

Long-term mental health outcomes following the 2004 Asian tsunami disaster

A comparative study on direct and indirect exposure

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Keywords: anxiety, depression, disaster, post-traumatic stress disorder, tsunami, Asia, prevalence, risk factors

Abbreviations: DEG, direct exposure group; IEG, indirect exposure group; PTSD, Post-Traumatic Stress Disorder; QOL, quality of life; SAS, Zung Self-rating Anxiety Scale; SDS, Zung Self-rating Depression Scale; SRQ, Self Reporting Questionnaire; SRS-PTSD, Self Rating Scale for PTSD; WHO, World Health Organisation; NS, not significant

There is inadequate information on the long-term mental health outcomes among disaster victims in low and middle income countries. It is especially so for the vast majority of victims who are indirectly exposed to disasters. To address this gap in knowledge we examined the prevalence of psychiatric morbidity, particularly anxiety, depression and post-traumatic stress disorder (PTSD) in the 2004 Asian tsunami victims in India, 4.5 y after the disaster. It was also intended to compare the mental health outcomes of the victims with direct exposure to tsunami waters and those who were indirectly exposed to tsunami disaster (people living near the sea who escaped tsunami waters but witnessed the disaster and suffered various losses). In a cross-sectional epidemiological study, 666 randomly selected victims in South India were assessed for psychiatric morbidity through the Self-Reporting questionnaire (SRQ), Zung Self-Rating Depression Scale, Zung Self-Rating Anxiety Scale, Self-Rating Scale for PTSD (SRS-PTSD) and suicidality screening. The disaster experience, quality of life and socio-demographic profile were also assessed. Psychiatric morbidity based on SRQ was 77.6% and estimated prevalence of anxiety symptoms (23.1%), depression (33.6%), PTSD (70.9%) and comorbidity (44.7%) suggested nature and extent of the psychiatric morbidity in the tsunami victims. The direct exposure group had a significantly greater proportion of psychiatric morbidity based on SRQ, anxiety symptoms and suicide attempts. Factors which predicted psychiatric morbidity were: lack of formal education, perception of disaster as highly stressful, damage to home and loss of livelihood and livestock. In conclusion, a large proportion of Asian tsunami victims were observed to have continuing mental health problems 4.5 y after the disaster, which highlighted the need for psychiatric services for the affected communities.

Introduction

The Asian earthquake and subsequent tsunami of December 2004 was one of the largest natural disasters in recent history, which resulted in the deaths of over 250,000 people and massive destruction in eight countries. One area particularly affected by this disaster was southern India.¹ Catastrophic disasters like this are likely to cause considerable mental health consequences in the affected populations. In the majority of disaster victims, it is thought that the traumatic reactions resolve without any long-term consequences. In contrast, depending upon the nature and severity of trauma, recovery may be impaired for a significant proportion of individuals leading to chronicity of psychological disturbances.² Indeed, many long-term studies following disasters suggest lasting impact on mental health of the victims. These effects can be delayed in onset and can persist over several years.³

Psychiatric studies following 2004 tsunami. There are a few studies on mental health outcomes of 2004 tsunami victims. The prevalence rates for psychiatric disorders (27.2%) and psychological symptoms (79.7%) in an adult population around 6 to 9 mo following the tsunami in coastal Tamil Nadu have been considerable. The most common psychiatric disorder was depression, followed by alcohol use disorders in males and anxiety disorders in females. The rate of post-traumatic stress disorder (PTSD), 12.5 per 1000, was found to be lower than expected.⁴ In a study of tsunami affected males in Kanyakumari, 43% had clinically significant psychological distress, and 31% had very high levels of psychological distress.⁵ Initial assessment in the Andaman and Nicobar Islands during the early phase of the 2004 tsunami disaster revealed that 5–8% of the population was suffering from significant mental health problems. It was felt that the psychiatric morbidity would be around 25–30% in the disillusionment

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Submitted: 11/29/12; Revised: 04/07/13; Accepted: 04/13/13
<http://dx.doi.org/10.4161/dh.24705>

phase.⁶ Among middle-aged Swiss tourists returning from the affected area 16.8% fulfilled criteria for PTSD, 17.8% for anxiety and 8% for depressive disorders. About two and a half years after the tsunami, 12.3% of untreated respondents fulfilled the criteria for PTSD and 38% of respondents who had received psychiatric treatment were still having syndromal PTSD.⁷ In Khao Lak, 2.5 y after the tsunami, the most prevalent disorders in adults were specific phobia (30.2%), agoraphobia (17.5%), social anxiety disorder (11.1%), PTSD (11.1%), major depressive disorder (11.1%) and dysthymic disorder (11.1%); the post-tsunami 2.5 y incidence of PTSD was 36.5%.⁸ It is evident from the observations that while a considerable proportion of tsunami victims suffered from the psychiatric disorders, the figures varied widely between studies. Various factors like trauma severity, individual circumstances, resilience and other associated stress might have contributed to these variations in the findings along with the methodologies. While many victims had direct exposure to tsunami waters, a vast majority did not, but nonetheless suffered the consequences; and there was no information regarding the morbidities of these indirectly affected people.

Long-term prevalence studies. Many studies report gradual decline in the prevalence of disaster related psychiatric morbidities; and follow-up studies over 20 y or more indicate that the psychological effects on victims are minimal relative to controls by this stage.³ However, in a proportion of cases the morbidities continue long-term without change.^{9,10} It may be highlighted that during the initial four years after the World Trade Center elevated PTSD risk remained largely unabated (rather increased) in the exposed firefighters.¹¹

A study after the North Sea oil rig disaster suggested that increased risk of psychopathology persisted 27 y after disaster. The prevalence of PTSD among the survivors was 6.1%, and the risk of having a psychiatric disorder was more than 3 times higher than that in the comparison group.¹² After 25 y, half of the survivors of a fire disaster reported that the fire had a determining effect on their lives; and 21.3% respondents indicated that the fire still had an impact on their daily lives.⁹ Chronic post-traumatic stress persisted in a minority of survivors 14 y after a ferry disaster; 27% reported significant symptoms and traumatic bereavement appeared to hinder recovery.¹³

Three years after the August 1999 earthquake in Turkey, estimated rates of PTSD and comorbid depression were 40% and 18%;¹⁴ the figures after 20 mo were 39% and 18%;¹⁵ and after 14 mo 63% and 42% respectively.¹⁶ The prevalence range for psychiatric disorders three years after the Chi-Chi earthquake in Taiwan was 0.2–7.2%, with rates for major depression and PTSD of 6.4% and 4.4%, respectively.¹⁷ About 2 y after the Taiwan earthquake the estimated rates of PTSD caseness and psychiatric morbidity were 20.9% and 39.8% respectively.¹⁸ Physiological changes to trauma also persist long-term. Oklahoma City bombing survivors had significantly greater autonomic reactivity to trauma reminders on all measures than comparison subjects 6.5 to 7 y after the terrorist attack.¹⁹ Literature on long-term consequences suggests continuing psychiatric morbidity in the disaster victims. Considering this, it is important to study the long-term mental health outcomes especially in developing economies with

resource-scarcity, where there is dearth of information in this regard; and where the mental health resources to identify and support the victims are either unequally distributed or almost non-existent.

Comparative studies. A comparative study 6.5 y after the Chernobyl accident showed significantly higher scores on the self-report questionnaires and higher medical service utilization in the exposed region compared with unaffected region. It suggested that the Chernobyl disaster had a significant long-term impact on psychological well-being, health-related quality of life, and illness behavior in the exposed population.²⁰ Another study, 6.5 y following the Chernobyl disaster reported that scores on the self-report scales were consistently higher in the exposed region; however, a higher risk of psychiatric disorders was observed only among women with children under 18 y of age.²¹

Fourteen months after the earthquake in Turkey, rates of PTSD and depression comorbid with PTSD were 23% and 16% respectively at the epicenter and 14% and 8% in Istanbul about 100 km from the epicenter.²² Another comparative study following Jupiter disaster found that 51.7% of survivors compared with 3.4% of the control had PTSD.²³ A postal questionnaire study of survivors of a rail accident and a commuter control group found that the accident group scored significantly higher on the Impact of Events scale than the control group.²⁴ The exposed rescue workers compared with the non-exposed colleagues reported more health complaints in the long-term.²⁵ The relationship between degree of exposure and psychiatric morbidity has also been studied.²⁶ Although the literature suggests higher morbidities in the exposed areas, studies comparing morbidities in exposed and non-exposed population are scant. There is hardly any study comparing morbidities in victims who are directly exposed to a disaster with those in people who are indirectly exposed to various effects of the disasters. As a great number of people get indirectly exposed to disasters, it makes this a pertinent area to explore.

Need for studies. There are considerable differences in post-disaster psychiatric morbidities and research scenarios between developing and developed countries. Natural disasters are not only more common in developing countries but also have greater devastating impact. Literature suggests that up to 90% of natural disasters and 95% of disaster-related deaths occur in developing countries.^{27,28} There are various reasons for the high mortality, which could be poor warning systems, inadequate emergency response during disaster, poor preparedness and mitigation measures for the disasters. Besides, disasters in developing countries usually affect a comparatively large number of people. Poor connectivity to affected areas and inadequate resources for acute relief appear as important determinants of morbidity. Pre-disaster factors like lower economic status, poor housing quality and poor communication systems add to the misery. Cultural differences regarding perception of stress, resilience and coping are well known.²⁹ These factors also affect the prevalence of psychiatric morbidity following disasters. Considering the above-mentioned factors, it is expected that there would be differences in post-disaster mental health outcomes in different cultures.³⁰

The World Health Organisation (WHO) prioritizes the need for studies from developing countries that are most affected by

Table 1. Sample characteristics

| Variable | Categories | Direct exposure group (n = 353) | Indirect exposure group (n = 313) | Total (n = 666) |
|-----------------|---------------------|---------------------------------|-----------------------------------|-----------------|
| | | % | % | % |
| Gender | Male | 47.0 | 41.9 | 44.6 |
| | Female | 53.0 | 58.1 | 55.4 |
| Age | 18–39 | 46.0 | 46.7 | 46.3 |
| | 40–64 | 42.9 | 43.4 | 43.1 |
| | 65+ | 11.1 | 9.9 | 10.6 |
| Education | No formal education | 36.3 | 33.4 | 35.0 |
| | School | 58.5 | 60.1 | 59.3 |
| | College | 5.2 | 6.4 | 5.8 |
| Occupation | Unemployed | 18.1 | 14.7 | 16.5 |
| | Fishing | 73.4 | 75.1 | 74.2 |
| | Other | 8.5 | 10.2 | 9.3 |
| Marital status | Single | 16.6 | 11.7 | 14.4 |
| | Married | 69.4 | 77.9 | 73.2 |
| | Widowed/Separated | 14.0 | 10.3 | 12.4 |
| Economic Status | Low | 37.8 | 31.2 | 34.8 |
| | Lower middle | 57.4 | 62.8 | 59.9 |
| | Upper middle/High | 4.8 | 6.0 | 5.4 |

natural and man-made disasters. This research would highlight cross-cultural variations in frequency, symptomatology, temporal patterns, outcome of psychological disorders and clarify moderating effects of culture on these disorders.³¹ While there are few studies on psychiatric morbidities following disasters in the short term, studies on long-term mental health outcomes among the victims are even less. In fact, there is also inadequate information on long-term psychiatric morbidity in disaster victims who live in low- and middle-income countries. These kinds of studies will reflect the continuing mental health needs of disaster victims which are often not acknowledged in the resource-crunch societies of developing economies. These will help in identifying the extent of problem and would help in the process of providing appropriate support.

Considering the huge population that was affected by the 2004 tsunami, there are hardly any studies from India about the chronic effects on mental health, especially comparing the impact of direct and indirect exposure. For the above reasons, it was intended to study the long-term mental health outcomes in the 2004 tsunami-affected population in India and to evaluate the sociodemographic factors and disaster experiences associated with it. Besides the general morbidity, it was specifically intended to assess the prevalence of disorders like anxiety, depression and PTSD which are commonly reported following disasters. Another objective was to compare the morbidities in villages that were directly affected by tsunami waters and those which were around the sea but escaped the direct devastation by the waters.

Methods

Areas. It was a cross-sectional epidemiological study in the tsunami-affected communities of Singarathope village, in the Cuddalore district of Tamil Nadu, a southern state of India. It is

situated around 200 m from the sea and is surrounded by brackish water which runs like a river. The village is connected to the nearby town by a bridge. It has a population of around 2200. Singarathope was affected by the tsunami directly; sea water came in the village and damaged it massively. Subjects from this village were categorized as direct exposure group (DEG).

Two other villages - Periyakuppam and Nanjanenjupettai (19 km from Singarathope) situated around 250 m from the sea were also studied. These villages were on higher grounds, with sand dunes between them and the sea and water did not reach the houses. They have a population of around 2400. Although these villages did not get affected directly by the tsunami water; the villagers not only observed the devastations around them from close quarters; they also suffered some of the stressful consequences of tsunami e.g., impact on occupation and damage to livelihoods. They also shared similar vulnerability. Subjects from this village were categorized as indirect exposure group (IEG).

Sample. The sample was randomly selected in the identified villages using the following method. From the available list of villagers, the serial numbers of the individuals aged 18 y or above were used to generate random numbers through a computer. The people bearing the randomly generated serial number were chosen as a sample and were approached. People who were not available on the days of study were excluded. All those approached agreed to participate in the study and there were no refusals. The gender ratio and literacy of the sample were comparable to those of the district based on census information.³²

Measures. The Self Reporting Questionnaire (SRQ) was used to screen the probable caseness in the victims.³³ This 20-item questionnaire was originally developed by an international team of investigators on behalf of the WHO; which has acceptable range of sensitivity (81–90%) and specificity (58–95.2%) in

Table 2. Disaster related traumatic experiences

| Variable | Direct exposure group (n = 353) | Indirect exposure group (n = 313) | Total (n = 666) | p |
|-----------------------------|---------------------------------|-----------------------------------|-----------------|---------|
| | % | % | % | |
| Perceived severity | | | | |
| • Extremely stressful | 35.0 | 31.7 | 33.4 | NS |
| • Very stressful | 33.5 | 27.1 | 30.5 | |
| • Somewhat stressful | 21.5 | 29.7 | 25.3 | |
| • Not at all stressful | 10.0 | 11.4 | 10.7 | |
| Physical injury in disaster | 40.2 | 13.4 | 27.6 | < 0.001 |
| Life threatening injury | 27.0 | 7.7 | 17.9 | < 0.001 |
| Injury to family members | 33.7 | 12.5 | 23.8 | < 0.001 |
| Death of family members | 16.5 | 2.2 | 9.8 | < 0.001 |
| Livelihood | | | | |
| • Complete loss | 25.2 | 16.0 | 21.1 | < 0.001 |
| • Partial damage | 39.0 | 60.6 | 48.7 | |
| • No impact | 35.8 | 23.4 | 30.3 | |
| Loss of livestock | 49.6 | 23.5 | 37.4 | < 0.001 |

NS, non significant.

various studies at a cut off score of 7/8.³⁴ SRQ has been used by a number of investigators in developing countries, including India.^{26,35} In this index study, a cut off score of 8 and above was used to identify persons with probable psychiatric morbidity.

The Zung Self-rating Depression Scale (SDS) is a self-reported 20-item measure of the symptoms of depression. Items responses are ranked from 1 to 4 (a little = 1, some = 2, a good part of the time = 3, or most of the time = 4). A subject with SDS score below 50 is considered normal, a score of 50–59 is considered mild depression; score 60–69 is considered moderate to severe; while a score of 70 or above is considered to be severe depression.³⁶ The SDS has high concurrent validity,³⁶ and the reliability of the SDS has been reported as between 0.73 (split half) and 0.90 (coefficient α).^{36,37} The reported figures of correlations between the Zung SDS and Hamilton Rating Scale for depression is high (0.80);³⁸ and the reliability of SDS in community sample has been found to be satisfactory (Cronbach's α at 0.79).³⁹

The Zung Self-rating Anxiety Scale (SAS) is a 20-item, self-report questionnaire that measures the presence and magnitude of anxiety-based symptoms.⁴⁰ Each item is scored on a 4-point scale in relation to whether the person has experienced each specific symptom: (1) none or a little of the time, (2) some of the time, (3) a good part of the time or (4) most or all of the time. The scores range from 20–80 with scores of 20–44 suggesting normal range, 45–59 suggesting mild to moderate anxiety; 60–74 marked to severe anxiety and 75–80 suggesting extreme anxiety levels. The SAS correlates 0.75 with the Hamilton Anxiety Scale; has a split half reliability of 0.71; and has been shown to significantly discriminate between a normal adult sample and patients with anxiety disorders.⁴⁰

The Self Rating Scale for PTSD (SRS-PTSD) is a 17-item scale with sufficient sensitivity (86%) and specificity (80%).⁴¹ It has been found to be useful for sites with limited clinical resources.

The items of SRS-PTSD correspond closely to Diagnostic and Statistical Manual of Mental Disorder (DSM-III R) criteria for PTSD.⁴²

Suicidality screening is a questionnaire consisting of 5 items on worthiness of living, death wishes, suicidal ideas, contemplation and attempt.⁴³ This screening instrument is useful in evaluating the suicidal cognitions and behavior in the community. Suicidal cognitions were studied within a month of the interview. Information regarding suicide attempts was ascertained since the disaster. The quality of life (QOL) in the previous 4 weeks of assessment was checked using a direct global rating as perceived by the participant in a scale from 0 to 10 where 0 is poor to 10 is excellent.⁴⁴

Perceived stressfulness of disaster experience was assessed through a semi-structured questionnaire which included items of injury to self, family members, death in family, damage to home, loss of occupation/livelihood, livestock and overall perception of stress. The socio-demographic profiles of the participants were also collected.

The scales were translated into the local language Tamil by bi-lingual experts following a translation and back-translation method. The discrepancies were discussed and sorted through consensus. These were additionally face-validated by bi-lingual psychiatrists. Questionnaires for the demographic details and disaster related experience were developed in the local language.

Data collection. Data collection was done in July 2009. Research assistants were recruited from the college students who were speaking the local language. Considering the cultural sensitivity there were both male and female research assistants to facilitate data collection from both genders. They were trained in the study process and materials, on how to approach and discuss the study with the participants and in supporting them in the process of going through the questionnaires and explaining the questions when needed by the participants. Some of the

Table 3. Comparison of psychiatric morbidity

| Variables | Direct exposure group (n = 353) | Indirect exposure group (n = 313) | Total (n = 666) | p |
|-----------------------------------|---------------------------------|-----------------------------------|-----------------|---------|
| | % | % | % | |
| SRQ Positive | 84.4 | 70.0 | 77.6 | < 0.01 |
| Anxiety (SAS) | 30.6 | 14.7 | 23.1 | < 0.001 |
| Severity | | | | |
| • Mild to moderate | 29.5 | 12.1 | 21.3 | |
| • Marked to severe | 1.1 | 2.6 | 1.8 | |
| Depression (SDS) | 34.3 | 32.9 | 33.6 | NS |
| Severity | | | | |
| • Mild | 30.6 | 31.6 | 31.1 | |
| • Moderate to severe | 3.7 | 1.3 | 2.6 | |
| PTSD | 72.0 | 69.6 | 70.9 | NS |
| Comorbidity | | | | |
| • All three diagnoses | 9.6 | 4.2 | 7.1 | < 0.05 |
| • Two diagnoses | 31.7 | 28.4 | 30.2 | |
| • Only one diagnosis | 44.5 | 47.9 | 46.1 | |
| • No diagnoses | 14.2 | 19.5 | 16.7 | |
| Suicidality screening | | | | |
| • Idea of life unworthy of living | 31.8 | 26.0 | 29.1 | NS |
| • Death wishes | 63.5 | 48.4 | 56.4 | < 0.001 |
| • Suicidal ideas | 27.7 | 21.1 | 24.6 | *0.05 |
| • Contemplated suicide | 21.0 | 13.2 | 17.3 | < 0.01 |
| Suicide attempt | 8.5 | 4.2 | 6.5 | < 0.05 |

*approached significance.

participants, especially those who are elderly or had no formal education, needed help in writing their responses.

Research assistants remained available throughout the data collection process; they provided the study questionnaires to the participants and collected them following completion. A psychiatrist was also available in the field along with the research assistants to further help the participants and research assistants. The study protocol was approved by the ethics committee of Quality of Life Research and Development Foundation. Written informed consent was taken from the participants. Assurance was given regarding the confidentiality of the information collected.

Statistical analysis. The statistical tests were done by SPSS package. The categorical data were analyzed by using chi-square tests and the continuous variables were compared by two-tailed t-tests. Binary logistic regression analysis was used to determine the influence of the independent variables toward the morbidity status. Cronbach's α was used to test internal consistency of the questionnaires in this study, which was 0.82 for the SRQ, 0.85 for SRS-PTSD, 0.72 for SAS, 0.63 for SDS and 0.73 for the

Suicidality screening questionnaire. Statistical significance was defined at the standard 0.05 level.

Results

The sample included 353 persons from Singarathope village, which was directly exposed, and 313 persons from Periyakuppan and Nanjanenjupettai villages, which were indirectly exposed to the tsunami. The demographic details of the sample are given in Table 1. Age range was 18 to 97 y. There was no significant difference between the two groups regarding the mean age (DEG: 42.9 ± 13.9 vs. IEG: 42.6 ± 14.9 y) and other socio-demographic variables studied, which suggested that they were comparable. Occupation of a majority of the sample was fishing; all other occupations were grouped together for comparison purposes. There were only 3 persons with higher socioeconomic status (SES); they are grouped with the upper-middle group for statistical comparison. Disaster related traumatic experiences and loss in the two groups are given in Table 2. It was evident that in all

Table 4. Morbidity in different independent variables

| Variables | SRQ positive | | Anxiety | | Depression | | PTSD | | Comorbidity | |
|-----------------------------|--------------|-----|---------|-----|------------|-----|------|-----|-------------|-----|
| Gender | | | | | | | | | | |
| • Male | 75.4 | | 23.6 | | 31.3 | | 74.7 | | 83.9 | |
| • Female | 79.4 | | 22.8 | | 35.5 | | 75.3 | | 85.8 | |
| Age | | | | | | | | | | |
| • 18–39 | 75.6 | # | 22.4 | | 33.3 | | 74.8 | | 85.7 | |
| • 40–64 | 82.6 | | 22.0 | | 34.4 | | 74.7 | | 84.4 | |
| • 65+ | 72.5 | | 30.4 | | 36.2 | | 76.6 | | 84.4 | |
| Education | | | | | | | | | | |
| • No formal education | 84.8 | *** | 27.4 | | 35.7 | # | 78.7 | | 86.6 | |
| • School | 75.1 | | 20.5 | | 34.4 | | 73.0 | | 84.3 | |
| • College | 57.9 | | 21.1 | | 15.8 | | 74.3 | | 80.0 | |
| Occupation | | | | | | | | | | |
| • Unemployed | 82.7 | | 20.9 | | 33.6 | | 69.3 | | 79.2 | |
| • Fishing | 76.3 | | 23.7 | | 32.0 | | 77.2 | | 85.8 | |
| • Other | 79.0 | | 22.6 | | 46.8 | | 67.3 | | 87.3 | |
| Marital status | | | | | | | | | | |
| • Single | 75.8 | ** | 36.3 | *** | 42.9 | ** | 79.1 | | 89.5 | |
| • Married | 76.6 | | 19.3 | | 30.7 | | 72.1 | | 82.4 | |
| • Widow/Separated | 94.9 | | 33.3 | | 50.0 | | 77.9 | | 88.2 | |
| Socioeconomic status | | | | | | | | | | |
| • Low | 81.5 | | 31.7 | ** | 36.6 | | 77.9 | | 88.0 | |
| • Lower middle | 76.2 | | 18.4 | | 34.0 | | 73.5 | | 83.8 | |
| • Upper middle/High | 68.6 | | 20.0 | | 20.0 | | 66.7 | | 73.3 | |
| Disaster experience | | | | | | | | | | |
| • Extremely stressful | 84.0 | * | 33.8 | *** | 30.1 | * | 85.3 | *** | 92.6 | *** |
| • Very stressful | 77.5 | | 16.5 | | 30.0 | | 67.3 | | 78.6 | |
| • Somewhat stressful | 74.7 | | 16.3 | | 42.8 | | 70.1 | | 81.5 | |
| • Not at all stressful | 67.1 | | 24.3 | | 30.0 | | 79.0 | | 90.3 | |
| Physical injury in disaster | 90.2 | *** | 34.8 | *** | 39.7 | * | 79.8 | | 90.8 | * |
| Life threatening injury | 92.4 | *** | 38.7 | *** | 46.2 | ** | 77.0 | | 91.2 | * |
| Injury to family | 87.3 | ** | 36.1 | *** | 39.9 | # | 79.3 | | 91.0 | * |
| Death of family member | 93.8 | ** | 35.4 | * | 35.4 | | 78.5 | | 86.2 | |
| Livelihood | | | | | | | | | | |
| • Complete loss | 84.2 | *** | 34.6 | ** | 48.9 | *** | 77.4 | ** | 87.9 | * |
| • Partial damage | 82.4 | | 18.9 | | 34.5 | | 68.6 | | 80.3 | |
| • No impact | 68.6 | | 22.5 | | 24.1 | | 81.9 | | 89.0 | |
| Loss of livestock | 85.1 | *** | 30.6 | *** | 28.6 | * | 80.3 | * | 88.0 | |

*p < 0.05; **p < 0.01; ***p < 0.001; #, approached significance (p < 0.06).

the parameters studied except trauma perception, the two groups differed significantly. The material and personal loss were significantly greater in the DEG. In the DEG, 40.5% had their home completely damaged, 17.6% had partial damage which made it inhabitable, 34.0% had partial damage but it was habitable and 7.9% reported no damage to their homes.

Psychiatric morbidity. A considerable proportion of the subjects had psychiatric morbidity; the comparison of prevalence in

both the groups is given in Table 3. An SRQ score of 8 or more was present in 77.6% of the subjects. There was significant correlation among scores of SRQ, SAS and SDS (p = 0.01). The most prevalent diagnosis was PTSD in 472 (70.9%) subjects; however there were 37 (5.6%) subjects with inadequate data which precluded conclusion regarding PTSD diagnosis. Anxiety symptoms were estimated to be present in 23.1% based on SAS; and it was significantly more (p < 0.001) prevalent in the DEG (30.6%)

compared with IEG (14.7%). Most of the anxiety symptoms in both groups were mild to moderate in severity; in DEG, 29.5% had mild to moderate and 1.1% had marked to severe degree of anxiety; and in IEG, these figures were 12.1% and 2.6% respectively. Around one third (33.6%) of victims had depression and it was not significantly different in both groups (DEG: 34.3% vs. IEG: 32.9%). Depression severity in both groups was comparable; in DEG, these were mild in 30.6% and moderate to severe in 3.7%; whereas in IEG, these were 31.6% and 1.3% respectively. Morbidities in different independent variables are given in Table 4. As evident, various independent variables were significantly associated with different kinds of psychiatric morbidities. Damage to home was significantly associated with SRQ positive status.

Further binary logistic regression analysis found that several independent variables significantly influenced the probability of post-tsunami psychiatric morbidity. The demographic and disaster experience related factors were entered in the equation and the results are expressed here as odds ratio (OR) and its 95% confidence interval (CI). SRQ positive status was significantly contributed by various factors e.g., no formal education (OR: 4.5; 95% CI: 1.7–12.1; $p < 0.01$), perception of disaster as very stressful (OR: 2.4; 95% CI: 1.0–5.7; $p < 0.05$) or extremely stressful (OR: 4.8; 95% CI: 1.9–11.9; $p < 0.01$), damage of home either completely (OR: 2.3; 95% CI: 1.1–4.8; $p < 0.05$) or partially damaged, irrespective of whether habitable (OR: 2.7; 95% CI: 1.5–4.8; $p < 0.01$) or not (OR: 4.9; 95% CI: 2.2–11.0; $p < 0.001$), complete (OR: 2.6; 95% CI: 1.3–5.4; $p < 0.05$) or partial loss of livelihood (OR: 3.0; 95% CI: 1.7–5.2; $p < 0.001$); and loss of livestock (OR: 1.9; 95% CI: 1.1–3.4; $p < 0.05$).

The only independent variable that was found to be contributing to PTSD was partial damage of home rendering it inhabitable (OR: 2.4; 95% CI: 1.2–4.6; $p < 0.01$). While no factor predicted anxiety, depression was contributed significantly by a number of independent variables including no education (OR: 2.9; 95% CI: 1.1–8.6; $p < 0.05$) or school education (OR: 3.1; 95% CI: 1.1–8.5; $p < 0.05$), low SES (OR: 3.2; 95% CI: 1.1–9.6; $p < 0.05$), low middle SES (OR: 3.2; 95% CI: 1.1–9.3; $p < 0.05$), life threatening injury (OR: 2.4; 95% CI: 1.2–4.8; $p < 0.05$) and complete loss of livelihood (OR: 2.1; 95% CI: 1.2–3.6; $p < 0.05$).

Suicidality. Considerable proportions of victims had death related cognitions (Table 3). Comparing DEG and IEG, ideas of unworthiness of living were present in 31.8% vs. 26.0% (NS); death wishes in 63.5% of DEG vs. 48.4% of IEG ($p < 0.001$) and thoughts of taking own life were present in 27.7% vs. 21.1% ($p = 0.05$) respectively. Many victims (DEG: 21.0% vs. IEG: 13.2%, $p < 0.01$) reported that they reached a point where they seriously considered or planned suicide. The number of victims who reported suicide attempt following disasters was significantly more ($p < 0.05$) in the DEG (8.5%) than the IEG (4.2%). In the DEG, 2.1% victims had more than one attempt; while in the IEG the respective figure was 1.0%.

Comorbidity. Comorbidity was present in 44.7% ($n = 248$) of patients who had any diagnosis (Table 3). There were no

diagnoses in 95 (14.3%) of the subjects; and in 16 persons diagnosis was not determined because of inadequate data, who were not included in calculation. Comparing the two groups, it was found that comorbidity was more common in DEG ($p < 0.05$). There were one diagnosis in 44.5% vs. 47.9%, two diagnoses in 31.7% vs. 28.4% and all three diagnoses in 9.6% vs. 4.2%. By logistic regression, comorbidity was predicted by damage to home whether completely (OR: 4.7; 95% CI: 1.9–11.3; $p < 0.01$) or partially, habitable (OR: 2.9; 95% CI: 1.5–5.4; $p < 0.01$) or inhabitable (OR: 3.6; 95% CI: 1.6–8.1; $p < 0.01$).

Quality of life. There was no significant difference in the QOL mean scores between the groups (DEG: 6.1 ± 2.6 vs. IEG: 5.6 ± 2.3). There was significant negative correlation between QOL score and SDS depression score ($r: -0.08$, $p < 0.05$); however the SAS score was directly correlated with QOL ($r: 0.08$, $p < 0.05$).

Discussion

This study tried to find out mental health outcomes among victims affected by 2004 Asian tsunami 4.5 y after the disaster and compared the findings with those who were indirectly affected by it. Coastal areas of Southern India were massively affected by the tsunami and focused long-term mental health care for the victims was almost non-existent in these areas like many low and middle income countries. The study highlighted continuing long-term psychiatric morbidities following this catastrophic natural disaster of tsunami in these developing areas.

Prevalence and risk factors. *Psychiatric morbidity.* A considerable majority (77.6%) of the sample had psychiatric morbidity suggested by SRQ with significantly higher proportion in the DEG. This suggested that impact of the disaster on the mental health of the victims continued long-term and it remained high compared with those who had not been directly affected by the tsunami. This estimated proportion is considerably higher than the reported rates of prevalence of common mental disorders (figures being 16.5% and 20% of the adult population) in general population of India.^{45,46} Compared with the prevalence figures reported in short-term studies from South India following tsunami (27.2% for psychiatric disorders and 79.7% for psychological symptoms),⁴ 43% clinically significant psychological distress and 31% very high level of psychological distress,^{5,47} observations of this study are higher. However the prevalence figures were comparable to the reports of psychiatric morbidity following another natural disaster in a different part of India.²⁶ It is probable that in the absence of supporting mechanisms and unavailability of effective interventions the psychological symptoms have continued without abatement, rather they might have deteriorated further. However, there could be further reasons for the observed high prevalence in this study.

As evident in the results, various demographic vulnerability factors and disaster related loss were significantly associated with this high level of morbidity. Lack of formal education, middle age, being widowed or separated, perceived greater severity of the disaster, physical injury, life threatening injury, injury and

death in family, loss of livelihood and livestock were significantly associated with SRQ positive status. Similar observations have been reported in other studies on tsunami victims. Exposure considered to have danger-to-life was an important factor in causing more severe post-traumatic stress symptoms and affecting mental health in the long-term in a Swedish tourist population after exposure to the 2004 Southeast Asian tsunami. Physical injuries and experiencing threat-to-life during disaster exposure were observed to have substantial impact on survivors.⁴⁸ Severe trauma exposure and bereavement in tsunami-exposed tourists were reported to have considerable long-term impact on psychological distress and appeared to slow down the recovery process.⁴⁹ Another indicator of higher psychiatric morbidity was increased prevalence of death wishes, suicidal cognitions and attempts. Higher prevalence of these has been observed in post-disaster situations elsewhere.^{50,51}

Anxiety. Anxiety disorders are common in the victims of natural disasters.⁵²⁻⁵⁴ In this study anxiety symptoms were estimated to be prevalent in 23.1% of the sample studied; with the DEG having significantly higher proportion than the IEG. Various sociodemographic and disaster related factors e.g., being unmarried, lower SES, perception of disaster as extremely stressful, physical injury during disaster, life threatening injuries, injury of family members, death in family and loss of livelihood and livestock were significantly associated with the anxiety symptoms. Loss of resources following disasters has been observed to be associated with vulnerability for psychological disorder.⁵⁵ It is understandable that loss of livelihood and inadequate supporting resources bred anxiety in the victims. It may be highlighted that although in most cases anxiety severity was mild to moderate it was still clinically relevant and needed to be addressed through appropriate methods.

Depression. About one third of the sample (33.7%) studied had depression. This is comparable to another study where, 2.5 y after the tsunami, incidence of major depressive disorder was 28.6%.⁸ It has been highlighted that besides PTSD, depressive disorders are of clinical importance when considering long-term mental health effect of disasters. It is probable that in most cases the depression was chronic. Severity of the depression was mild in most victims; which nonetheless affect functionality and carries similar risks and challenges in management. In this study it was evident that the depression affected QOL of the tsunami victims.

A range of variables were significantly associated with depression in this study. Those were: no formal education, being single or widowed/separated, perception of disaster as extremely stressful, physical injury, life threatening injury and loss of livelihood and livestock. Similar risk factors for severe depression have been reported 20 mo after the 1999 earthquake in Turkey.¹⁵ The sociodemographic factors that could predict post-disaster depression were: no education or school level education and low or lower middle SES. These factors make the individuals already vulnerable to stress; and in the event of trauma of a catastrophic disaster, it is probable that these groups of people may decompensate more. The disaster related factors which predicted depression were life threatening injury during

disaster and complete loss of livelihood. The results suggested that medical support for the disaster related injuries and financial/occupational support for these economically compromised disaster victims should be prioritized; and these efforts might help mitigate depression.

PTSD. An estimated 70.9% of the tsunami victims had a diagnosis of PTSD. High prevalence of posttraumatic symptoms has been reported following the tsunami in various groups: e.g., in adolescents,⁵⁶ as an acute condition,¹ and around 2.5 y after the tsunami.⁸ Long-term studies following various disasters indicate presence of posttraumatic stress symptoms in a sizeable proportion of the victims.^{12,13} The observations suggested that, depending upon the nature and severity of the disaster, a considerable proportion of victims might have chronic psychiatric morbidity. This has been particularly reported for PTSD which can be chronic, along with many variations of longitudinal course of PTSD namely delayed, intermittent, residual and reactivated patterns which have been highlighted in the literature.⁵⁷ Although continued vulnerability and unresolved trauma related issues can be implicated, factors that make PTSD a chronic disorder are worth exploring.

Interestingly there was no statistical difference of PTSD prevalence between the DEG and IEG. There could be various reasons for this observation. Although the IEG did not experience the tsunami waters themselves, being in close proximity to the sea, observing all the devastations and trauma around them, and sharing the similar fear of recurrence of the disaster could have made the IEG group vulnerable to this stress-related disorder. It is known that a range of post-disaster psychopathology and PTSD can occur in individuals who are indirectly exposed.^{58,59} In this study, the IEG group was so close to the tsunami disaster that it would have been difficult to miss the impact of stress.

There can be various reasons for the higher prevalence of PTSD. The disaster was extremely stressful and the villages were completely devastated with massive loss to livelihood and death of family members. Perception of disaster as extremely stressful, loss of livelihood and livestock were significantly associated with the PTSD in this study. Most of the affected persons were in the lower or lower-middle SES which added to the burden. Fishing in the sea and the related activities were the occupation for a majority of the victims. Damage to the amenities to continue this vocation severely affected the community. Significant financial loss has been reported to be a risk factor for PTSD in the Taiwan Chi-Chi earthquake survivors.⁶⁰ It is usually believed by the people that the sea does not cross its limits, a belief which was shaken following the tsunami. There was an implicit fear in these villagers regarding probable recurrence of the disaster and lack of any specific preventive or protective mechanism. There could be another possible reason for this higher morbidity figure. In spite of the explanation that the study was not related to any benefit or relief schemes related to the tsunami, it cannot be ruled out that some of the subjects might have responded positively toward presence of symptoms with expectations of some gain. In this regard, clinical evaluation and structured diagnostic assessments might be helpful.

Co-morbidity. Co-morbidity of psychiatric disorders was common and was present in a considerable proportion (44.7%) of the victims with a diagnosis, as has been observed in studies elsewhere.^{26,52} This suggests that the clinicians should look for co-morbidities which make the presentation and management more complex and challenging in the post-disaster situations. Perception of disaster as extremely stressful, physical injury, life-threatening injury, injury to family members and loss of livelihood were significantly associated with having co-morbidity in this study. Comorbidity was particularly predicted by damage to home whether complete or partial, habitable or inhabitable. Lack of home following disasters is associated with various other associated problems, including displacement and living in shelters with poor conditions of inadequate basic amenities of life. Unfortunately for many victims these conditions continued for months and years before they could arrange to find their own place to stay.

Modifiable factors. The results of the study suggested various factors that may help in decreasing the impact of the disasters. Lack of formal education was significantly associated with the psychiatric morbidity in general and depression in particular. Thirty-five per cent of sample had no formal education. Lack of education may come in the way of understanding the information relevant to disaster warning, preparedness and post-disaster supportive interventions, knowing the types of help available and seeking appropriate help. Psychiatric morbidity, especially depression, is known to be associated with a lack of self-confidence and motivation. Coupled with inadequate awareness of the supports available these factors can increase and prolong the misery.

A major associated factor was loss of livelihood, including that of livestock. The link between resource loss and stress making people vulnerable to psychological disorder is well known.^{61,62} Financial support and endeavors to develop employment locally are expected to be helpful in this regard. Enabling victims to get back to gainful vocations may facilitate recovery. However, in developing economies the supportive initiatives are often inadequate and cease too soon following the disaster, leaving the victims on their own. It cannot be overemphasized that long-term support should be a part of the disaster management programs.

Injuries of self and family members were identified as concerns. Especially those injuries which were perceived as life threatening were significantly associated with psychiatric morbidity. Besides the physical injuries and their implications, lack of adequate resources for their treatment was a secondary stress in many instances. In the immediate aftermath of the disaster, the existing medical care infrastructure in the developing countries is usually overstretched. Most of the victims were not attended to adequately or they could not afford the required medical care without any outside help. A focused attention to provide adequate medical care to the disaster victims should be an essential part of disaster management, which might reduce psychiatric morbidity.

Severity of disaster experience had considerable influence on the post-disaster psychiatric morbidity. This is a common finding in many post-disaster studies.²⁶ Perception of disaster severity may be influenced by adequate and appropriate pre-disaster

warning and information, improved preparedness, along with timely support in the immediate post-disaster period.

Limitations. There are a few limitations in the study. Translated versions of the scales were used in absence of the standardised scales in the local language. Other psychiatric disorders which might have onset in the post-disaster period could not be studied because of feasibility issues. There is a possibility of other traumatic events affecting the individual or community in the intervening period which could have contributed to the morbidity in some of the subjects. This is a factor that is relevant for studies evaluating continuing effect of a stressful event that occurred in distant past. Although there was information on short-term psychiatric morbidity from a few affected regions of South India following the tsunami; in the absence of pre-disaster and immediate post-disaster psychiatric morbidity in the same localities it may be difficult to determine the changes in morbidity over the years.

Conclusion

The study found that 4.5 y after the 2004 Asian tsunami, a considerable majority of directly and indirectly exposed victims had psychiatric morbidity. PTSD was most common diagnosis followed by depression and anxiety; and in considerable proportions of victims these were comorbid. Various demographic and disaster related factors were associated with psychiatric morbidities. There are practical implications of these findings. Timely and appropriate support for the victims regarding physical injury in the disaster, their damaged home, and occupation/livelihood are expected to help as these have contributed to psychiatric morbidities. The demographic factors that uniquely predicted post-disaster psychiatric morbidities were related to lower or no education and lower socioeconomic status. These factors contribute to the vulnerabilities of individuals in various ways and in the aftermath of a catastrophic disaster these become all the more important contributors. It is expected that improvement of the educational level of the population will have far reaching benefits than just management of disasters. High stress perception of the tsunami was associated with morbidities and these can be ameliorated to some extent, by adequate pre-disaster warning where possible, preparedness and appropriate support. The need for long-term continuing support to the victims for psychiatric disorders cannot be overemphasized. There should be processes in place for these remote areas to get psychiatric and psychological evaluations and help. Future research may focus on the effectiveness of community-based psychiatric assessment and intervention programs for these silently suffering victims.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Acknowledgments

The study was supported by Quality of Life Research and Development Foundation. The authors wish to thank the local study group including all the research assistants who helped in data collection.

References

- John PB, Russell S, Russell PSS. The prevalence of posttraumatic stress disorder among children and adolescents affected by tsunami disaster in Tamil Nadu. *Disaster Manag Response* 2007; 5:3-7; PMID:17306747; <http://dx.doi.org/10.1016/j.dmr.2006.11.001>.
- Foa EB, Stein DJ, McFarlane AC. Symptomatology and psychopathology of mental health problems after disaster. *J Clin Psychiatry* 2006; 67(Suppl 2):15-25; PMID:16602811.
- Laugharne J, van der Watt G, Janca A. After the fire: the mental health consequences of fire disasters. *Curr Opin Psychiatry* 2011; 24:72-7; PMID:20844434; <http://dx.doi.org/10.1097/YCO.0b013e32833f5e4e>.
- Nambi S, Desai N, Shah S. Mental health morbidity and service needs in tsunami affected population in coastal Tamil Nadu. *Indian J Psychiatry* 2007; 49:s2-3.
- George C, Sunny G, John J. Disaster experience, substance abuse, social factors and severe psychological distress in male survivors of the 2004 tsunami in South India. *Indian J Psychiatry* 2007; 49:S47.
- Math SB, Girmaji SC, Benegal V, Uday Kumar GS, Hamza A, Nagaraja D. Tsunami: psychosocial aspects of Andaman and Nicobar islands. Assessments and intervention in the early phase. *Int Rev Psychiatry* 2006; 18:233-9; PMID:16753660; <http://dx.doi.org/10.1080/09540260600656001>.
- Kraemer B, Wittmann L, Jenwein J, Schnyder U. 2004 Tsunami: long-term psychological consequences for Swiss tourists in the area at the time of the disaster. *Aust N Z J Psychiatry* 2009; 43:420-5; PMID:19373702; <http://dx.doi.org/10.1080/00048670902817653>.
- Hussain A, Weisaeth L, Heir T. Psychiatric disorders and functional impairment among disaster victims after exposure to a natural disaster: a population based study. *J Affect Disord* 2011; 128:135-41; PMID:20619900; <http://dx.doi.org/10.1016/j.jad.2010.06.018>.
- Lundin T, Jansson L. Traumatic impact of a fire disaster on survivors—a 25-year follow-up of the 1978 hotel fire in Borås, Sweden. *Nord J Psychiatry* 2007; 61:479-85; PMID:18236316; <http://dx.doi.org/10.1080/08039480701773329>.
- Kar N. Psychosocial issues following a natural disaster in a developing country: a qualitative longitudinal observational study. *International Journal of Disaster Medicine* 2006; 4:169-76; <http://dx.doi.org/10.1080/15031430701875551>.
- Berninger A, Webber MP, Cohen HW, Gustave J, Lee R, Niles JK, et al. Trends of elevated PTSD risk in firefighters exposed to the World Trade Center disaster: 2001-2005. *Public Health Rep* 2010; 125:556-66; PMID:20597456.
- Boe HJ, Holgersen KH, Holen A. Mental health outcomes and predictors of chronic disorders after the North Sea oil rig disaster: 27-year longitudinal follow-up study. *J Nerv Ment Dis* 2011; 199:49-54; PMID:21206247; <http://dx.doi.org/10.1097/NMD.0b013e31820446a8>.
- Arnberg FK, Eriksson NG, Hultman CM, Lundin T. Traumatic bereavement, acute dissociation, and post-traumatic stress: 14 years after the MS Estonia disaster. *J Trauma Stress* 2011; 24:183-90; PMID:21442665; <http://dx.doi.org/10.1002/jts.20629>.
- Salcioglu E, Basoglu M, Livanou M. Post-traumatic stress disorder and comorbid depression among survivors of the 1999 earthquake in Turkey. *Disasters* 2007; 31:115-29; PMID:17461919; <http://dx.doi.org/10.1111/j.1467-7717.2007.01000.x>.
- Salcioglu E, Basoglu M, Livanou M. Long-term psychological outcome for non-treatment-seeking earthquake survivors in Turkey. *J Nerv Ment Dis* 2003; 191:154-60; PMID:12637841; <http://dx.doi.org/10.1097/01.NMD.0000054931.12291.50>.
- Livanou M, Basoglu M, Salcioglu E, Kalender D. Traumatic stress responses in treatment-seeking earthquake survivors in Turkey. *J Nerv Ment Dis* 2002; 190:816-23; PMID:12486369; <http://dx.doi.org/10.1097/00005053-200212000-00003>.
- Wu HC, Chou P, Chou FHC, Su CY, Tsai KY, Ou-Yang WC, et al. Survey of quality of life and related risk factors for a Taiwanese village population 3 years post-earthquake. *Aust N Z J Psychiatry* 2006; 40:355-61; PMID:16620318; <http://dx.doi.org/10.1080/j.1440-1614.2006.01802.x>.
- Chen CH, Tan HKL, Liao LR, Chen HH, Chan CC, Cheng JJS, et al. Long-term psychological outcome of 1999 Taiwan earthquake survivors: a survey of a high-risk sample with property damage. *Compr Psychiatry* 2007; 48:269-75; PMID:17445522; <http://dx.doi.org/10.1016/j.comppsy.2006.12.003>.
- Tucker PM, Pfefferbaum B, North CS, Kent A, Burgin CE, Parker DE, et al. Physiologic reactivity despite emotional resilience several years after direct exposure to terrorism. *Am J Psychiatry* 2007; 164:230-5; PMID:17267785; <http://dx.doi.org/10.1176/appi.ajp.164.2.230>.
- Havenaar J, Rumyantzeva G, Kasyanenko A, Kaasjager K, Westermann A, van den Brink W, et al. Health effects of the Chernobyl disaster: illness or illness behavior? A comparative general health survey in two former Soviet regions. *Environ Health Perspect* 1997; 105(Suppl 6):1533-7; PMID:9467078.
- Havenaar JM, Rumyantzeva GM, van den Brink W, Poelijoe NW, van den Bout J, van Engeland H, et al. Long-term mental health effects of the Chernobyl disaster: an epidemiologic survey in two former Soviet regions. *Am J Psychiatry* 1997; 154:1605-7; PMID:9356574.
- Basoglu M, Kiliç C, Salcioglu E, Livanou M. Prevalence of posttraumatic stress disorder and comorbid depression in earthquake survivors in Turkey: an epidemiological study. *J Trauma Stress* 2004; 17:133-41; PMID:15141786; <http://dx.doi.org/10.1023/B:JOTS.0000022619.31615.e8>.
- Yule W, Bolton D, Udwin O, Boyle S, O'Ryan D, Nurrish J. The long-term psychological effects of a disaster experienced in adolescence: I: The incidence and course of PTSD. *J Child Psychol Psychiatry* 2000; 41:503-11; PMID:10836680; <http://dx.doi.org/10.1111/1469-7610.00635>.
- Selly C, King E, Peveler R, Osola K, Martin N, Thompson C. Post-traumatic stress disorder symptoms and the Clapham rail accident. *Br J Psychiatry* 1997; 171:478-82; PMID:9463610; <http://dx.doi.org/10.1192/bjp.171.5.478>.
- Huizink AC, Slotje P, Witteveen AB, Bijlsma JA, Twisk JWR, Smidt N, et al. Long term health complaints following the Amsterdam Air Disaster in police officers and fire-fighters. *Occup Environ Med* 2006; 63:657-62; PMID:16644894; <http://dx.doi.org/10.1136/oem.2005.024687>.
- Kar N, Jagadisha, Sharma P, Murali N, Mehrotra S. Mental health consequences of the trauma of super-cyclone 1999 in orissa. *Indian J Psychiatry* 2004; 46:228-37; PMID:21224904.
- Long F. The Impact of Natural Disasters on Third World Agriculture: An Exploratory Survey of the Need for Some New Dimensions in Development Planning. *Am J Econ Sociol* 1978; 37:149-63; <http://dx.doi.org/10.1111/j.1536-7150.1978.tb02809.x>.
- Roy N, Thakkar P, Shah H. Developing-world disaster research: present evidence and future priorities. *Disaster Med Public Health Prep* 2011; 5:112-6; PMID:21685306; <http://dx.doi.org/10.1001/dmp.2011.35>.
- Marsella AJ, Christopher MA. Ethnocultural considerations in disasters: an overview of research, issues, and directions. *Psychiatr Clin North Am* 2004; 27:521-39; PMID:15325491; <http://dx.doi.org/10.1016/j.psc.2004.03.011>.
- Kar N. Natural disasters in developing countries: mental health issues. *Indian J Med Sci* 2009; 63:327-9; PMID:19770522; <http://dx.doi.org/10.4103/0019-5359.55882>.
- World Health Organization. Psychosocial consequences of disasters: prevention and management. Geneva: Mental Health Division, World Health Organization; 1992.
- <http://www.census2011.co.in/census/district/39-cuddalore.html> [Internet]. [cited 2012 Dec 2]; Available from: <http://www.census2011.co.in/census/district/39-cuddalore.html>
- World Health Organization. Self Reporting Questionnaire. Geneva: World Health Organization; 1994.
- World Health Organization. Catalogue of WHO psychiatric assessment instruments. Geneva: World Health Organization; 1995.
- Patel V, Araya R, Chowdhary N, King M, Kirkwood B, Nayak S, et al. Detecting common mental disorders in primary care in India: a comparison of five screening questionnaires. *Psychol Med* 2008; 38:221-8; PMID:18047768; <http://dx.doi.org/10.1017/S0033291707002334>.
- Zung WW. A self-rating depression scale. *Arch Gen Psychiatry* 1965; 12:63-70; PMID:14221692; <http://dx.doi.org/10.1001/archpsyc.1965.01720310065008>.
- Zung WW. From art to science. The diagnosis and treatment of depression. *Arch Gen Psychiatry* 1973; 29:328-37; PMID:4724142; <http://dx.doi.org/10.1001/archpsyc.1973.04200030026004>.
- Biggs JT, Wylie LT, Ziegler VE. Validity of the Zung Self-rating Depression Scale. *Br J Psychiatry* 1978; 132:381-5; PMID:638392; <http://dx.doi.org/10.1192/bjp.132.4.381>.
- Knight RG, Waal-Manning HJ, Spears GF. Some norms and reliability data for the State-Trait Anxiety Inventory and the Zung Self-Rating Depression scale. *Br J Clin Psychol* 1983; 22:245-9; PMID:6640176; <http://dx.doi.org/10.1111/j.2044-8260.1983.tb00610.x>.
- Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971; 12:371-9; PMID:5172928.
- Carlier IV, Lamberts RD, Van Uchelen AJ, Gersons BP. Clinical utility of a brief diagnostic test for posttraumatic stress disorder. *Psychosom Med* 1998; 60:42-7; PMID:9492238.
- American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders 3rd Edition – Revised. 1987th ed. Washington DC: American Psychiatric Association; 1987.
- Paykel ES, Myers JK, Lindenthal JJ, Tanner J. Suicidal feelings in the general population: a prevalence study. *Br J Psychiatry* 1974; 124:460-9; PMID:4836376; <http://dx.doi.org/10.1192/bjp.124.5.460>.
- IGDA Workgroup, WPA. IGDA. 7: Standardised multi-axial diagnostic formulation. *Br J Psychiatry Suppl* 2003; 45:s52-4; PMID:12724266.
- John S, Vijaykumar C, Jayaseelan V, Jacob KS. Validation and usefulness of the Tamil version of the GHQ-12 in the community. *Br J Community Nurs* 2006; 11:382-6; PMID:17077760.
- Math SB, Srinivasaraju R. Indian Psychiatric epidemiological studies: Learning from the past. *Indian J Psychiatry* 2010; 52(Suppl 1):S95-103; PMID:21836725; <http://dx.doi.org/10.4103/0019-5545.69220>.
- Kar N. Indian research on disaster and mental health. *Indian J Psychiatry* 2010; 52(Suppl 1):S286-90; PMID:21836696; <http://dx.doi.org/10.4103/0019-5545.69254>.
- Johannesson KB, Michel PO, Hultman CM, Lindam A, Arnberg F, Lundin T. Impact of exposure to trauma on posttraumatic stress disorder symptomatology in Swedish tourist tsunami survivors. *J Nerv Ment Dis* 2009; 197:316-23; PMID:19440104; <http://dx.doi.org/10.1097/NMD.0b013e3181a206f7>.

49. Johannesson KB, Lundin T, Fröjd T, Hultman CM, Michel PO. Tsunami-exposed tourist survivors: signs of recovery in a 3-year perspective. *J Nerv Ment Dis* 2011; 199:162-9; PMID:21346486; <http://dx.doi.org/10.1097/NMD.0b013e31820c73d1>.
50. Kar N. Suicidality following a natural disaster. *Am J Disaster Med* 2010; 5:361-8; PMID:21319554.
51. Chou YJ, Huang N, Lee CH, Tsai SL, Tsay JH, Chen LS, et al. Suicides after the 1999 Taiwan earthquake. *Int J Epidemiol* 2003; 32:1007-14; PMID:14681266; <http://dx.doi.org/10.1093/ije/dyg296>.
52. Viswanath B, Maroky AS, Math SB, John JP, Cherian AV, Girimaji SC, et al. Gender differences in the psychological impact of tsunami. *Int J Soc Psychiatry* 2013; 59:130-6; PMID:22053075; <http://dx.doi.org/10.1177/0020764011423469>.
53. Kar N, Bastia BK. Post-traumatic stress disorder, depression and generalised anxiety disorder in adolescents after a natural disaster: a study of comorbidity. *Clin Pract Epidemiol Ment Health* 2006; 2:17; PMID:16869979; <http://dx.doi.org/10.1186/1745-0179-2-17>.
54. Math SB, Tandon S, Girimaji SC, Benegal V, Kumar U, Hamza A, et al. Psychological impact of the tsunami on children and adolescents from the andaman and nicobar islands. *Prim Care Companion J Clin Psychiatry* 2008; 10:31-7; PMID:18311419; <http://dx.doi.org/10.4088/PCC.v10n0106>.
55. Kar N, Mohapatra PK, Nayak KC, Pattanaik P, Swain SP, Kar HC. Post-traumatic stress disorder in children and adolescents one year after a super-cyclone in Orissa, India: exploring cross-cultural validity and vulnerability factors. *BMC Psychiatry* 2007; 7:8; PMID:17300713; <http://dx.doi.org/10.1186/1471-244X-7-8>.
56. Agustini EN, Asniar I, Matsuo H. The prevalence of long-term post-traumatic stress symptoms among adolescents after the tsunami in Aceh. *J Psychiatr Ment Health Nurs* 2011; 18:543-9; PMID:21749561; <http://dx.doi.org/10.1111/j.1365-2850.2011.01702.x>.
57. McFarlane AC. Posttraumatic stress disorder: a model of the longitudinal course and the role of risk factors. *J Clin Psychiatry* 2000; 61(Suppl 5):15-20, discussion 21-3; PMID:10761675.
58. Pfefferbaum B, Seale TW, McDonald NB, Brandt EN Jr., Rainwater SM, Maynard BT, et al. Posttraumatic stress two years after the Oklahoma City bombing in youths geographically distant from the explosion. *Psychiatry* 2000; 63:358-70; PMID:11218559.
59. Zimering R, Gulliver SB, Knight J, Munroe J, Keane TM. Posttraumatic stress disorder in disaster relief workers following direct and indirect trauma exposure to Ground Zero. *J Trauma Stress* 2006; 19:553-7; PMID:16929511; <http://dx.doi.org/10.1002/jts.20143>.
60. Su CY, Tsai KY, Chou FHC, Ho WW, Liu R, Lin WK. A three-year follow-up study of the psychosocial predictors of delayed and unresolved post-traumatic stress disorder in Taiwan Chi-Chi earthquake survivors. *Psychiatry Clin Neurosci* 2010; 64:239-48; PMID:20602724; <http://dx.doi.org/10.1111/j.1440-1819.2010.02087.x>.
61. Hobfoll SE. Conservation of resources. A new attempt at conceptualizing stress. *Am Psychol* 1989; 44:513-24; PMID:2648906; <http://dx.doi.org/10.1037/0003-066X.44.3.513>.
62. Hobfoll SE, Jackson AP. Conservation of resources in community intervention. *Am J Community Psychol* 1991; 19:111-21; PMID:1867144; <http://dx.doi.org/10.1007/BF00942259>.