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ORIGINAL ARTICLE

Long-Term Fluctuations in Traumatic Symptoms of High School Girls Who Survived from the 2011 Japan Tsunami: Series of Questionnaire-Based Cross-Sectional Surveys

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Abstract On March 11, 2011, Japan was struck by a massive earthquake and tsunami. The tsunami caused tremendous damage and traumatized children. We aimed to evaluate and compare the changes in the traumatic symptoms of high school girls 8, 20, 30, and 42 months after the 2011 tsunami. The Post-Traumatic Stress Symptoms for Children 15 items (PTSSC-15), a self-rating questionnaire on traumatic symptoms, was administered to 811 high school girls at the above-mentioned intervals. We calculated the total score, post-traumatic stress disorder (PTSD) subscale, and depression subscale of PTSSC-15. The total score was correlated with house damage, evacuation experience, and bereavement experience. The PTSSC-15 total scores of high school girls with traumatic experience were significantly higher than the scores of children without these experiences (all $p < 0.0001$). The PTSSC-15 total score did not decrease significantly over time. Furthermore, the PTSD subscale of the PTSSC-15 did not significantly improved over the study duration. However, the depression subscale of the PTSSC-15 significantly improved at 30 months, but significantly worsened at 42 months (both $p < 0.0001$). This study demonstrates that the traumatic symptoms of high school girls who survived the massive tsunami fluctuated unpredictably with time. Nonetheless, high school girls continued to suffer depressive symptoms (insomnia, withdrawal, appetite loss, inattention, and physical symptoms) after 42 months.

Keywords Child survivor · Tsunami · Earthquake · Trauma · PTSD

Introduction

On March 11, 2011, Japan was struck by a huge earthquake and tsunami. Numerous children who survived the tremendous tsunami experienced the traumatic loss of parents, siblings, and friends [1–18]. Many previous studies have been conducted on children who have survived disasters and who have had traumatic symptoms [19–21]. The traumatic symptoms of children was related with environmental damage and living in adverse conditions [22, 23]. Some of these surviving children were diagnosed with post-traumatic stress disorder (PTSD) [20, 21, 24–37]. Previous studies have shown that traumatic symptoms tend to heal spontaneously over time. Therefore, the apparent severity of PTSD depends on the time elapsed, individual differences, and methods used in a survey [35–38].

Following the tsunami, we collected information on activities of daily living, damage to environmental conditions, and traumatic symptoms of kindergarten, elementary, junior high and high school students who survived the 2011 Japanese tsunami. We have previously published several studies about traumatic symptoms and daily functioning in students of these age groups [1–6].

The first study demonstrated a direct correlation between traumatic symptoms and environmental damage conditions in kindergarten, elementary, and junior high school children who had suffered from the disaster. Factors examined in studying the relationship between environmental damage

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conditions and traumatic symptoms were gender, age, house damage, evacuation experience, and bereavement experience.

The second study elucidated that the traumatic symptoms, including PTSD and depression subscores, and activities of daily living of kindergarten, elementary, and junior high school children improved after 20 months compared with 8 months after the disaster [5, 6]. This study suggested that traumatic symptoms of the children who survived the disaster improved with time. These studies did not track individual children's scores over time, and they are simply looking at the overall group scores at each time point.

The third study supported the thesis that the traumatic symptoms including PTSD and depression subscores of elementary and junior high school children improved inconsistently over the time period after the disaster [1]. These symptoms of children belonging to the 1st–9th grade groups, who were tested 30 and 20 months after the tsunami, significantly decreased compared with those of children tested 8 months after the tsunami. The PTSD symptoms in these children tested after 30 months did not significantly improve compared with those in children tested after 20 months. The depression symptoms of these children evaluated after 30 months significantly decreased compared with those of children evaluated after 20 months. Thus, it is important not only to evaluate the traumatic symptoms using a self-rating questionnaire but also to analyze specific information regarding depressive symptoms, PTSD symptoms, age, gender, and time elapsed after a disaster.

Forty-two months after the disaster, we collected the same information regarding the traumatic symptoms of child survivors of the 2011 tsunami. We analyzed traumatic symptom of elementary and junior high school children 8, 20, 30 after huge disasters in previous studies. For the first time, this study analyzed the specific changes of traumatic symptoms of high school girls.

The hypothesis of this study was that high school girls who survived huge disasters would have psychological damages similar to those found in elementary and junior high school children [3]. This study aimed to evaluate and compare the changes in the traumatic symptoms of high school girls 8, 20, 30, and 42 months after the 2011 tsunami.

Methods

Study Design and Settings

This study was based on a series of questionnaire-based cross-sectional surveys and involved observation of changes in the traumatic symptoms among children after the 2011 Japanese earthquake and tsunami. Ishinomaki City is the second largest city in the Miyagi Prefecture, Japan. The population of Ishinomaki city remained consistent at about 160,000 throughout the study period. The number of children 8, 20, 30, and 42 months after the disaster was 13,353, 12,947, 12,470, and 12,161 children in municipal kindergarten, elementary, junior high, and high schools of Ishinomaki City. There are two Ishinomaki municipal girls' high schools in Ishinomaki City. Other high schools in Ishinomaki City were the Miyagi municipal high schools.

Recruitment and Participants

Each survey was conducted as part of the school education program under the initiative of the Board of Education in Ishinomaki City. Surveys were distributed to all children who attended five kindergartens, 43 elementary schools, 21 junior high schools, and two girl's high schools in Ishinomaki City. The surveys were conducted between November 2011 and 2012 and between September 2013 and 2014 (8, 20, 30, and 42 months after the disaster, respectively).

The method of administering the surveys in all years was the same. Care was taken to inform all stakeholders, including the city education committee, school principals, teachers, parents, and students about the nature, scope, and use of the surveys. Informed consent was obtained when the students filled out the questionnaire. The Ethics Committee of the National Center for Global Health and Medicine approved the survey protocol including the consent procedure.

In November 2011, the Post-traumatic Stress Symptoms in Children 15 items (PTSSC-15; a self-rating questionnaire on traumatic symptoms) was distributed to 13,353 children enrolled in the municipal schools of Ishinomaki City. A questionnaire on the environmental damage experienced by the children was distributed to their teachers. PTSSC-15 and a questionnaire on the environmental damage were allocated an anonymized study number before distribution and were collected by the teachers immediately after completion. In November 2012, September 2013, and September 2014, copies of PTSSC-15 were distributed to 12,947, 12,470, and 12,161 children enrolled in municipal schools and to their teachers.

An effective response was obtained from 12,470 (93.4 % of the 8 month group), 11,461 (88.5 % of the 20 month group), 11,152 children (89.4 % of the 30 month group), and 11,256 children (92.6 % of the 42 month group).

Answers to the questionnaire on disaster experience 8 months after the disaster for all 12,470 children were obtained from teachers.

Measures

This was a paper-based survey with questions regarding traumatic symptoms in the self-rating format. The self-rating questionnaire comprised PTSSC-15.

PTSSC-15

PTSSC-15 is a self-rating questionnaire on the stress reactions in children after a disaster. Five questions regarding symptoms that are believed to reveal important psychosomatic characteristics after a disaster, comprises flashbacks, appetite loss, somatic reactions such as headache and abdominal pain, attention deficit, and anxiety were added to the Post-Traumatic Stress Symptoms 10-item (PTSS-10) questionnaire that was used as a screening test after the Great Hanshin earthquake and the 2004 Southeast Asia tsunami [37]. PTSSC-15 was thus constructed in Japan. Each question in the questionnaire was scored on a six-point scale from 0 (completely disagree) to 5 (completely agree). A high total score indicates more severe traumatic symptoms.

The depression subscale comprises items regarding insomnia, withdrawal, appetite loss, inattention, and physical symptoms. The PTSD subscale comprises irritability, displeasure, emotional upset, avoidance, nervousness, guilt, flashbacks, and anxiety. Tominaga et al. [39] demonstrated reliability and validity of PTSSC-15 in Japanese children and adolescents.

Disaster Experience Questionnaire

The authors and the educational committee in Ishinomaki City developed the questionnaire regarding the disaster experienced by the children. The form was designed to be completed by teachers to avoid the psychological invasiveness due to directly hear the affected disaster experiences of children and parents. Some children have miserable disaster experiences such as family bereavement [3]. It included questions about the conditions of disaster damage, bereavement experience, and life in evacuation centers. With regard to the environmental damage conditions of the children's houses, one of the following three answers was selected: "no damage," "total collapse by the earthquake or tsunami (incapable of living in the house)," "half collapse by the earthquake or tsunami (necessary to repair the house in order to live in it)."

Regarding the living conditions in evacuation centers, multiple-choice questions and answers were selected from the following options: "no experience," "currently living in the evacuation center," "used to live in the evacuation center," "living in a temporary house," and "used to live in a temporary house."

As to the bereavement experience (including the experience of unexplained disappearance due to the earthquake), multiple answers were allowed from the following eight responses: "no experience," "father," "mother," "brothers and sisters," "grandfather and grandmother," "kindergarten and school classmates at the time of the earthquake," "teacher in charge of the class at the time of the earthquake," and "others."

Statistical Analysis

Previous studies show that the average total score in PTSSC-15 varies depending on gender and grade level. Therefore, we discussed the PTSSC-15 scores and information of environmental damage from high school girls in this study.

Distribution of PTSSC-15 Total Score, Depression Subscale, and PTSD Subscale

The average PTSSC-15 total score, depression subscale, and PTSD subscale in high school girls were calculated separately for the four time points: 8, 20, 30, and 42 months after the tsunami. The differences in the average PTSSC-15 total score, depression subscale, and PTSD subscale after 8 months were assessed by two-factor analysis of variance for each and interval.

PTSSC-15 and Environmental Damage Conditions

House damage, evacuation conditions, and bereavement experience were examined. Then the average PTSSC-15 score in high school girls was calculated. The average PTSSC-15 score was calculated separately in the subjects who experienced each of the three types of environmental disruption, and the difference in the average PTSSC-15 score between groups was statistically analyzed by two-factor analysis of variance (ANOVA) in each grade group and gender. In addition, the total number of disaster experiences of the high school girls was examined and compared with the average PTSSC-15 score.

The Differences in the Average PTSSC-15 Total Score, Depression Subscale, and PTSD Subscale After 8, 20, 30, and 42 Months

The hypothesis of this study was that high school girls who have survived huge disasters would have psychological damages similar to those found in elementary and junior

high school children. Therefore, the average PTSSC-15 total, depression subscale, and PTSD subscale scores in each grade group were calculated separately for the four time points. The differences in the average PTSSC-15 total, depression subscale, and PTSD subscale scores at each interval were assessed by two-factor ANOVA for each and time interval. Furthermore, these differences were compared using Bonferroni post hoc tests.

In all tests, a significance level of 0.05 was used in two-sided tests. All calculations were performed using PASW 18.0 and Graphpad Prism 5 for Mac OS X.

Results

Descriptive Information of High School Girls

The number of high school girls enrolled in Ishinomaki City at 8, 20, 30, and 42 months after the disaster was 829, 754, 651, and 618, respectively. Effective responses were obtained from 811 (93.4 %), 716 (88.5 %), 602 children (89.4 %), and 600 children (92.6 %) at the four intervals, respectively. The effective responses were not related to those at any other point because of anonymity.

Answers to the environmental damage questionnaire 8 months after the disaster were obtained from teachers for 797 of the 829 children (96.1 %). Table 1 shows the data for disaster experience (house damage, evacuation conditions, and bereavement experience) at this point. When teachers had no information regarding these variables, the answer was marked "unknown."

Table 1 Damage to the living conditions of children affected by the 2011 Japan earthquake and tsunami

Items	High school girls n = 797	
House damage		
No	337	42.3 (%)
Yes		
Total collapse	205	25.7 (%)
Half collapse	182	22.8 (%)
Total	387	48.5 (%)
Unknown	73	9.2 (%)
Evacuation experience		
No	544	68.1 (%)
Yes		
Currently living in an evacuation center	0	0.0 (%)
Used to live in an evacuation center	156	19.6 (%)
Living in temporary housing	23	2.9 (%)
Used to live in temporary housing	1	0.1 (%)
Evacuation experience at least once	0	0.0 (%)
Unknown	73	9.2 (%)
Bereavement experience		
No	565	70.9 (%)
Yes		
Father	4	0.5 (%)
Mother	10	1.3 (%)
Brothers and sisters	4	0.5 (%)
Grandfather and grandmother	30	3.8 (%)
Classmates	54	6.6 (%)
Teacher in charge	1	0.1 (%)
Others	0	0.0 (%)
At least one bereavement experience	102	12.8 (%)
Unknown	140	17.6 (%)

M mean, *SD* standard deviation, *N* number of cases

Disaster Experience of High School Girls After 8 Months

The average PTSSC-15 total score was compared with house damage, evacuation experience, and bereavement experience (Table 2). The PTSSC-15 total scores were significantly different between high school girls with and without exposure to these variables. However, effect sizes of these differences were very small (house damage: 0.014, evacuation experience: 0.049, bereavement experience: 0.219).

PTSSC-15 Total Score, Depression Subscale, and PTSD Subscale After 8, 20, 30, and 42 Months

The PTSSC-15 total scores changed significantly when assessed by one-factor ANOVA for each time point. However, when Bonferroni post-tests was used to compare the time points, the PTSSC-15 total score did not significantly decrease with time. Furthermore, the PTSD subscale of the PTSSC-15 did not significantly decrease with time at 8, 20, 30, and 42 months (Table 3). However, the depression subscale of the PTSSC-15 significantly improved at 30 months but regressed at 42 months (20 vs 30 months: $t = 5.159$, 30 vs 42 months: 6.889, all $p < 0.0001$).

Discussion

This study shows that the PTSSC-15 total score, PTSD subscale, and depression subscale in high school girls did not decrease with time after this severe natural disaster.

Previously, our studies showed that the PTSSC-15 total score, PTSD subscale, and depression subscale of elementary school, and junior high school students did not decrease [1–6]. The traumatic symptoms of elementary school, and junior high school students related with their environmental conditions after the tsunami. However, the

Table 2 Average PTSSC-15 score by presence or absence of type of disaster experience

Disaster experience	No			Yes			*p* value	Effect size
	M	SD	N	M	SD	N		
House damage	26.5	13.7	387	26.7	14.3	337	<0.0001	0.014
Evacuation experience	26.4	14.2	544	27.1	13.3	180	<0.0001	0.049
Bereavement experience	26.4	14.0	565	29.5	13.6	92	<0.0001	0.219

M mean, *SD* standard deviation, *N* number of cases, *NS* not significant, *PTSSC-15* the 15-item Post-Traumatic Stress Symptoms for Children

traumatic and depressive symptoms of children who survived the 2011 tsunami did not improve progressively 8, 20, and 30 months after the disaster. Our study showed that these symptoms had improved 20 months after the disaster compared with those observed after 8 months [5, 6]. However, these symptoms did not changed between 20 and 30 months after the disaster.

This study indicated that the traumatic symptoms of high school girls related with their environmental conditions after the tsunami. However, the effect sizes were very small. Therefore, the minor hypothesis that high school girls who survived the tsunami had traumatic symptoms related with disaster experiences was supported.

On the other hand, this study showed that the PTSSC-15 scores including PTSD and depressive subscale of high school girls who survived the 2011 earthquake did not improve progressively after the disaster and that the depression subscale of high school girls actually worsened between the 30 and 42 month study periods. Therefore, the hypothesis that average traumatic symptoms improve progressively 8, 20, 30, and 42 months after the disaster was not practically supported.

This study demonstrates that the mental state of high school girls did not improve progressively. Clinically, it is important that children's traumatic symptoms after a huge disaster be subdivided into PTSD symptoms (irritability, displeasure, emotional upset, avoidance, nervousness, guilt, flashbacks, and anxiety) and depression symptoms (insomnia, withdrawal, appetite loss, inattention, and physical symptoms). In addition, psychiatrists should not forget to take into account the age of a child. Since the rate of depression and depressive symptoms increase with age, it is just impossible to say whether this increase is purely an effect of the older age of each of these girls at the last wave [40]. These depressive symptoms might be affected by their experiences of the tremendous disaster of when they were elementary or junior high school students. Results of this study indicated that the depressive symptoms improved 30 months after the disaster compared with 8 months after, but these symptoms were significantly worse 42 months after than 30 months after. Albeit, these results did not show the developmental implications with respect to age.

This survey had some limitations in methodology. This survey was conducted only at four time points: 8, 20, 30, and 42 months after the 2011 tsunami. Furthermore, this survey was based on a self-rating questionnaire and was conducted in only one district in Japan. It is impossible to determine when the traumatic symptoms stopped decreasing: before or after the 20-month time point. It is also impossible to calculate the severity of PTSD in children after the 2011 Japanese earthquake and tsunami based on the results of our survey. Furthermore, there was always the possibility that youth experienced other forms of trauma (besides the tsunami) that may be contributing to PTSD symptoms. This study did not discuss the traumatic symptoms caused by potential confounding factors such as abuse, poverty, and bereavement experience after the disaster.

Another limitation is that subjects of this study were only high school girls. The results of our survey did not elucidate changes in the traumatic symptoms of high school boys. Therefore, we cannot discuss the differences between high school girls and boys.

The final limitation is that this survey did not track down the cause of each individual's traumatic symptoms. Our study shows only the improvement in the depressive symptoms of high school girls in Ishinomaki City. Therefore, this study did not track individual children's scores over time, and they are simply looking at the overall group scores at each time point. Each time point had a different set of participants, which impacts the average being compared. This study cannot serve as an epidemiological survey or cohort study for formulating a psychiatric diagnosis. Examination by child psychiatrists using operational diagnostic criteria and structured interviews is still necessary for accurate psychiatric diagnosis. Moreover, the results of this study on children in Ishinomaki City do not reflect all the characteristics of children affected by the 2011 Japanese earthquake and tsunami.

Summary

Japanese high school girls were experienced a huge earthquake and tsunami on March 11, 2011. This study evaluated and compared the changes in the traumatic

Table 3 Average total score and subscores of the PTSSC-15 by period

PTSSC-15	Months after disaster									F	*p* value		t	*p* value
	2011 After 8 months			2012 After 20 months			2013 After 30 months			2014 After 42 months				
	M	SD	N	M	SD	N	M	SD	N	M	SD	N		
Total score	26.7	14.1	811	27.3	14.0	716	27.1	13.8	602	27.3	14.6	600	0.3642	NS	8 versus 20 months	0.776	NS
															20 versus 30 months	0.174	NS
															30 versus 42 months	0.155	NS
															8 versus 20 months	1.735	NS
PTSD subscore	15.5	8.9	811	16.2	8.8	716	15.9	9.0	602	15.9	8.9	600	1.014	NS	20 versus 30 months	0.767	NS
															30 versus 42 months	0.054	NS
															8 versus 20 months	0.710	NS
Depression subscore	7.7	4.6	811	7.5	4.5	716	6.2	3.9	602	8.0	4.9	600	18.53	<0.0001	20 versus 30 months	5.159	<0.001
															30 versus 42 months	6.889	<0.001

M mean, *SD* standard deviation, *N* number of cases, *NS* not significant, *PTSSC-15* the 15-item Post-Traumatic Stress Symptoms for Children, *PTSD* post-traumatic stress disorder

symptoms of these high school girls 8, 20, 30, and 42 months after the 2011 tsunami. It demonstrates that the traumatic symptoms of high school girls who survived the massive tsunami generally improved with time. However, the depressive symptoms (insomnia, withdrawal, appetite loss, inattention, and physical symptoms) of high school girls actually worsened between the 30 and 42 month after the disaster. Clinicians should evaluate not only PTSD symptoms but also depressive symptoms of high school girls for several years after a tremendous disaster as potentially unexpected changes in previously improving symptoms can develop.

This study surveyed high school girls following a natural disaster that affected a large population of Japan. This study demonstrates that the traumatic symptoms of the high school girls, who survived the massive tsunami, unpredictably fluctuated with time. The high school girls continued to suffer depressive symptoms (insomnia, withdrawal, appetite loss, inattention, and physical symptoms) after 42 months which highlights the long term impact of the natural disaster on high school girls.

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Compliance with Ethical Standards

Conflict of interest None.

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