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## Abstract

**Background** Survivors of natural disasters are thought to be at an increased risk of psychiatric disorders, however the extent of this risk, and whether it is linked to pre-existing psychopathology, is not known. We aimed to establish whether Swedish survivors of tsunamis from the 2004 Sumatra–Andaman earthquake had increased risks of psychiatric disorders and suicide attempts 5 years after repatriation.

**Methods** We identified Swedish survivors repatriated from southeast Asia (8762 adults and 3742 children) and 864 088 unexposed adults and 320 828 unexposed children matched for sex, age, and socioeconomic status. We retrieved psychiatric diagnoses and suicide attempts from the Swedish patient register for the 5 years after the tsunami (from Dec 26, 2004, to Jan 31, 2010) and estimated hazard ratios (HRs), then adjusted for pre-tsunami psychiatric disorders, and, for children, for parental pre-tsunami disorders.

**Findings** Exposed adults were more likely than unexposed adults to receive any psychiatric diagnosis (547 [6.2%] *vs* 47 734 [5.5%]; adjusted HR 1.21, 95% CI 1.11–1.32), particularly stress-related disorders (187 [2.1%] *vs* 8831 [1.0%]; 2.27, 1.96–2.62) and suicide attempts (38 [0.43%] *vs* 2752 [0.32%]; 1.54, 1.11–2.13), but not mood or anxiety disorders. Risk of psychiatric diagnoses did not differ between exposed and unexposed children and adolescents (248 [6.6] *vs* 22 081 [6.9%]; 0.98, 0.86–1.11), although exposed children and adolescents had a higher risk for suicide attempts with uncertain intent (1.43; 1.01–2.02) and stress-related disorders (1.79; 1.30–2.46), mainly during the first 3 months after the tsunami.

**Interpretation** The 2004 tsunami was, independently of previous psychiatric morbidity, associated with an increased risk of severe psychopathology, mainly stress-related disorders and suicide attempts, in children and adults. Survivors of natural disasters should be targeted with early interventions and active long-term follow-up to prevent, detect, and alleviate psychiatric disorders that might follow.

## Introduction

In the last decade, natural disasters afflicted more than 200 million people each year,<sup>1</sup> resulting in loss of lives, property destruction, and psychological suffering worldwide. Literature reviews suggest that survivors are at increased risk of psychiatric disorders, particularly posttraumatic stress disorder (PTSD).<sup>2-5</sup> As noted previously,<sup>6-8</sup> however, due to the limitations of past studies uncertainties remain about the effect of disaster exposure on the risk of PTSD,<sup>3-5</sup> other psychiatric diagnoses,<sup>9,10</sup> and suicide attempts.<sup>11</sup> Given the well-known lasting nature of severe stress-related disorders,<sup>12</sup> surprisingly few studies have followed survivors beyond the first three years post-disaster,<sup>6-8</sup> and existing long-term studies often suffer from attrition or small samples.<sup>13</sup> Furthermore, the majority of investigations rely on self-reported outcomes without a clinical assessment.<sup>13,14</sup> Similarly, researchers have largely relied on retrospective self-reports on pre-disaster psychopathology.<sup>6,7</sup> There are a few exceptions,<sup>15-17</sup> and they generally show that pre-existing psychopathology influences post-disaster mental health. Thus, it awaits to be firmly established the extent to which disasters induce lasting risks of severe psychiatric disorders independently of underlying vulnerabilities.

With complete population registries of healthcare utilization and medical diagnoses of every inhabitant, Sweden provides an excellent setting for such investigations. On December 26, 2004, a massive earthquake caused a series of tsunamis that inundated coastal areas around the Indian Ocean<sup>18</sup> and took more than 200,000 lives.<sup>19</sup> The Swedish government estimated that 20,000 Swedish tourists were in Southeast Asia at the time of the event; 543 Swedish lives were lost, making Sweden the hardest hit country after the countries in Southeast Asia.<sup>20</sup> The Swedish authorities organized an airlift to evacuate survivors and within 20 days approximately 16,000 citizens were repatriated to their intact homes and communities.<sup>20</sup> Traumatic experiences and self-reported distress have been reported among the Swedish survivors<sup>21,22</sup> while it remains unexplored whether this population suffers lasting risks of psychiatric disorders as diagnosed in healthcare services. The aim of this study was to understand whether tsunami survivors, independently of their pre-tsunami psychiatric history, had elevated risks of receiving psychiatric diagnoses and committing suicide attempts during five years after the tsunami. We also planned a dose-response analysis in a

subgroup of survivors with available data on disaster exposure severity, expecting that more severe exposure was related to increasing risk of a psychiatric diagnosis.

## **Methods**

### **Study population and design**

We did a matched cohort study of Swedish inhabitants who arrived at Swedish airports from selected destinations in southeast Asia between Dec 26, 2004, and Jan 15, 2005, and were confirmed alive through the register of the state police services (n=16068). The socioeconomic characteristics of the group returning from southeast Asia were considerably different from those of the general population (table 1).<sup>23</sup> We therefore matched exposed individuals to unexposed individuals with similar characteristics (appendix). To draw from national register data in the matching process, we selected native Swedes (n=14002), comprising adults (n=10 248; age  $\geq 18$  years in 2004; median age 42.10 years [IQR 19.26]) and children and adolescents (n=3754; age <18 years in 2004; median age 12.58 years [6.01]). We then included only those with permanent residence in Sweden at the time of the event. Each exposed individual was matched with about 100 unexposed individuals to ascertain a sufficient number of incident cases in the unexposed group.

The comparison group was matched to the exposed group through the Swedish total population register on the following variables: sex, birth year, cohabitation (yes or no), educational attainment (primary and lower secondary, upper secondary, postsecondary, postgraduate), employment status (unskilled/blue or white collar, according to the Statistics Sweden adaptation of the International Standard Classification of Occupation 2008), and annual income in 2004 (<20 or 20–79 or  $\geq 80$  percentile). We matched children and adolescents for sex, birth year, parental cohabitation status, disposable family income, education, and employment of both parents as defined above.

The final cohort included 8762 exposed and 864088 unexposed adults and 3742 exposed and 320 828 unexposed children and adolescents. We followed the exposed and matched cohorts from Dec 26, 2004, until emigration, death, or end of follow-up (Jan 31, 2010), whichever came first.

Individuals returning from southeast Asia were registered in a database by Swedish officials, and could therefore, together with the matched individuals, be linked to the Swedish patient register<sup>24</sup> for ascertainment of psychiatric diagnoses by using their unique personal identification numbers.<sup>25</sup> The Swedish patient register includes all primary and secondary diagnoses according to ICD-10<sup>26</sup> made in psychiatric inpatient care in Sweden since 1973 and in psychiatric outpatient visits at private and public caregivers since 2001.<sup>27</sup> The coverage of the Swedish patient register was reported in 2010 to be as high as 97% of all psychiatric diagnoses needing inpatient care.<sup>27</sup> The coverage for outpatient visits was 72–75% in 2004–10. For these visits, a diagnosis was registered in 42% of the visits in 2004 and had increased to 91% in 2010.<sup>24</sup>

The study was approved by the Regional Ethics Committees of Karolinska Institutet and Uppsala University. After register-linkage on national identifiers, unique for every Swedish resident, data analyses were done on deidentified datasets.

## **Outcomes**

Our assessed outcomes were first presentation of a psychiatric disorder (diagnostic codes F00–F99), a definite suicide attempt based on a diagnosis of intentional self-harm (X60–X84), or an uncertain suicide attempt based on a diagnosis of events of undetermined intent (Y10–Y34). For the sake of precision we report mainly diagnoses in the category of disorders related to stress and adjustment disorders (F43; henceforth labeled stress-related disorders), and diagnoses with 20 or more events in the tsunami cohort during the observation period. We report all psychiatric diagnoses in the appendix.

## **Exposure severity**

Exposure severity is an important risk modifier for post-traumatic psychopathology,<sup>28,29</sup> and a diagnosis of PTSD is conditional on traumatic exposure.<sup>26</sup> Therefore, we did an analysis in tsunami survivors who had available data for exposure severity. We collected exposure data in a postal survey sent 14 months after the event to 10 501 tsunami survivors from the repatriated cohort who were aged 16 years or older; 4932 (47%) responded.<sup>22</sup> We included 3534 respondents who had complete data on matching variables and thus were used in the main analysis.

Categorisations of exposure severity usually differentiate between being subjected to life threat and indirect exposure.<sup>22,28,29</sup> We categorised survey participants to direct exposure, indirect exposure, or low exposure groups accordingly on the basis of 30 survey items that asked about their disaster experiences.<sup>22</sup> Participants were included in the direct exposure group if they had been caught in or chased by the tsunamis, had felt that their life was threatened, or had injuries needing immediate inpatient care. The indirect exposure group included participants who reported none of the above, but indicated bereavement of relatives, minor physical injuries to themselves or their loved ones, or being witness to distressing disaster scenes (e.g., dead bodies, wounded survivors).

### **Statistical Analysis**

We used Cox regression models conditioned on the matching variables to calculate the hazard ratios (HRs) for relative risks of any psychiatric disorder as well as specific diagnostic groups between the tsunami survivors and the unexposed cohorts. We individually matched cohorts for age, sex, and socioeconomic characteristics. We did analyses with and without adjustment for pre-tsunami psychiatric diagnoses (i.e., any outcome documented in the Swedish patient register from Jan 1, 1973, to Dec 25, 2004). We did similar for children while also adjusting for previous psychiatric diagnoses of their parents. We compared each exposure group against their respective unexposed controls with and without adjustment for traumatic bereavement. To clarify the role of bereavement, we did an analysis on the survey subsample from the exposure population stratified by bereavement (yes or no). Lastly, we compared overall survival curves, constructed with the Kaplan-Meier method, with the log-rank test between groups and we calculated HRs for psychiatric disorders in the tsunami survivors at different times of follow-up (categorised as 0–3, 4–11, 12–23, and  $\geq 24$  months post-disaster) as compared with the unexposed cohorts. We did statistical analyses with SAS software (version 9.3).

### **Role of the funding source**

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. FF and AB had access to the raw data and did the

statistical analyses. With approval from all authors, FKA and UAV had the final decision to submit.

## Results

During the 5 years after the tsunami (mean follow-up 59 months [SD 6.37]), 547 (6.2%) new psychiatric diagnoses were recorded for the adult tsunami-exposed cohort and 47 734 (5.5%) for the matched unexposed cohort. The corresponding numbers of pre-tsunami diagnoses in adults were 427 (4.9%) and 47 329 (5.5%), respectively. Overall relative risk of psychiatric disorders was increased in the tsunami cohort (adjusted HR 1.21, 95% CI 1.11–1.32), particularly for PTSD (table 2, appendix). The risk of PTSD among survivors was seven times higher than that in the matched population (adjusted HR 7.51; 95% CI 5.47–10.32), whereas risks were not raised for anxiety disorders and depression (table 2). Risk of definite suicide attempt was increased in exposed women but not men, whereas the risk of alcohol disorders was increased in exposed men but not women (table 2).

88 (2.4%) children and adolescents in the tsunami cohort and 10 096 (3.2%) in the unexposed cohort had pre-tsunami psychiatric diagnoses. The number of diagnoses after the tsunami were similar between cohorts—248 (6.6%) of those in the exposed cohort compared with 22 081 (6.8%) in the unexposed cohort (table 3). The overall risk of a post-tsunami disorder was not increased in the tsunami cohort (adjusted HR 0.98, 95% CI 0.86–1.11), but risks were higher of stress-related disorders (1.79, 1.30–2.46) and suicide attempts (1.43, 1.01–2.02) with uncertain intent (table 3). By contrast, exposure to the tsunami was linked to a lower risk of anxiety disorders and unipolar depression (table 3, appendix).

A post-hoc analysis of stress-related disorders and attempted suicide in which we stratified children by sex indicated an increased risk in both boys and girls for stress-related disorders (14 [0.76%] vs 546 [0.34%], adjusted HR 2.26, 95% CI 1.33–3.86 for boys; 25 [1.32%] vs 1281 [0.79%], 1.59, 1.06–2.39 for girls). Risk was increased of uncertain suicide attempts in boys (2.26, 1.33–3.89), but not in girls (1.19, 0.67–2.10).

Because of the dissimilar findings for stress-related disorders versus other psychiatric disorders, and to preserve precision for meaningful comparisons, we used diagnostic

groups composed of stress-related disorders and non-stress-related disorders (i.e., mental disorders except for stress-related disorders) in the analyses for time from disaster to diagnosis. For adults, exposure to the tsunami was associated with a shorter time to a diagnosis of stress-related disorders (log-rank  $\chi^2=0.93$ ;  $p<0.0001$ ; figure 1). The adult tsunami cohort had a higher risk of stress-related disorders at each individual time period, peaking in the first 3 months post-exposure (table 4). For children and adolescents, exposure was related to a shorter time to diagnosis of stress-related disorders (log-rank  $\chi^2=0.099$ ,  $p=0.001$ ), whereas the risk was increased only during the first 3 months (figure 1; table 4). In neither adults nor children was tsunami exposure associated with a shorter time to diagnosis of non-stress-related disorders and we found no indications of a higher risk of these disorders at any specific time interval (table 4).

We categorised 1660 people into the direct exposure group and 903 into the indirect exposure group. Individuals in the direct exposure group also frequently reported experiences in the indirect exposure category (e.g., bereavement of relatives, minor physical injuries to themselves or their loved ones, or witnessing distressing disaster scenes). 231 participants in the direct and 111 in the indirect exposure group indicated bereavement of family members (29% of those bereaved), relatives (16%), or friends (67%). The 971 people in the low exposure group did not endorse any of the 30 exposure survey items, but were likely to have been in areas proximal to the afflicted ones and have met or travelled with distressed survivors.

Data suggested a dose–response relation between increasing severity of exposure and risk of psychiatric disorders (figure 2, appendix). Direct exposure was related to an increased risk of any psychiatric disorder compared with unexposed individuals (HR 1.51, 95% CI 1.25–1.83); mainly stress-related disorders (3.18, 2.40–4.22) and particularly PTSD (14.6, 8.60–24.9). Direct exposure was also related to a higher risk of alcohol abuse (1.65, 1.08–2.53). Indirect exposure was related to only a higher risk of PTSD (3.48, 1.02–11.9). Low exposure was related to an overall lower risk of any psychiatric diagnosis compared with the unexposed group (0.69, 0.48–0.98), whereas no difference was found for individual diagnostic categories (lowest  $p=0.22$ ).

After adjustment for bereavement status (yes or no), the elevated risks in directly exposed individuals were somewhat attenuated for stress-related disorders (HR 1.97,



95% CI 1.36–2.87) and PTSD (6.31, 2.71–14.67), whereas the risk of alcohol abuse was essentially unchanged (1.71, 1.10–2.66). For the indirect exposure group, the raised risk of PTSD was no longer significant after adjustment for bereavement status.

After we compared the bereaved survivors to their matched controls (appendix), risks of any disorder were raised (48 [14%] *vs* 1840 [5%]; adjusted HR 3.47, 95% CI 2.59–4.64), mainly driven by stress-related disorders (26 [8%] *vs* 380 [1%]; 7.92, 5.26–11.91). For individuals who were exposed but not bereaved (*n*=3192), only risk of stress-related disorders was significantly higher (45 [1%] *vs* 3258 [1%]; 1.42, 1.05–1.91; appendix).

## Discussion

We did a 5 year follow-up of Swedish citizens after the 2004 Indian Ocean tsunami and provide evidence for an increased short-term risk of post-tsunami psychiatric disorders, especially stress-related disorders, in adults and children and adolescents. In children and adolescents, the increased risk was limited to the first 3 months after the disaster, whereas, in adults, the increased risk of stress-related disorders peaked and then continued for the 5 year follow-up. In this cohort of individuals predominantly from higher socioeconomic strata, we show increased risks of suicidal attempts in women and alcohol abuse in men. Our study is the first to provide complete and prospectively collected data, with virtually no loss to follow-up, for the effect of a large-scale disaster on psychiatric morbidity in a civilian population that also accounted for pre-disaster psychiatric morbidity and used a sociodemographically matched unexposed cohort.

The increased risk of psychopathology in both adult and children survivors was mainly caused by a rise in PTSD and other stress-related disorders, which concurs with findings from previous studies for various traumatic events.<sup>3,4</sup> The link between trauma exposure and stress-related disorders is strengthened by the indication of a dose-response pattern of exposure severity among adults, and retained raised risks among directly exposed individuals after adjusting for bereavement. Notably, only direct exposure was related to increased risks after bereavement adjustment, and this group probably contributed to the higher risk of stress-related disorders seen in those

who were not bereaved. In addition, our data confirm the strong effect of bereavement associated with traumatic events on future risk of psychopathology.<sup>8</sup>

Adult survivors had protracted stress-related disorders diagnosed across several years after the event, extending findings from previous studies that show prolonged effects of trauma, but that did not adjust for pre-event disorders—e.g., findings after the 2001 World Trade Center terrorist attacks.<sup>13</sup> However, risk in children was only raised in the first 3 months after the disaster, suggesting general resiliency in children; smaller studies have shown unclear findings for the long-term effects in children.<sup>4</sup> Adverse post-disaster events are associated with chronic PTSD symptom maintenance in children,<sup>30</sup> which might explain the absence of any increased long-term risk in our cohort.

We showed an increased risk of suicide attempts in adults, and of suicide attempts with uncertain intent in boys. The category suicide attempts with uncertain intent includes injuries from accidents, self-inflicted injuries, and assaults, which indicate impulsivity and risk-taking behaviour. These behaviours increase in young people after trauma<sup>31</sup> and are being increasingly recognised as symptoms of PTSD in adolescents.<sup>32</sup> Among psychiatric disorders, PTSD is one of the strongest predictors of suicide attempts in adults and has been associated with a seven-times increased risk of suicide.<sup>33</sup> Taken together, it seems that the effects of the tsunami independent of previous psychopathology were largely related to stress-related disorders.

We showed a raised risk of alcohol-related disorders in exposed men. Previous work has suggested that post-disaster alcohol disorders are associated with pre-disaster misuse.<sup>9</sup> By contrast, our data indicate that disaster exposure might exacerbate pre-existing alcohol problems or lead to new cases. The different methods of other investigators necessitate further robust research to test the consistency of this finding.

The post-tsunami circumstances for the survivors—returning to an intact home environment and support networks—might have averted development of mood and anxiety disorders.<sup>34</sup> This is supported by previous findings that link the occurrence of these disorders in adults after a disaster to secondary stressors and adverse life circumstances.<sup>14,29</sup> For children, previous work has linked disaster exposure severity to more severe PTSD symptoms, but not depression or anxiety.<sup>15,35</sup> In this cohort we

show lower risks of mood and anxiety disorders in those exposed than in unexposed individuals, possibly because of a resiliency not accounted for by the matching variables. Overall, the risk estimates increased when adjusting for pre-existing diagnoses, relating to the slightly lower prevalence of pre-tsunami diagnoses in the exposed cohort than in the matched controls.

The Swedish nationwide complete registries provide prospective information on clinically confirmed psychiatric disorders. Thus, outcome ascertainment in our study is nearly complete and does not rely on retrospective self-reports, which lowers risks of selection bias and various sources of information bias. Use of these resources allowed us to adjust for prospective data for pre-tsunami psychopathology. Also, whereas the effect of a disaster itself is usually confounded with the effects of post-disaster stressors,<sup>10,34</sup> in our study the survivors returned to an environment unaffected by the disaster and had very few other post-disaster stressful events during the follow-up.<sup>21,22,36</sup> We showed a dose–response pattern, increasing our confidence in the direct link between the tsunami and later psychopathology.

There are some limitations to our study. First, the outcomes concern severe symptoms with functional impairment suffice for the survivors or their parents to seek professional help and then be referred to specialist care within a public health-care system. Several survivors received interventions from services that do not provide data to the Swedish patient register (e.g., support centres, primary care).<sup>37</sup> Thus, we emphasise that the reported risks do not show the exact prevalence of post-tsunami psychiatric disorders.

Health-care-seeking behaviours might differ between the exposed and unexposed groups because the survivors might have been encouraged to seek and receive care for ill health. Disaster survivors with substantial distress seem to be reluctant to seek health-care services,<sup>38,39</sup> although neither exposure status nor distress levels seem to have affected health-care-seeking behaviour in Danish survivors of the 2004 tsunami.<sup>40</sup>

Also, doctors might have been biased towards stress-related diagnoses among exposed due to cognitive biases (e.g., discounting the probability of non-stress-related diagnoses among exposed, or exposed patients framing their health on the tsunami),

which would magnify the differences shown here. However, our survival curves do not indicate an exaggerated number of stress-related diagnoses because this would be accompanied by a corresponding decrease in other diagnoses. Additionally, the findings for increased suicide attempts are less, if not at all, susceptible to this bias, lending particular weight to this outcome.

Despite the large sample size and several years of follow-up, few incident cases were diagnosed for several disorders, yielding inconclusive findings for several outcomes. This limitation is particularly noticeable in the survey sample. Because this was the first study to investigate outpatient and inpatient psychiatric diagnoses after a disaster we opted to analyse all diagnosis groups. The high socioeconomic status of the exposed cohort needed a careful matching process. Nonetheless, the pre-tsunami psychiatric morbidity was slightly lower in the tsunami cohort than in the unexposed cohort, which suggests the existence of unmeasured confounders and suggests that the tsunami group was generally more predisposed against psychopathology. This finding also diminishes the probability of potential bias due to the fact that we were not able to match for urban versus rural dwelling as a proxy for access to specialised mental health services. The lower risk of post-disaster psychopathology in the low-exposure group might also show that low exposure was insufficient to produce severe psychopathology<sup>28</sup> while the event simultaneously resulted in an influx of beneficial factors such as social support.

Finally, we started data collection on the day of the disaster so that we did not omit any potential cases. However, most exposed individuals were abroad during the first few days, whereas unexposed individuals provided outcome data from day one. Given that the repatriation took place within 3 weeks and the average time to diagnosis was more than 2 years, we assume that the potential bias would be small and, if anything, result in conservative estimates. Further conservative bias is also likely in the large tsunami cohort due to slight oversampling at the airports because circumstances prevented a thorough verification of the repatriated individuals' exposure to the tsunami.

In conclusion, Swedish survivors from this major yet, for them, transient natural disaster had an increased risk of severe psychopathology, predominantly caused by stress-related disorders. In a population and context that otherwise have a low risk of

psychiatric illnesses, it is reasonable to assume that the disaster itself was the causal agent for the raised risk. The increased long-term risk among exposed adults underscore the need for prolonged observation periods in both research and clinical practice.

### **Contributors**

All authors conceived of and designed the study and interpreted the data. FKA, PL, CMH, and UAV acquired the data. AB and FF analysed the data. FKA, FF, and UAV drafted the work, and RG, AB, FF, PL, and CMH revised it critically for important intellectual content.

### **Declaration of interests**

We declare no competing interests.

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## **Research in context**

### **Evidence before this study**

We searched reviews and PubMed for papers published in English between Jan 1, 2005, and Jan 1, 2015, and found no reports for psychiatric outcomes after a disaster with use of a matched comparison group. Our search string was (((disasters[MeSH Terms]) AND cohort studies[MeSH Terms]) AND ((comparison OR control)))) AND disorder, mental[MeSH Terms]. Other published work shows that a substantial number of disaster survivors have transient post-traumatic stress. Yet, studies of mental health in disaster survivors have methodological challenges. Several comprehensive literature reviews report that most studies are small, cross-sectional, short term, do not have (or are limited to retrospective self-report) data for pre-existing psychopathology, and do not use matched unexposed comparison groups. Uncertainties remain about capacity of the disastrous event, independent of psychiatric morbidities and secondary trauma, to produce severe psychopathology, including suicide attempts.

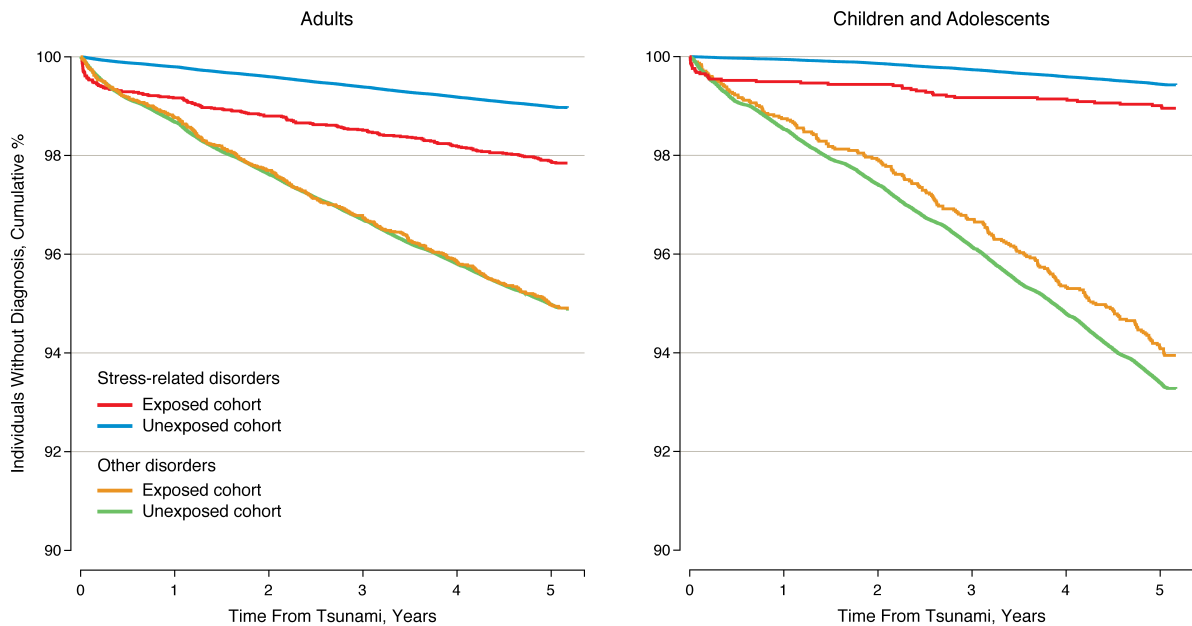
### **Interpretation**

Findings from our study robustly show that a transient disaster can, in the absence of severe secondary stressors (loss of property, etc.), lead to longstanding increased risks of stress-related psychiatric diagnoses and suicide attempts in adults, and short-term effects in children, after accounting for pre-existing psychopathology.

### **Implications of all the available evidence**

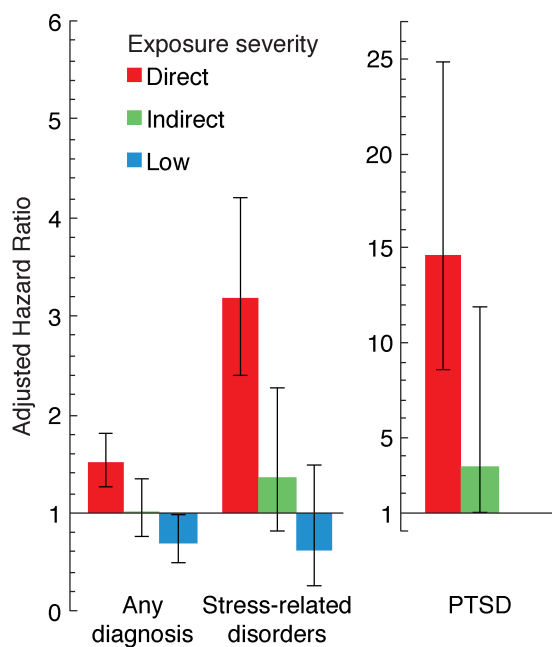
Early surveillance of children and prolonged monitoring of adult survivors is important after natural disasters.

## Figures



**Figure 1. Time to a diagnosis of psychiatric disorders in tsunami survivors as compared with matched unexposed individuals**

Log-rank  $p < 0.001$  for stress-related disorders in both adults and in children and adolescents.



**Figure 2. Risk of any psychiatric diagnosis, stress-related disorders, and PTSD in tsunami survivors**

We stratified survivors by disaster exposure and compared with matched unexposed individuals. HRs are adjusted for pre-disaster psychiatric diagnoses. Error bars are 95% CI. No cases of PTSD were reported in the low-exposure group. PTSD=post-traumatic stress disorder.

## Tables

**Table 1: Demographic characteristics and psychiatric history in the tsunami cohort and general Swedish population**

	General population (N=7285292)		Tsunami-exposed cohort (N=12734)	
	No.	%	No.	%
Age, years				
16–29	1 505 365	21	3 638	29
30–49	2 457 821	34	5 651	44
>49	3 322 106	46	3 445	27
Women	3 704 955	51	6 152	48
Born in Sweden	6 272 329	86	11 383	89
Post-secondary education*†	1 869 820	30	4 887	41
Married or cohabiting*	3 084 784	44	5 041	42
Yearly income in population top 20%*	1 445 547	20	4 273	34
Unskilled or blue-collar occupation*§	1 519 287	29	2 011	20
Pre-event psychiatric disorders*	637 632	9	697	6
Psychiatric disorders among fathers	350 350	5	750	5
Psychiatric disorders among mothers	398 733	6	832	7

Data from individuals included in the Longitudinal Integration Database for Health Insurance and Labour Market Studies in 2004.<sup>23</sup>  $p < 0.001$  for all comparisons between groups according to two-tailed  $\chi^2$  tests.

\*Data only for adults (general population=7 053 259; tsunami cohort=12 050).

†Highest level of education is missing for 14% of the general population and 1.4% of the tsunami-exposed cohort.

§Occupation was unknown for 27% of the general population and 15% of the tsunami-exposed cohort.

ve risks of psychiatric disorders and attempted suicide in adults during the 5 years after the tsunami

	Total				Men			Women		
	No. (%)		HR (95% CI)		No. (%)		HR (95% CI)	No. (%)		HR (9
	Exposed n=8762	Unexposed n=864088	Crude	Adjusted*	Exposed n=4544	Unexposed n=448057	Adjusted*	Exposed n=4218	Unexposed n=416031	Adj
order	547 (6.24)	47734 (5.52)	<b>1.14 (1.04-1.24)</b>	<b>1.21 (1.11-1.32)</b>	246 (5.41)	21519 (4.80)	<b>1.17 (1.02-1.33)</b>	301 (7.14)	26215 (6.30)	<b>1.25 (1</b>
finite	38 (0.43)	2752 (0.32)	1.36 (0.99-1.87)	<b>1.54 (1.11-2.13)</b>	16 (0.35)	1205 (0.27)	1.41 (0.85-2.34)	22 (0.52)	1547 (0.37)	<b>1.65 (1</b>
certain	43 (0.49)	3438 (0.40)	1.24 (0.92-1.68)	1.27 (0.94-1.71)	27 (0.59)	2035 (0.45)	1.32 (0.91-1.92)	16 (0.38)	1403 (0.34)	1.19 (0
n	176 (2.01)	18130 (2.10)	0.96 (0.83-1.11)	1.03 (0.88-1.19)	56 (1.23)	7208 (1.61)	0.79 (0.61-1.04)	120 (2.84)	10922 (2.63)	1.19 (0
ndence	102 (1.16)	8467 (0.98)	1.17 (0.97-1.43)	<b>1.27 (1.04-1.54)</b>	72 (1.58)	5775 (1.29)	<b>1.30 (1.03-1.64)</b>	30 (0.71)	2692 (0.65)	1.20 (0
pendence	42 (0.48)	4073 (0.47)	1.01 (0.75-1.37)	1.11 (0.82-1.50)	29 (0.64)	2392 (0.53)	1.27 (0.88-1.83)	13 (0.31)	1681 (0.40)	0.87 (0
	148 (1.69)	16434 (1.90)	0.89 (0.76-1.04)	0.95 (0.81-1.12)	62 (1.36)	6386 (1.43)	1.00 (0.78-1.29)	86 (2.04)	10048 (2.42)	0.92 (0
ders	187 (2.13)	8831 (1.02)	<b>2.10 (1.82-2.43)</b>	<b>2.27 (1.96-2.62)</b>	71 (1.56)	3211 (0.72)	<b>2.30 (1.81-2.90)</b>	116 (2.75)	5620 (1.35)	<b>2.25 (1</b>
tion	75 (0.86)	3636 (0.42)	<b>2.03 (1.62-2.54)</b>	<b>2.16 (1.72-2.71)</b>	29 (0.64)	1492 (0.33)	<b>1.96 (1.36-2.83)</b>	46 (1.09)	2144 (0.52)	<b>2.30 (1</b>
ress disorder	46 (0.52)	692 (0.08)	<b>6.61 (4.95-8.83)</b>	<b>7.51 (5.47-10.32)</b>	16 (0.35)	168 (0.04)	<b>11.48 (6.77-19.47)</b>	30 (0.71)	524 (0.13)	<b>6.30 (4</b>
e stress NOS	46 (0.52)	2000 (0.23)	<b>2.26 (1.69-3.01)</b>	<b>2.44 (1.82-3.27)</b>	19 (0.42)	718 (0.16)	<b>2.78 (1.78-4.34)</b>	27 (0.64)	1282 (0.31)	<b>2.26 (1</b>

ched for sex, year of birth, income, and marital, educational, and occupational status. HR=hazard ratio. NOS=not otherwise specified.  
ny psychiatric disorder before the tsunami.

**Table 3: Relative risks of psychiatric disorders and attempted suicide in children and adolescents**

Outcome	Incidence, No. (%)		Hazard ratio (95% CI)	
	Exposed n=3742	Unexposed n=320828	Crude	Adjusted*
Any psychiatric disorder	248 (6.63)	22081 (6.88)	0.94 (0.83-1.06)	0.98 (0.86-1.11)
Suicide attempt, definite	18 (0.48)	1997 (0.62)	0.73 (0.46-1.15)	0.74 (0.47-1.17)
Suicide attempt, uncertain	32 (0.86)	1933 (0.60)	<b>1.42 (1.01-2.01)</b>	<b>1.43 (1.01-2.02)</b>
Unipolar depression	42 (1.12)	4825 (1.50)	<b>0.71 (0.53-0.96)</b>	<b>0.73 (0.54-0.98)</b>
Eating disorders	21 (0.56)	2082 (0.65)	0.87 (0.56-1.34)	0.90 (0.58-1.39)
Alcohol abuse/dependence	54 (1.44)	3633 (1.13)	1.24 (0.94-1.62)	1.25 (0.96-1.64)
Substance abuse/dependence	21 (0.56)	1346 (0.42)	1.27 (0.82-1.96)	1.35 (0.87-2.10)
Anxiety disorders	47 (1.26)	5637 (1.76)	<b>0.70 (0.53-0.94)</b>	<b>0.74 (0.55-0.98)</b>
Stress-related disorders	39 (1.04)	1827 (0.57)	<b>1.75 (1.28-2.39)</b>	<b>1.79 (1.30-2.46)</b>
Acute stress reaction	20 (0.53)	768 (0.24)	<b>2.13 (1.38-3.27)</b>	<b>2.14 (1.38-3.32)</b>
Post-traumatic stress disorder	9 (0.24)	270 (0.08)	<b>2.62 (1.36-5.01)</b>	<b>2.83 (1.44-5.54)</b>

Not including psychotic disorders, bipolar mood disorders, personality disorders, and the remaining stress-related disorders (all n<10 in exposed population).

\*Adjusted for any own or parental psychiatric disorders before the tsunami.

**Table 4: Relative risks of stress-related disorders and other psychiatric disorders at different times after the disaster**

	Time from event, Mo.	Incidence, No. (%)		Hazard ratio (95% CI)	
		Exposed	Unexposed	Crude	Adjusted
Adults		8762	864 088		
Stress-related disorders*	0–3	56 (0.64)	637 (0.07)	8.58 (6.52-11.29)	10.89 (8.05-14.72)
	4–11	18 (0.21)	1179 (0.14)	1.49 (0.93-2.37)	1.63 (1.02-2.62)
	12–23	33 (0.38)	1763 (0.21)	1.86 (1.32-2.62)	2.00 (1.41-2.83)
	24–60	80 (0.93)	5252 (0.61)	1.52 (1.22-1.90)	1.62 (1.30-2.02)
Other psychiatric disorders	0–3	45 (0.51)	4771 (0.55)	0.93 (0.70-1.25)	1.08 (0.80-1.47)
	4–11	68 (0.78)	7348 (0.86)	0.91 (0.71-1.15)	0.98 (0.77-1.25)
	12–23	99 (1.15)	9450 (1.11)	1.03 (0.84-1.25)	1.09 (0.89-1.33)
	24–60	232 (2.74)	22500 (2.69)	1.01 (0.89-1.16)	1.05 (0.93-1.20)
Children		3742	320 828		
Stress-related disorders*	0–3	17 (0.45)	53 (0.02)	27.19 (15.46-47.82)	29.7 (16.42-53.77)
	4–11	2 (0.05)	131 (0.04)	1.25 (0.31-5.06)	1.19 (0.27-5.27)
	12–23	2 (0.05)	275 (0.09)	0.63 (0.16-2.54)	0.63 (0.16-2.54)
	24–60	18 (0.49)	1368 (0.43)	1.07 (0.67-1.71)	1.08 (0.67-1.73)
Other psychiatric disorders	0–3	17 (0.45)	1660 (0.52)	0.87 (0.54-1.41)	0.83 (0.49-1.41)
	4–11	30 (0.81)	3130 (0.98)	0.79 (0.55-1.14)	0.88 (0.61-1.28)
	12–23	33 (0.89)	3665 (1.16)	0.75 (0.53-1.06)	0.78 (0.56-1.11)
	24–60	145 (3.97)	13021 (4.18)	0.92 (0.78-1.08)	0.94 (0.79-1.10)

\*Includes acute stress reaction, post-traumatic stress disorder, adjustment disorder, other reaction to severe stress, and reaction to severe stress not otherwise specified.