSD (Brewin et al., 2000). The levels
14 of posttraumatic stress were essentially unchanged in the long term, indicating more
15 consolidated distress at levels bordering on PTSD, as indicated by our validation of the IES-R
16 in this sample (Arnberg et al., 2014). Although the severe chronic group was the smallest,
17 which is in line with previous reports (Bonanno et al., 2011; Bryant et al., 2015), this group
18 includes the hardest-hit participants in the study, with an almost seven times higher risk for
19 being exposed to life threat and an almost five times higher risk for having suffered traumatic
20 bereavement. In addition, in relation to the moderate chronic group, the larger likelihood for
21 lower education, indication of more additional negative life events after the tsunami and
22 greater disappointment with social support might contribute to a less benign pattern of
23 resilience. The moderate chronic and the severe chronic groups combined made up almost
24 16% of the exposed sample, which is a substantial proportion of the survivors.

1 No delayed trajectory appeared in our analyses. Delayed reactions have been debated and they
2 could be delayed elevation of threshold symptoms (Bonanno et al., 2011). Delayed onset is
3 rare in the absence of any prior symptoms (Andrews, Brewin, Philpott, & Stewart, 2007).
4 Although there might well have been delayed reactions within the first year, we believe that
5 the low number of secondary stressors reported by the present sample provided fewer triggers
6 for a late resurgence of posttraumatic stress reactions (Tracy et al., 2011). We also note that
7 although we chose a model with four trajectories based on interpretability and parsimony,
8 there were indications of heterogeneity within these trajectories as indicated by the LMR-test.

9 Corresponding to findings from our three-year follow-up (Johannesson, Lundin, Frojd, et al.,
10 2011), and in accordance with other studies (Gilbertson et al., 2010; McLaughlin et al., 2011;
11 North, Pollio, et al., 2011), exposure to life threat and bereavement were important
12 determinants for the symptomatic trajectories. The violent circumstances involved in a
13 traumatic loss have been suggested as risk factors for PTSD (Kaltman & Bonnano, 2003).
14 There is some evidence that sudden bereavement impacts posttraumatic stress through long-
15 standing feelings of guilt (Kristensen, Weisaeth, & Heir, 2012).

16 A low level of satisfaction with social support at all assessments was associated with higher
17 levels of distress. In the analysis of predictors for the symptomatic trajectories we noted a
18 higher risk for dissatisfaction with social support, utilization of more mental health services,
19 and more post-disaster adverse events as compared to the low exposure group. It appears that
20 even after many years, individuals who experience disaster-related psychological distress feel
21 let down, are vulnerable to stressors, and feel distressed to the extent that they seek out
22 treatment. We hesitate to draw firm conclusions based on these data alone; however,
23 considered together with findings from other disasters, it seems increasingly clear that single
24 transient events can also have negative effects on psychological adjustment in a very long-
25 term perspective (Breslau, 2001; Galea et al., 2008; North, Pfefferbaum, et al., 2011).

1 There are limitations of the present study that must be recognized. The response rate in the
2 first survey was modest (49%), although low response rates are not uncommon in studies of
3 disasters (Bonanno, Galea, Bucciarelli, & Vlahov, 2006; McFarlane, Clayer, & Bookless,
4 1997). A thorough investigation of nonresponse in a highly similar survey of Norwegian
5 tsunami survivors found that individuals who were not exposed were less likely to respond
6 (Hussain, Weisaeth, & Heir, 2009). Thus, potential bias due to nonresponse would affect the
7 comparison group and have less influence on the trajectory analysis. A second limitation is
8 the lack of data for the one-year period after the disaster, which could have shed more light on
9 the development of reactions and on the possibility of delayed reactions within this time
10 period. We therefore reiterate that the findings herein concern long-term distress. Third,
11 despite the use of an extensive set of items concerning disaster exposure, several indicators
12 were assessed with one or two items only, which can increase the risk for error and may fail to
13 capture multifaceted aspects such as social support (Joseph, Andrews, Williams, & Yule,
14 1992). Fourth, the indicators of direct trauma exposure used for categorization into high and
15 moderate exposure were tailored to the specific event and not an established measure of
16 exposure. In our previous studies (Johannesson, Lundin, Frojd, Hultman, & Michel, 2011),
17 however, this gradient in direct exposure was linked to differences in posttraumatic stress.
18 Nevertheless, the LGMM analyses were based on the combined group of directly exposed.
19 Finally, we are cognizant of the limitations associated with self-report data. In this respect our
20 study is an improvement over previous studies because of the validation of the IES-R in a
21 subsample.

22 Having noted these limitations, this study nevertheless has major strengths. In this field of
23 research there are few studies that incorporate a comparable longitudinal design, large sample,
24 detailed exposure classification, and a highly similar comparison group. In addition, the
25 survivors were mainly from higher socioeconomic strata, with few pre-disaster stressors, and

they returned to mainly intact communities with few secondary stressors. Together with the dose-response pattern, these characteristics suggest a causal pathway between the disaster and the long-term psychological distress.

4.1. Conclusions

This long-term study of a non-clinical civilian population exposed to a single trauma demonstrates the risk for elevated symptoms of distress for several years, mainly after severe exposure and traumatic bereavement of family members. Different trajectories of long-term distress are apparent and are largely consistent with previous studies.

Although a majority of the survivors can be categorized as resilient, with low symptom levels over time - indeed, with lower rates of poor general mental health than a highly similar comparison group - their event-specific distress is still higher than what would be expected. Among those who do recover the recovery process can take several years, and the length may be related to pre-existing psychiatric illness. Severe life threat and traumatic bereavement are powerful determinants for long-term psychological distress. These findings have potentially important implications regarding anticipation of long-term psychological adjustment after natural disasters. From a clinical perspective we can anticipate long-term resilience and recovery in the majority of disaster survivors in the context of a transient disaster with limited influence of secondary stressors. Further research is needed to determine to what extent symptomatic recovery and resilience, but particularly moderate chronic distress, correspond to measures of function and quality of life. This study also highlights the risk and the burden of long-term negative effects in a substantial proportion of survivors, particularly after severe exposure and bereavement. These findings imply that psychosocial post-disaster support systems may benefit from including services that can be sustained over several years targeting a minority of survivors. Finally, the increasing knowledge about trajectories of posttraumatic stress after disasters can provide better ways of ultimately predicting survivors' trajectories, in

order to allocate scarce resources to those in greatest risk of severe or moderate chronic distress.

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Conflict of interest

None

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