Acta Psychiatr Scand 2009: 1–12

DOI: 10.1111/j.1600-0447.2009.01466.x

ACTA PSYCHIATRICA SCANDINAVICA

Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia tsunami

Descilo T, Vedamurtachar A, Gerbarg PL, Nagaraja D, Gangadhar BN, Damodaran B, Adelson B, Braslow LH, Marcus S, Brown RP. Effects of a yoga breath intervention alone and in combination with an exposure therapy for PTSD and depression in survivors of the 2004 South-East Asia tsunami.

Objective: This study evaluated the effect of a yoga breath program alone and followed by a trauma reduction exposure technique on post-traumatic stress disorder and depression in survivors of the 2004 Asian tsunami.
Method: In this non-randomized study, 183 tsunami survivors who scored 50 or above on the Post-traumatic Checklist-17 (PCL-17) were assigned by camps to one of three groups: yoga breath intervention, yoga breath intervention followed by 3–8 h of trauma reduction exposure technique or 6-week wait list. Measures for post-traumatic stress disorder (PCL-17) and depression (BDI-21) were performed at baseline and at 6, 12 and 24 weeks. Data were analyzed using ANOVA and mixed effects regression.
Results: The effect of treatment vs. control was significant at 6 weeks ($F_{2,178} = 279.616$, $P < 0.001$): mean PCL-17 declined by 42.5 ± 10.0 SD with yoga breath, 39.2 ± 17.2 with Yoga breath + exposure and 4.6 ± 13.2 in the control.
Conclusion: Yoga breath-based interventions may help relieve psychological distress following mass disasters.

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Key words: yoga; post-traumatic stress; depression; tsunami; mind–body

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Accepted for publication July 14, 2009

Significant outcomes

- Eight months after the 2004 tsunami, survivors living in refugee camps, who were given a yoga breath program (BWS) alone and followed by an exposure therapy (BWS + TIR), had significantly reduced scores on PCL-17 compared with that in a wait list control group.
- Among these survivors, the BWS and BWS + TIR interventions significantly reduced scores on BDI compared with that in the control group.
- Decreases of at least 60% in PCL-17 scores and 90% in BDI scores occurred in the BWS and BWS + TIR groups by 6 weeks and were maintained at 24-week follow-up.

Limitations

- Because of conditions in the refugee camps, randomization of subjects was not possible. Instead each camp was assigned to one of three groups in no systematic order.
- The research team was not able to maintain practice logs or weekly attendance records.
- The timing of tests and TIR interventions did not adhere strictly to the study protocol because they required more days to complete under conditions in the camps.

Introduction

The December 2004 Indian Ocean tsunami killed nearly 300 000 people and left more than 1 000 000 without homes in 13 countries. Following natural disasters, high rates of psychiatric morbidity have been found, particularly in rural areas: 75% of victims of the 1978 cyclone in Sri Lanka and 55% of victims of the 1987 volcanic eruptions in Columbia (1). More specifically, 23% of rural villagers had post-traumatic stress disorder (PTSD) in the Marathwada region of western India, 21% had depression and 24% had other psychiatric disorders impacting on quality of life 1 month after the 30 September 1993 earthquake (2). A random sample of people living in Sarno, Italy, 1 year after the 1998 landslide found that among those living in the high-risk area, 27% met DSM-IV criteria for PTSD and 59% were rated as 'probable cases' (3). High-impact survivors of the Taiwan earthquake of 1999 had significantly elevated suicide rates (4). Moreover, survivors of the 1999 earthquakes in Turkey with PTSD were found to have impaired prefrontal organization and processing of verbal information (5).

This study was motivated by the need to develop effective interventions for the psychological trauma of mass disasters in which the magnitude of affected populations and the destruction of infrastructures often render standard psychiatric services ineffective (6). This study administered and evaluated two interventions targeting PTSD, depression and quality of life in survivors of the tsunami. PTSD in this population was characterized in the following way: many tsunami survivors reported over-reactivity to the sound of the ocean, responding with feelings of anxiety, terror and panic. The sound of the ocean was a trigger for memories and re-experiencing of the disaster. Because of this intolerance to the sound of the ocean, many were not able to return to their coastal villages or to their livelihood (fishing). Other common complaints were recurring images of faces drowning in the flood. Depression in this population was characterized by the expression of constant, intense, unbearable sadness and a high level of pessimism about the future and their ability to deal with it. Decrease in quality of life in this population was characterized generally by feelings of strain, inability to sleep, loss of capacity to enjoy normal day-to-day activities and constant feelings of worry.

Clinical studies of yoga suggest that yoga breath interventions could target the symptoms of PTSD, depression and anxiety (7–9). Multi-component mind–body programs, including breath practices, postures (asanas) and movements, may alleviate symptoms of anxiety (10–12), depression (13–15), PTSD (16–20) and schizophrenia (21). Neurophysiological studies provide plausible mechanisms by which these effects may occur. Over activity or erratic activity of the sympathetic nervous system (SNS) associated with PTSD is evident in hyperarousal, hypervigilance and somatic symptoms such as rapid heart rate. Underactivity of the parasympathetic nervous system (PNS) has also been associated with PTSD (22–26). Yoga breathing can shift autonomic balance towards parasympathetic dominance (27). Moreover, the voluntary use of different breath patterns can account for up to 40% of the variance in emotions, particularly anger, fear, joy and sadness (28). Voluntarily controlled breathing may alter autonomic nervous system functions via vagal afferents to the central cholinergic system and could influence the limbic system, thalamus, cerebral cortex (including prefrontal cortex), forebrain reward systems and hypothalamus, inducing changes in emotion, cognition and state of consciousness (7, 29).

Aims of the study

This study was designed to test the following hypotheses:

i) The breath intervention called Breath, Water, Sound with Sudarshan Kriya (described below), which are believed to reduce over-reactivity, sadness and fear, would decrease the symptoms and experience of PTSD, depression and decrements in quality of life in tsunami survivors.
ii) The exposure intervention, traumatic incident reduction (TIR) (described below), when administered after breath intervention, would further reduce PTSD, depression and decrements in quality of life.

Material and methods

The study population consisted of 183 survivors of the 2004 South-East Asia tsunami from 50 coastal fishing villages in Nagapattinam district on the south-east coast of India. These villages were among the most severely devastated on mainland India (30). Subjects were native Tamil speakers living in five refugee camps 8 months after the tsunami. The camps were maintained by the International Association for Human Values (IAHV), a United Nations chartered Non-Governmental Organization (NGO). The population of the five camps was demographically comparable. The

camp residents came from nearby coastal villages that had suffered equivalent damage during the tsunami. Study participants were survivors of rural fishing families most of whom could neither read nor write. Most had lost at least one relative and all of their property. Conditions in the camps were stressful; there were small amounts of food and water, makeshift shelters and extreme heat. The camps were all near the subjects' home villages and near each other. The study was undertaken 8 months after the tsunami because of difficulties in obtaining funding, training Tamil-speaking experimenters and TIR facilitators and negotiating with the involved parties.

Recruitment and inclusion criteria

The Ethics Committee of the National Institute of Mental Health and Neurosciences of India (NIMHANS) approved the study. Subjects were recruited by members of the research team who asked camp residents if they would like to participate in a program for stress relief. Those who volunteered were given the informed consent procedure. Those who signed consent forms were screened for PTSD using the PCL-17 checklist (31). Subjects who were above the age of 18 and who scored 50 or more on the PCL-17 were included; those who were under 18 years of age or who scored below 50 on the PCL-17 were excluded. Of the 350 individuals who volunteered for testing, 240 (69%) met the inclusion criterion. The total number of residents in each camp was not known because refugees came and left each day. Of the 240, 57 subjects were unable to participate. Some had childcare responsibilities; some had their boats replaced by the government and were able to return to work. Among the 183 eligible subjects who were able to participate, there were 23 men and 160 women ranging in age from 18 to 65 years. Refugees who did not meet the inclusion criteria or who did not want to participate in the study were also offered the Breath, Water, Sound program for stress relief.

Design

The study was designed to be a randomized wait list controlled trial in which the intervention a subject received was to be fully crossed with the camp in which the subject resided. However, conditions in the camps required a modification. Camp administrators would not allow refugees within the same camp to be given different interventions because the social order and peaceful cooperation within the camps depended upon the perception that each resident was given exactly the same amount of whatever limited supplies and services were available. If some refugees were given BWS while others were put on a waiting list, the perception of unfairness would be disruptive. Therefore, all residents within each camp who volunteered to participate were given the same intervention at the same time. There was no *systematic* relationship between the assignment of an intervention to a camp, and the camps were comparable demographically (Table 1, left) and symptomatically (Table 1, right) at the initial testing. Furthermore, all of the camps had similar levels of services and resources. Subjects resided in five camps. After baseline screening with the PCL-17, the number of eligible participants in each camp was established. One camp provided a sufficient number of subjects to form one group; the remaining four camps were paired to create a total of the three approximately equal groups (see Fig. 1, study flow chart). Camps were assigned to one of three groups:

- *BWS* received the breath intervention described below.
- *BWS + TIR* received the breath intervention followed 3–10 days later by the exposure intervention described below.
- *CON* was the 6-week wait list control group.

After baseline testing using the PCL-17, BDI-21 (32) and GHQ-12 (33), two groups received their assigned intervention, while the control received no intervention. The PCL-17, BDI-21 and GHQ-12 were again administered to the treatment groups at 6, 12 and 24 weeks. The BWS group was also tested at 1 week (following breath intervention). The design called for testing of the BWS + TIR groups (two camps) at 1 week (following the breath intervention and prior to TIR). However, because of staff oversight, only the subjects in one of the camps ($n = 28$) were retested at the 1-week evaluation point. Therefore, these data are presented separately (see Table 3 below). The control

Table 1. Comparison of baseline characteristics and mean baseline scores for the study and control groups

Groups	Men (%)	Women (%)	Mean age (years)	Lost relative (%)	Lost property (%)	Mean baseline scores		
						PCL	BDI	GHQ
BWS	15.0	85.0	30.8	58.3	76.7	66.5	26.7	21.3
BWS + TIR	3.3	96.7	35.1	68.3	85.0	64.1	27.3	22.0
CON	18.8	81.3	34.7	66.7	85.7	67.9	27.5	24.7

PCL, Post-traumatic Stress Disorder Checklist; BDI, Beck Depression Inventory; GHQ, General Health Questionnaire; BWS, Breath Water Sound; BWS + TIR, Breath Water Sound + Traumatic Incident Reduction.

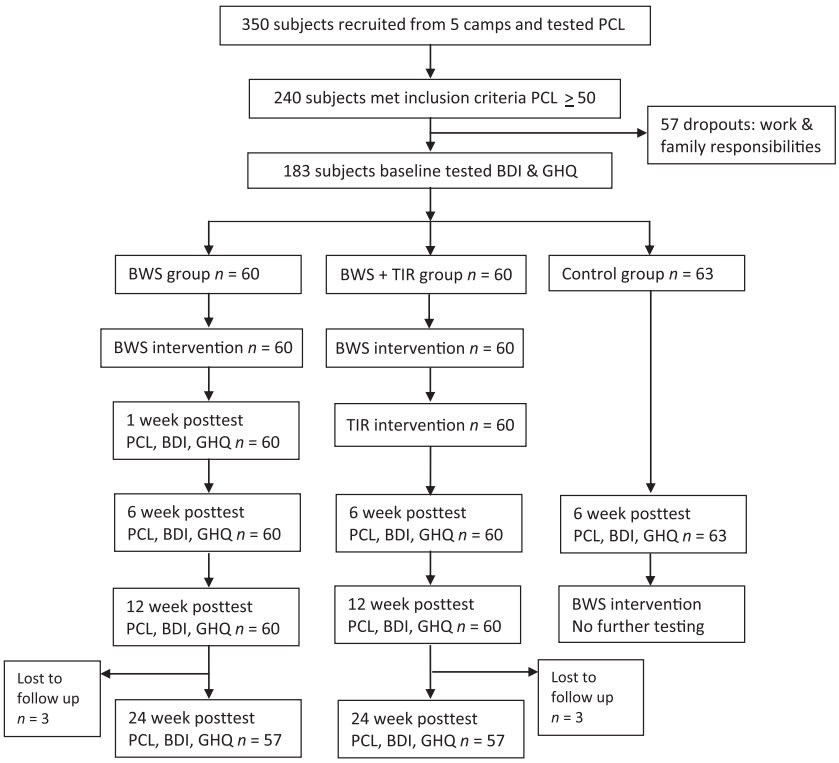

Fig. 1. Tsunami study flow chart.

group was tested after the 6-week waiting period. They were then given the breath intervention, but received no further testing. Three subjects from the BWS and three subjects from the BWS + TIR conditions could not be found for the 24-week testing (see Fig. 1, study flow chart).

Measures

All of the test measures were translated into Tamil and back translated into English to check for accuracy. Subjects were also asked whether they had lost property and close relatives in the tsunami (Table 1, left). Studies of other disasters found that the risk of PTSD increased with the amount of loss of family, friends and property (34). All tests were administered by the experimenters. Three instruments were used to evaluate the effect of the interventions on PTSD, depression and general wellbeing.

Post-traumatic stress disorder. The PTSD Check List (PCL-17) (31) is a 17-item self-administered scale corresponding to DSM-IV (35) criteria for PTSD. Each item on the checklist is rated from 1 to 5 (1 = not at all, 2 = a little bit, 3 = moderately, 4 = quite a bit and 5 = extremely). An exemplar item from the PCL-17, designed to assess hypervigilance in PTSD, asks, 'Do you find yourself being 'super-alert' or watchful or on guard?' The score, derived by summing across the 17 items, can range from 17 to 85. Studies in primary care settings indicate that PCL-17 scores above 30 suggest the presence of PTSD (36). The more stringent inclusion criterion for this study, in accord with other studies of traumatized populations, was a PCL-17 score ≥50 (37).

Depression. The Beck Depression Inventory (BDI-21) is a 21-item test in a multiple-choice format that measures the absence or presence and degree of depression. Individual items are rated from 0 to 3. Total scores can range from a minimum of 0 to a maximum of 63. Levels of depression are rated as mild to moderate [10–18], moderate to severe [19–29] and severe [30–63]. The BDI is considered a valid measure of depressed mood for diverse populations (32). An exemplar item from the BDI asks whether the subject is, 'so sad or unhappy that I can't stand it'. The last question on the BDI, which asks about sexual desire, was dropped as culturally inappropriate. Our subjects therefore could attain a maximum score of only 60.

Quality of life. The General Health Questionnaire (GHQ-12) is a 12-item screening test, designed to identify short-term changes in health and decrements in quality of life: it taps depression, anxiety, social dysfunction and somatic symptoms (33). Each item is scored from 0 to 3 with a minimum total score of 0 and maximum of 36. An exemplar item from the GHQ asks whether the subject has, 'Lost much sleep over worry?'

Interventions

The interventions were intended to decrease over-reactivity, re-experiencing and other symptoms of PTSD; decrease sadness and other symptoms of depression; and decrease worry, ameliorate insomnia and increase overall quality of life. To this end, the interventions were a breath course taught to subjects targeted at these symptoms followed by an exposure intervention targeted to further reduce symptoms specific to the subjects' trauma. Tamil-speaking testers and BWS teachers were trained to administer all test instruments. The lead BWS teachers were fully trained teachers of Sudarshan Kriya Yoga (SKY) which includes all the breath forms used in BWS. They studied SKY for a minimum of 2 years and taught SKY under supervision for at least 1 year before training to be BWS teachers. The assistant BWS teachers had taken at least one basic course in SKY but were not SKY teachers. They had 1 week of training to teach BWS. Twenty of the BWS teachers received 1 week of TIR exposure therapy training with Descilo, a certified TIR trainer, who selected the top six to become TIR facilitators. These were given an additional 3 weeks of TIR supervision.

Breath Intervention. Breath Water Sound (BWS) and Sudarshan Kriya were developed by Sri Sri Ravi Shankar, co-founder (with the Dalai Lama) of the non-profit organization IAHV, which set up, supported and managed the refugee camps. The intervention was taught as an 8-h program given in 2-h sessions over four consecutive days, and included four breathing techniques: three-stage Ujjayi (Victorious Breath), Bhastrika (Bellows Breath), chanting 'OM' and Sudarshan Kriya (SK) (Clear Vision through Purifying Action). These ancient yogic practices have Sanskrit names. English translations appear in parentheses. All breath forms are performed with the eyes and mouth closed while breathing through the nose. The intervention included some brief discussion about trauma reduction and life-meaning. Ujjayi breathing employs a slight contraction of the laryngeal muscles and partial closure of the glottis (increasing airway resistance) while breathing through the nose. This enables the practitioner to finely control airflow to prolong inspiration and expiration. Combined pharyngeal stimulation, airway resistance and prolonged expiration are thought to stimulate vagal afferents leading to increased parasympathetic effects (7). Three-stage Ujjayi employs arm movements with Ujjayi breathing, counts for each phase of the breath cycle, and holds at end-inspiration and end-expiration. Ujjayi is performed for about 8 min. Practitioners often report a feeling of calm accompanied by a pronounced decrease in feelings of worry after doing Ujjayi (38). Bhastrika involves repeatedly raising the arms above the head and then bringing them down against the sides of the ribs, like the handles of a bellows, leading to vigorous exhalation through the nose. It is performed for approximately 2 min. This is thought to stimulate the SNS. Practitioners often report increased energy and feelings of happiness which counteract the apathy and pessimism of depression (38). Sudarshan Kriya (SK) uses a sequence of breathing at different rates starting slowly (4–6 breaths per minute), then at a moderate rate (10–12 breaths per minute), then briefly at a fast rate (80–100 breaths per minute). The sequence is repeated several times over a total period of approximately 10 min. This mimics natural breath rate responses to emotion-laden events, but here each rate is performed for a limited and systematic period of time, jointly under the control of the facilitator and practitioner. The particular repeated, planned mimicking of natural rhythms is thought to restore balance to the autonomic and stress response systems while alleviating trauma-related symptoms (4). Why this is the case is not yet known and is the subject of further research. Practitioners report feelings of calmness and emotional relief (9, 29) that counteract over-reactivity and loss of wellbeing.

Using an interactive discussion format, participants received education about stress reduction, for example, techniques to shift their focus away from past regrets and future worries while increasing attention to current realities. Sharing experiences and giving one another support enabled participants, who had lost significant personal and community relationships, to develop new bonds, a sense of belonging and feelings of resilience. Participants were encouraged to perform 20 min of daily breath practice and to attend weekly group sessions to further reduce stress and maintain improvements after the course. Daily practice and follow-up group attendance could not be monitored under the postdisaster conditions.

Exposure therapy intervention. Traumatic incident reduction (TIR) is a one-on-one method which has been shown to reduce the negative effects of trauma (39–41). TIR is a representative form of this treatment. Three to seven days after completing BWS, 60 of the participants were given three to five individual TIR sessions lasting 1–3 h per session, addressing trauma, including the tsunami and domestic violence by looking back on the events of the tsunami, the loss of loved ones, the

loss of property; and addressing the stressful experience of displacement/living in a camp. The TIR protocol requires the client to flood him/herself with cues associated with traumatic memories to induce a state similar to the trauma experience. This evokes a conditioned fear response (or other aversive emotion) while in the safe presence of a non-interfering facilitator. With repetition, clients find a decline in painful affect and greater awareness of the full details of the event and its meaning (39–41). This process is repeated until the cues become less or non-aversive. A single session concludes when the subject reaches a point characterized by positive emotions, calmness or serenity. The intervention sessions end when these feelings stabilize and the subject reaches insight into feelings and/or decisions made at the time of the trauma.

In this study subjects first received the breath intervention followed by TIR. This was performed because it has sometimes been found that clients who are severely traumatized are unable to endure a reliving of trauma-related experiences evoked during exposure therapy. However, case studies of clients who had previously been unable to tolerate TIR showed that when yoga breathing preceded TIR, they were then able to tolerate and benefit from TIR (T. Descilo, personal observation). Therefore, this study used the same sequence.

Statistical analysis

The BWS and BWS + TIR groups were to be evaluated at five time points from baseline to 24 weeks: baseline, within 3 days after completing BWS (1 week), 6, 12 and 24 weeks. All 60 subjects in the BWS group and a subset of 28 subjects (one camp) of BWS + TIR group were evaluated at these five points from baseline to 24 weeks. However, the other BWS + TIR camp with 32 subjects missed the 1-week evaluation tests (shortly after BWS but before TIR). The control group was untreated for a 6-week wait list period and was evaluated at two time points: baseline and 6 weeks. SPSS 15.0 was used to analyze the effects of treatment, age and gender (42): for each measure – PCL-17, BDI-21 and GHQ-12 – a separate three-way analysis of variance (ANOVA) was performed on the change scores for each participant. A change score was obtained by subtracting an individual's initial score from their score 6 weeks later. The ANOVA factors were:

- *Treatment* (three levels): BWS, BWS + TIR and CON;
- *Age* (four levels): age 17–22, 23–30, 31–40 and 41 + years;
- *Gender* (two levels): male, female;
- *Time* (four levels): before the intervention and postintervention at 6, 12 and 24 weeks.

The age divisions gave us groups of roughly the same size and seemed principled in that they corresponded to adolescence, early adulthood, full adulthood and senior community member.

As the ANOVA has some inherent limitations (e.g. statistical assumptions related to a complete data set, randomization and a common set of time periods cannot be entirely met) (43), mixed effects regression was also performed. Mixed effects regression analysis uses all available data on each subject, can model time effects, allows the use of realistic variance and correlation patterns, handles covariates that change, as well as those that do not change over time, enables estimation of average time trends for treatment groups and deals with unequally spaced observations over time (44). Mixed effects regression models can describe each individual's pattern of change and accommodate missing data points and different numbers of observations per subject (45). This model was particularly suitable for this study because there were only two test measure points for the control group: baseline and 6 weeks. Consequently, this method was employed to estimate how the wait list control group would do over a 24-week period. SUPERMIX software was used to perform mixed effects linear regression and mixed effects ordinal regression to adjust for the intra-subject correlation because of multiple time points per subject (46). To test the main hypotheses, we modeled each of the three primary outcomes as a function of period, group and period–group interaction where period is a random effect. Initially, we compared all three groups using two dummy variables. As there was no statistically significant difference between the BWS and BWS + TIR groups, we combined these two groups and compared this with the control group. The treatment groups were compared with the control group over a period of 24 weeks divided into five time periods.

Results

Baseline characteristics

The populations in the three study groups were comparable demographically regarding average age, degree of losses and initial test scores. Conditions within the camps, including the amount of

material supplies and services, were similar during the study (Table 1).

Effects on PTSD (PCL-17 scores)

The effect of treatment vs. control was significant through the 6-week post-test ($F_{2,178} = 279.616$, $P < 0.001$). The effects of age and gender were not significant ($F_{2,178} = 2.307$, $P > 0.1$ and $F_{2,178} = 2.259$, $P > 0.1$ respectively). None of the two- or three-way interactions of the treatment, age and gender reached significance at the 0.05 level (Table 2). Table 2 shows the mean scores and the mean changes in scores (last two columns) for each group. At 6 weeks, the mean decreases in PCL scores for the breath (BWS), breath + exposure (BWS + TIR) and control (CON) groups were 42.5 ± 10.0, 39.2 ± 17.2 and 4.6 ± 13.2 respectively. In the treatment groups, the mean PCL scores were 60% lower at both 6 and 24 weeks compared with pre-intervention scores. The *post hoc* Newman–Keuls test did not show a significant difference between the two treatment groups (BWS and BWS + TIR).

Effects on depression (BDI-21 scores)

The effect of treatment vs. control was significant ($F_{2,178} = 198.243$, $P < 0.001$). The effects of age and gender were not significant ($F_{2,178} = 0.218$, $P > 0.6$ and $F_{2,178} = 1.498$, $P > 0.2$ respectively). None of the interactions reached significance at the 0.05 level. Table 2 shows the mean scores and the changes in mean scores for each group. At 6 weeks, the mean decreases in BDI scores for the BWS, BWS + TIR and CON were 23.1 ± 8.6, 23.6 ± 10.5 and 1.9 ± 7.7 respectively. In both treatment groups, the mean BDI scores were 90% lower at both 6 and 24 weeks compared with pre-intervention scores. The Newman–Keuls test did not show a significant difference between the two treatment groups, although the difference between the control and two treatment groups was significant.

Effects on general health questionnaire

The effect of treatment vs. control was significant ($F_{2,177} = 94.737$, $P < 0.01$). The effects of age and gender were not significant ($F_{2,177} = 3.148$, $P > 0.08$ and $F_{2,177} = 0.729$, $P > 0.4$ respectively). None of interactions reached significance at the 0.05 level. Table 2 shows the mean scores and the changes in mean scores for each group. At 6 weeks, the mean decreases in GHQ-12 scores for the BWS, BWS + TIR and CON were 9.8 ± 6.7, 11.5 ± 6.7 and 1.6 ± 3.8 respectively. The Newman–Keuls test did not show a significant difference between the two treatment groups; the difference between control and two treatment groups was significant.

Comparison of BWS group with BWS + TIR subgroup at 1 week testing

Mean scores on the PCL, BDI and GHQ dropped substantially after the BWS intervention (1 week evaluation point) in both the BWS group and the BWS + TIR subgroup ($n = 28$) who were tested within 3 days after completing the BWS intervention. The 6-week scores showed no significant improvement after the BWS + TIR subgroup received the TIR intervention and did not differ significantly from the 6-week scores of the BWS group (see Table 3).

Table 2. Comparison of mean scores (columns 2–6) and the changes in mean scores with standard deviations from baseline to 6 weeks (column seven) and from baseline to 24 weeks (column 8) for the study and control groups

	Mean test scores					Changes in mean scores ± SD	
	Baseline	1 week	6 weeks	12 weeks	24 weeks	0–6 weeks	0–24 weeks
PCL-17							
BWS	66.5	27.5	23.9	26.7	20.6	42.5 ± 10.0	45.5 ± 9.6
BWS + TIR	64.1		24.6	27.0	19.6	39.2 ± 17.2	44.6 ± 11.3
CON	67.9		63.3			4.6 ± 13.2	–
BDI-21							
BWS	26.7	5.9	3.5	10.6	2.9	23.1 ± 8.6	24.0 ± 9.9
BWS + TIR	27.3		4.3	8.0	1.8	23.6 ± 10.5	25.4 ± 9.5
CON	27.5		26.0			1.9 ± 7.7	–
GHQ-12							
BWS	21.3	13.7	11.5	11.3	12.8	9.8 + 6.7	8.7 ± 5.3
BWS + TIR	22.0		10.6	10.0	7.9	11.5 + 6.7	14.3 ± 6.0
CON	24.7		23.7			1.6 + 3.8	

SD, standard deviation; PCL, Post-traumatic Stress Disorder Checklist; BDI, Beck Depression Inventory; GHQ, General Health Questionnaire; BWS, Breath Water Sound; BWS + TIR, Breath Water Sound + Traumatic Incident Reduction; CON, control.

Table 3. Comparison of mean scores between the BWS group (n = 60) and BWS + TIR subset (n = 28)

	BWS group (n = 60)			BWS + TIR subset (n = 28)		
Test	Baseline	1 week	6 weeks	Baseline	1 week	6 weeks
PCL-17	66.5	27.5	23.9	64.1	25.4	19.7
BDI-21	26.7	5.9	3.5	27.9	2.6	2.4
GHQ-12	21.3	13.7	11.5	24.1	11.5	8.9

PCL, Post-traumatic Stress Disorder Checklist; BDI, Beck Depression Inventory; GHQ, General Health Questionnaire; BWS, Breath Water Sound; BWS + TIR, Breath Water Sound + Traumatic Incident Reduction.

Mixed effects regression

The results of the mixed effects regressions with dependent variables – PCL, BDI, and GHQ – show for each of the three outcomes that the treatment groups improved more compared with the control group and also improved more quickly. For PCL, the BWS and BWS + TIR groups had significantly lower PTSD scores (z = 7.26, P = 0.0000) and improved at a faster rate (z = −26.6, P = 0.0000; estimated 10.0 points per period vs. 2.3 points per period for the control) compared with the control group. For BDI, the BWS and BWS + TIR groups had significantly lower scores (z = 4.81, P = 0.0000) and improved at a faster rate (z = 4.97, P = 0.0000). For GHQ, the BWS and BWS + TIR groups had significantly lower scores (z = 6.42, P = 0.0000) and improved at a faster rate (z = 3.49, P = 0.0000; 7.5 points per period vs. 1.1 points per period for the control) (43, 44).

Adverse reactions and drop-outs

Fifty-seven subjects dropped out after baseline screening before starting the interventions (see Fig. 1). Although there was an attrition rate of about 23% this was not because of adverse reactions. The rate of drop-outs was the same in the intervention and control groups. Drop-outs were mainly due to conflicts with childcare, household duties and return to work. The Government of India was responding to property claims by providing fishermen with new boats. When a family received a new boat, the men resumed fishing and the women had to wait onshore to clean and then market the fish. Six subjects, three from each intervention group, were lost to follow-up between 3 and 6 months. We believe that these subjects left the area because they could not be found in their villages; they did not report adverse reactions. Some subjects reacted with embarrassment and distress when they were asked about sexual interest on question number 21 of the BDI. Dropping this question from the study resolved the problem. No adverse reactions to BWS were reported. During TIR, there were a few incidents in which young female subjects became uncomfortable during one-on-one sessions with male facilitators because such private discussions are not part of their traditional culture. In these cases, female facilitators were substituted. Subsequently, male facilitators were assigned to subjects who were either men or older women. For the facilitators, administering the TIR intervention was more challenging and possibly stressful compared with BWS in that TIR facilitators directly addressed issues concerning personal and sexual abuse in addition to tsunami-related traumas. Secondary stress among staff was relieved through yoga breathing and TIR sessions.

Discussion

Many obstacles impede research on mental health interventions in mass disasters. Immediate efforts focus on rescue and physical care; conditions are chaotic, making controlled study difficult. Subjects cannot always be followed during massive population displacements. One-on-one interventions become impractical as the number of victims overwhelms healthcare providers. Furthermore, the sudden, unexpected nature of disasters denies researchers the time needed to develop protocols, obtain grants and mobilize teams. Ethical concerns about the wellbeing of disaster victims sometimes discourage research. Consequently, most studies are performed years after disasters have occurred and/or designs cannot be as strictly controlled as they are in laboratory studies. Despite these obstacles, it is important to pursue studies of interventions for relief of psychological symptoms in the aftermath of mass disasters. The lack of such information has left an enormous void. Governments, NGOs and healthcare providers do not know how to provide effective, affordable, accessible psychological interventions to large populations in complex emergencies. Even now, after many disasters, there is insufficient evidence and no consensus regarding what kinds of training to provide or what kinds of interventions to develop and deploy when the next flood, earthquake, war or terrorist act occurs (47). Mollica et al. at the Harvard Program in Refugee Trauma concluded that research should be conducted with survivors of complex emergencies even if it must be performed without all the controls and procedures that obtain in less chaotic circumstances (48).

Strengths and limitations of the study

The strength of this study is that it documented positive responses to a brief group intervention under real-life post-tsunami conditions in refugee camps. It contributes to the small but growing literature on therapeutic programs that could be provided following mass disasters in situations where medical professionals and medications may be in short supply.

Although treatments were assigned to camps by camp administrators, the assignment was not systematic. However, the subjects' experiences of loss in the tsunami (collected during inclusion screening, Table 1) and their initial PCL scores were comparable among the camps. Also comparable were the subjects' experiences during the study in terms of resources (shelter, food, water and medical supplies) and services (ratio of staff to residents, medical care and programs). All camps were administered by the IAHV and careful attention was given to the equitable distribution of resources among the camps and their residents. The rate of attrition was similar in all the camps. Therefore, it does not seem that the events in the camps form a more parsimonious explanation for the treatment effects than the treatments do. The sample is weighted toward women (87%). Although women did not outnumber men in the camps, a greater proportion of women volunteered to participate in the study. Women are more likely to develop PTSD than men according to previous studies, and the gender difference is more pronounced in the context of traditional cultures and of severe conditions as occurred in the tsunami (1, 2). Furthermore, in general, women are more likely than men to report symptoms of PTSD and to seek help.

Sociodemographic data were limited. Information on religion and ethnicity was not collected. Telles et al. (11) found differences in response to trauma among tsunami survivors in the Andaman Islands who had emigrated from the mainland compared with endogenous people. The population in the camps in this study was homogeneous in that they came from fishing families of coastal villages who shared the same language, culture and social structures. The overall distribution of religious groups in the District of Nagapattinam includes 87% Hindu, 8% Muslim and smaller groups of Christians, Buddhists and Jains. While more detailed information about the various cultures, religions and customs of the subjects would have enriched the study and possibly detected differences among subpopulations, it is unlikely that such differences among the camps would have significantly affected the outcome of this study. Residents of all camps showed comparable levels of PTSD and depression at baseline, suggesting comparable levels of distress 8 months after the tsunami. Among the camps receiving active interventions, there were no significant differences in treatment responses.

Lack of blinding of subjects and testers was a limitation of this study. It is possible that the testers, who were practitioners of the intervention and who volunteered to provide service through the IAHV, could have allowed their enthusiasm for the interventions to bias their administration of the tests. The TIR facilitators (who were BWS teachers) also administered test measures, but they were not assigned to test any subjects with whom they had worked directly. Of the 10 authors of this study, eight have no affiliation with AOLF or IAHV. Two authors – A. Vedamurthy and B. Damodaran – are affiliated with AOLF and assist in some relief efforts of IAHV. Subjects could have inflated their improvements out of gratitude or eagerness to please the testers (whom they identified with the organization providing their food and shelter).

The use of a wait list control group as opposed to an active control group raises the question of whether simply having active diversion, group interaction and attention from teachers and testers could account for the improvements in scores. Based on clinical trials of other treatment modalities for PTSD, it is unlikely that 8 h of diversion and group interaction would significantly impact the level of PTSD and depression documented in this population or that such effects would persist for 24 weeks. In addition, the timing of tests and interventions did not adhere strictly to the study protocol. Sometimes testing required 2 or 3 days to complete because of conditions in the camps, time required to travel and limitations in the number of testers. The TIR intervention had to be spread over a 3-week period because the one-on-one sessions were more time consuming and the number of TIR facilitators was limited. The research team was not able to maintain practice logs or weekly attendance records because of their work overload and chaotic conditions in the camps. The fact that the improvement in scores was sustained over 6 weeks and showed further modest improvements at 24 weeks suggests two possibilities: i) participants were doing the practices with some regularity and this regularity was necessary and ii) the benefits of the enhanced BWS course persist for at least 24 weeks even without regular practice. Anecdotal reports from the team of 24-week testers suggested that people were doing well, even though

most were no longer doing the breath practices. About 20% of the participants continued to be actively involved in the breath program by volunteering to help and by bringing their friends to ongoing breath courses. Further study is needed to determine the amount of practice necessary to maintain the level of improvement found in this study.

While the addition of the exposure therapy to the breath program resulted in no further improvement in scores on the measures used, based on prior experience (T. Descilo, personal observation), the exposure therapy may have additional benefits that could have been detected by qualitative analysis of TIR treatment transcripts.

It could be argued that a yoga-based breath intervention would be more effective in a country such as India where yoga philosophy and practices are more widely accepted than in other cultures. While it is possible that the people in rural Nagapattinam may have more readily accepted the breath practices, it is not true that people of other cultures do not respond to these interventions. Similar programs are available in many countries and have been used to relieve stress, PTSD and depression in civilians and military personnel in the aftermath of floods (Jakarta, Indonesia; Poland; Dresden, Germany; Hurricane Katrina, New Orleans), earthquakes (India, Iran and Pakistan), terrorist attacks (Madrid, Spain; Beslan, Russia; World Trade Center, New York), war or civil strife (Chechnya, Kosovo, Serbia, Croatia, Armenia, Azerbaijan, Kashmir, India, Pakistan, Iraq, Afghanistan, Palestine, Gaza, South Africa, Kenya, Botswana, Sudan and Malawi) (49).

Despite the limitations of this study, as discussed above, the marked changes in the two treatment groups compared with the control group suggest that the breath practices used in BWS enhanced with Sudarshan Kriya may provide rapid and significant reduction in symptoms of PTSD and depression, improvements in quality of life and sustainability of these benefits. After receiving the interventions, many refugees anecdotally reported relief from anxiety, insomnia, images of faces in the flood and depression. Some said that they were able to return to their fishing villages because the sound of the ocean ceased to trigger PTSD symptoms. It is also noteworthy that the rural people in Nagapattinam accepted the Western TIR intervention.

In conclusion, this study suggests that multi-component mind–body programs, such as the 8-h yoga-based Breath Water Sound course enhanced with the 10-min Sudarshan Kriya, may provide safe, effective interventions for rapid and sustained relief of PTSD and depression following a mass disaster. Controlled studies in diverse cultures are needed to extend these findings and develop multi-component interventions that can be rapidly deployed and adapted for future disasters.

Acknowledgements

We thank Ved Vignan Maha Vidya Peeth (VVMVP) and the Lynford Family Trust for providing unrestricted grants to support this research. Financial assistance was also provided by Olivia Strutt and The Trauma Resolution Center of Miami. M. Bhoopathy MEd helped translate the tests into Tamil. We also want to honor the many volunteers who devoted long hours and endured physical hardship as well as emotional distress while working with the refugees.

Disclaimer

None of the investigators on this study derive financial remuneration from the AOLF or IAHV. Dr Vedamurthachar, B. Damodaran and Dr Brown are certified yoga breath teachers. Dr Vedamurthachar's travel expenses were paid by VVMVP. B. Damodaran's travel and living expenses were covered by VVMVP while working on this project. Teresa Descilo, MSW CT, is the Director of the Victim Services Center of Miami. She is a TIR trainer and certified traumatologist. During her work on this project she received her usual salary from VSC.

For Statistical Analysis, ANOVA and Newman–Keuls were performed by Beth Adelson and Laura Braslow (New York University, laura.braslow@gmail.com) assisted by David Braslow. Mixed effects regression was carried out by Sue Marcus (Mount Sinai School of medicine marcus5@sbcglobal.net).

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