

1 Original Article

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3 **Psychological Distress in Children and Adolescent Disaster Survivors**

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5 Short running title: Psychological Distress in Disaster Survivors

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21
22 Number of text pages: 13

23 Number of words: 3520

24 Number of reference pages: 3

25 Number of tables: 6

26 Number of figures: 2

27 Number of legends to figures: 2

Abstract

32

33 **Background**

34 This study aimed to clarify the association between mental and behavioral changes and
35 subsequent psychological distress among children and adolescents living in areas
36 affected by the 2011 Great East Japan Earthquake.

37 **Methods**

38 We conducted a two-wave study, with waves 1 and 2 occurring in 2011 and 2014,
39 respectively. Data of 462 respondents, aged 9–14 years during wave 1, who participated
40 in both surveys were used in the present analysis. A factor analysis was performed using
41 the mental and behavioral changes reported by respondents in wave 1. Psychological
42 distress was defined as a score of ≥ 5 on the six-item Kessler Psychological Distress
43 Scale, as measured in wave 2. With the factors generated in this analysis set as
44 independent variables, the odds ratios (95% confidence intervals) for psychological
45 distress were calculated using logistic regression, adjusting for age, sex, house damage,
46 living environment, and loss of family or friends.

47 **Results**

48 Psychological distress was present in 108 (23.4%) of the respondents. The factor
49 analysis yielded three factors describing mental and behavioral changes: interpersonal
50 issues, brain fog, and anxiety and panic. Of these, interpersonal issues were
51 significantly associated with subsequent psychological distress, with an odds ratio of
52 2.59 (95% confidence interval, 1.58–4.25). This association did not change even when
53 stratified by age and sex.

54 **Conclusions**

55 This study suggests that interpersonal issues are a significant predictor of psychological
56 distress in children and adolescents living in areas affected by a large-scale disaster.

57 **Key words**

58 Adolescent, child, earthquakes, mental health, psychological distress

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61 It is widely reported that natural disasters affect mental health in children and
62 adolescents; however, little is known about the effects on their mental health several
63 years after the disasters. Two studies reported that adverse effects persisted in
64 adolescents at least 2.5 years after a major earthquake. One study focused on areas
65 affected by the 2015 earthquake in Nepal, and reported that depressive symptoms
66 occurred in 33.2% of adolescents 31 months after the disaster. (1) Another study
67 examined areas affected by the 1999 earthquake in Turkey and demonstrated that 30.8%
68 of adolescents in the affected areas had probable depression 3.5 years after the disaster.
69 (2) An array of tools is available for assessing mental health; however, many contain a
70 lengthy list of questions, and are difficult to use in times of emergency. The six-item
71 version of the Kessler Psychological Distress Scale (K6) is relatively brief and
72 straightforward; however, to our knowledge, it has never been used to monitor mental
73 health in children and adolescents after the disasters.

74 In Japan, several studies used the Child Behavior Checklist to screen for mental
75 health problems in children and adolescents living in areas affected by the Great East
76 Japan Earthquake (GEJE) of March 2011. Findings revealed that certain mental health
77 problems persisted three years after the disaster, including internalized behavioral issues
78 such as depressive symptoms and anxiety, and externalized behavioral issues such as

79 aggressive and destructive behavior. (3–6)

80 Disasters cause trauma and changes to the living environment. These effects
81 may exacerbate existing mental and behavioral disorders. Therefore, behavioral changes
82 in children and adolescents following a disaster may contribute to negative mental
83 health effects. However, to our knowledge, no study has examined the association
84 between such behavioral changes and mental health in this population.

85 The present study thus focused on children and adolescents in areas impacted
86 by the GEJE. We examined if mental and behavioral changes that were present six
87 months after the disaster predicted psychological distress in this population three years
88 after the disaster.

89

90 **Methods**

91 **1. Study population**

92 The present study forms part of the Research Project for the Prospective
93 Investigation of Health Problems among survivors of the Great East Japan Earthquake
94 and Tsunami Disaster (the RIAS Study). The RIAS Study was launched by Iwate
95 Medical University in 2011, and it monitors health problems among the population of
96 the disaster affected coastal areas of Iwate Prefecture (Yamada, Otsuchi, Rikuzen-
97 takata, and the Heita district of Kamaishi). As part of this study, two independent cross-
98 sectional surveys were conducted to investigate health problems in children and
99 adolescents in 2011, and in the late 2014 and early 2015, respectively.

100 Figure 1 presents a flowchart showing how participants were recruited in the
101 two surveys. The first survey (wave 1) was conducted from October to November 2011.

102 Questionnaire forms were posted to 8,122 persons aged under 18 years living in the
103 abovementioned areas, and 4,132 persons responded (response rate: 50.9%). The second
104 survey (wave 2) was conducted from December 2014 to February 2015. Questionnaire
105 forms were posted to 9,380 persons aged under 20 years living in the same areas, out of
106 which 3,970 (42.0%) responded (response rate: 42.0%). In cases where the individual
107 was aged under 12 years, a parent or guardian was requested to respond on their behalf.

108 A total of 596 respondents, aged 9–14 years at wave 1, completed the surveys
109 in both waves 1 and 2. Of these, data on 134 persons were excluded because of missing
110 values. Consequently, the data subjected to analysis pertained to 462 individuals. The
111 study was approved by the ethics committee of Iwate Medical University (approval no.
112 H23-69, August 16, 2011).

113 **2. Measurements**

114 *Mental and Behavioral Changes in Children and Adolescents*

115 In wave 1, we assessed mental and behavioral changes in children and
116 adolescents. The survey comprised the 12 questions shown in Table 2. Each question
117 was answered on a three-point scale (agree, somewhat agree, disagree). An advisory
118 group of experts selected the survey questions that minimized the psychological burden
119 of the respondents.

120 *Disaster Exposure*

121 In wave 2, we measured the extent of disaster exposure. Content of this nature
122 had been omitted from wave 1 out of sensitivity to the survivors. The survey consisted
123 of three questions: house damage, living environment, and loss of family or friends. For
124 some respondents, the child's parent or guardian answered after consulting with them.

125 For house damage, respondents rated the damage on a seven-point scale:

126 “completely destroyed,” “mostly destroyed,” “half destroyed,” “partially destroyed,”
127 “water ingress but no major damage,” “no water ingress and no major damage,” and
128 “other.” For the analysis, the responses were grouped into three categories describing
129 the extent of the damage, where the first two points were classified as *major damage*,
130 the next three points *medium damage*, and the final two points *no damage*, respectively.

131 For living environment, respondents selected one of nine options: “no change,”
132 “prefab temporary housing,” “temporary rental under housing lease program (private or
133 public housing stock),” “public housing allocated for disaster victims,” “moved to
134 rented accommodation outside housing lease program,” “rebuilt home in same
135 location,” “rebuilt home in different location,” “living in home of friend or relative,”
136 and “other.” For the analysis, the responses were grouped into four categories, where
137 option 1 indicated *no change*, options 3 to 4 indicated *temporary housing*, options 5 and
138 6 indicated *rebuilt home*, and the remaining options not listed in the first three
139 categories constituted *other*.

140 The loss of family or friends was confirmed (*Loss of family or friends: Yes*) or
141 disaffirmed (*Loss of family or friends: No*) if the respondent reported that a co-residing
142 family member or school friend had or had not perished in the disaster, or had or had
143 not been missing since, respectively.

144 ***Psychological Distress***

145 Psychological distress was assessed in wave 2 using the six-item version of the
146 K6. Developed by Kessler et al. (2002), K6 measures mental health issues, such as
147 depressive symptoms and anxiety disorders. (7) Sakurai et al. tested K6 on Japanese
148 adults and reported an optimal cutoff of 4/5, at which it achieves 100% sensitivity and
149 68.7% specificity for depression and anxiety disorders. (8) In the USA, K6 performed

150 effectively in large school samples (ages 11–18). (9, 10) Similarly, in Japan, K6 was
151 used to screen people aged 12 and above as part of the Comprehensive Survey of Living
152 Conditions. (11) In the present study, a K6 score of ≥ 5 indicates the presence of
153 psychological distress; this score was adopted as the cutoff to sensitively screen for
154 high-risk cases of post-disaster psychological distress, ensuring an inclusive process for
155 supporting the victims.

156 **3. Statistical Analysis**

157 We described the basic characteristics of 462 respondents and the response
158 distribution for each of the 12 items examining mental and behavioral changes. To
159 ascertain patterns in these responses, a factor analysis was performed by promax
160 rotation ($Kappa = 4$) using unweighted least squares. A value was assigned to each
161 response: 2, 1, and 0 for “agree,” “somewhat agree,” and “disagree,” respectively. Since
162 there were few responses to the item “Sometimes engages in self-harm,” we excluded it.
163 The number of factors was determined by retaining all factors with an eigenvalue of ≥ 1 .
164 Those with a loading of > 0.4 were adopted as factors to analyze. The factor scores were
165 calculated, and dichotomous variables were made by separating respondents with values
166 \geq mean from those with values $<$ mean. The characteristics of respondents were
167 compared between the two groups of each generated factor using a chi-squared test.

168 The following analyses were conducted to examine the factors associated with
169 psychological distress: First, we compared the respondents’ characteristics based on the
170 presence and absence of psychological distress at wave 2 using a chi-squared test.
171 Second, for each factor generated above, odds ratios (ORs) and 95% confidence
172 intervals (95% CIs) of psychological distress were calculated using a logistic regression
173 for three models: Model 1, unadjusted model; Model 2, age and sex adjusted model; and

174 Model 3, age, sex, house damage, living environment, and loss of family or friends.
175 Similarly, ORs and 95% CIs were calculated stratified by age group (9–11 and 12–14
176 years at wave 1) and sex. All statistical analyses were performed using IBM SPSS
177 Statistics Version 24.0, with a p-value of less than 0.05 indicating statistical
178 significance.

179

180 **Results**

181 Table 1 shows the basic characteristics of the 462 respondents. Psychological
182 distress was present in 108 (23.4%) of the respondents. Figure 2 presents the K6 scores
183 in a histogram. Table 2 shows the distribution of responses for the 12 items on mental
184 and behavioral changes. At least 20% of respondents indicated that the following
185 changes had occurred by answering either “agree” or “somewhat agree”: “Often acts
186 defiantly” (37.3%), “Appears unfocused on studies” (29.2%), “Appears unmotivated”
187 (29.0%), and “Panics unnecessarily and is easily startled” (20.2%). Meanwhile, 10–20%
188 of respondents reported experiencing the following changes: “Becomes restless and
189 agitated, and can no longer concentrate” (18.2%), “Has become scared of certain
190 locations” (16.0%), and “Bullies siblings or a pet, or struggles to play with friends”
191 (11.3%). Less than 10% of the respondents indicated that the following changes had
192 occurred: “Dislikes going to school” (8.2%), “Has become less talkative” (8.0%),
193 “Appears anxious and sad without reason” (7.3%), “Often quarrels with friends”
194 (6.1%), and “Sometimes commits self-harm” (0.4%).

195 Table 3 shows the results of the factor analysis. Three factors were generated,
196 each with an eigenvalue of ≥ 1 . The validity of the factor analysis was confirmed by a

197 sampling adequacy value of 0.812 in the Kaiser-Meyer-Olkin Test and a p-value of <
198 0.001 in Bartlett's Test of Sphericity. The first factor contained the following items:
199 "Bullies siblings or a pet or struggles to play with friends;" "Has become less talkative;"
200 "Often quarrels with friends;" "Dislikes going to school;" and "Appears anxious and
201 sad without reason." This was termed "*interpersonal issues*." The second factor
202 contained the following items: "Appears unfocused on studies;" "Appears
203 unmotivated;" and "Becomes restless and agitated and can no longer concentrate." This
204 was termed "*brain fog*." The third factor contained the following items: "Has become
205 scared of certain locations" and "Panics unnecessarily and is easily startled." This was
206 termed "*anxiety and panic*."

207 Table 4 shows the characteristics of respondents for each of the three factors of
208 mental and behavioral changes. Respondents with interpersonal issues and brain fog had
209 witnessed significantly higher proportions of house damage and loss of family or
210 friends compared to their corresponding counterparts. Respondents with anxiety and
211 panic were younger and had experienced a significantly higher proportion of loss of
212 family or friends than those without anxiety and panic.

213 Table 5 shows the characteristics of respondents by the presence and absence of
214 psychological distress. Respondents with psychological distress at wave 2 were more
215 likely to be old, female, have lost family or friends, and have had interpersonal issues at
216 wave 1 compared to those without psychological distress.

217 Table 6 shows the odds ratios (95% confidence intervals) for psychological
218 distress by each of the three factors of mental and behavioral changes. In all three
219 models, the factor "interpersonal issues" was associated with psychological distress
220 (Model 3, OR = 2.59 [95% CI 1.58–4.25]). This significant association did not change

221 when stratified by sex and age. There was no significant association between brain fog
222 and psychological distress in any of the three models. The factor “anxiety and panic”
223 was significantly associated with psychological distress in Model 2 (1.77 [1.05–2.97]);
224 however, the significance disappeared (1.69 [0.99–2.87]) in Model 3. The significant
225 association between anxiety and panic was observed only in males and not in females
226 (Model 3, 2.98 [1.35–6.56]). The significant association was also observed in
227 respondents aged 12–14 years in Models 1 and 2 (Model 2, 2.13 [1.02–4.44]); however,
228 the significance disappeared in Model 3 (1.83 [0.85–3.93]).

229

230

Discussion

231 We examined the prevalence of psychological distress among children and
232 adolescents three years after the GEJE in 2014–15. We generated three factors
233 describing mental and behavioral changes that had occurred six months after the disaster
234 in 2011: interpersonal issues; brain fog; and anxiety and panic. Among the respondents,
235 the presence of interpersonal issues was significantly associated with a higher risk for
236 psychological distress. This tendency did not change even when stratified by age and
237 sex. The factor “anxiety and panic” was associated with a higher risk only in males.
238 There was no significant association between brain fog and psychological distress. We
239 performed a multivariable logistic analysis using a hierarchical model to examine the
240 modified effects of the three factors—“damage to home,” “living environment,” and
241 “loss of family or friends”—on the association between mental and behavioral changes
242 and psychological distress. The association between interpersonal issues and
243 psychological distress weakened after adjusting for the three factors, which indicated

244 that interpersonal issues caused by the GEJE may affect psychological distress.

245 Psychological distress was present in 23.4% of the respondents who were aged
246 12–17 years at the time of wave 2. The 2013 Comprehensive Survey of Living
247 Conditions reported a prevalence of psychological distress in 21.9% of individuals aged
248 12–19 years. (11) Although there was a difference in the age range of the study
249 population, our results suggest that children and adolescents living in disaster-affected
250 areas are more likely to experience psychological distress than their peers living in other
251 areas.

252 Our study is unique as we screened for mental health issues over 2.5 years
253 following the earthquake disaster. Silwal et al. used the Depression Self-Rating Scale to
254 screen for mental health issues in 515 adolescents (aged 11–17 years) living in areas
255 affected by the 2015 earthquake in Nepal. Depressive symptoms occurred in 37.5% of
256 their sample at 18 months and in 33.2% at 31 months after the earthquake. (1) Similarly,
257 Karakaya et al. used the Beck Depression Inventory to screen for depressive symptoms
258 among 334 high-school students living in areas affected by the 1999 Marmara
259 earthquake in the northwest of Turkey. They found that 30.8% of adolescents in the
260 affected areas had probable depression at 3.5 years after the disaster. (2) Due to
261 differences in screening tools, it is difficult to compare the results of our study with
262 those of the others; however, our study also emphasized the need for mental health
263 follow-ups just as the previous studies. In addition, to our knowledge, ours is the only
264 study to have used K6 as a screening tool. As discussed, K6 performed effectively in
265 large school samples (ages 11–18) in the USA. (9, 10) Similarly, in Japan, K6 is used to
266 screen people aged 12 and above as part of the Comprehensive Survey of Living
267 Conditions. (11) Our results suggest that K6 serves as a quick and convenient method

268 for evaluating mental health in disaster impacted areas.

269 Regarding the three factors of mental and behavioral changes reported in wave
270 1, 22.9%, 37.4%, and 25.8% of the respondents experienced interpersonal issues, brain
271 fog, and anxiety and panic, respectively. Thus, interpersonal issues, brain fog, and
272 anxiety and panic may have been prevalent among children and adolescents in areas
273 affected by the GEJE. We also found that these three factors of mental and behavioral
274 changes were significantly associated with damage to the home; change in living
275 environment; and loss of family or friends. This suggests that disaster exposure
276 increases the likelihood of mental and behavioral changes in children and adolescents
277 living in affected areas.

278 Risk factors for negative mental health among children and adolescents in
279 large-scale disasters include witnessing death or injury during the disaster, feeling
280 mortally endangered, or feeling that one's family members are mortally threatened. (12–
281 16) Our results indicate that interpersonal relationships are also an important risk factor
282 for poor mental health. Previous studies suggest that interpersonal issues increase the
283 risk of depression and anxiety. The Nord-Trøndelag Health Study (The HUNT Study)
284 screened for anxiety and depression among 7,639 adolescents aged 13–18 years using
285 the five-item version of the Hopkins Symptom Checklist, and indicated that living with
286 parents, enjoying good familial relationships, and having at least two friends were
287 associated with lower symptom levels. (17) Similarly, Kwong et al. used data from the
288 Avon Longitudinal Study of Parents and Children (a British longitudinal study
289 established in 1990) to examine depressive symptoms via the Short Mood and Feelings
290 Questionnaire, on nine occasions from ages 10 to 24 years. They reported that
291 depressive symptoms were significantly more likely to occur in individuals who were

292 bullied at 10 years of age than in those who were not bullied. (18) Our study provides
293 insights into the effects of interpersonal issues on the mental health of children and
294 adolescents living in disaster impacted areas.

295 Anxiety and panic were significantly associated with psychological distress
296 only among males. Anxiety and panic at six months from the disaster may denote the
297 presence of post-traumatic stress disorder (PTSD). In a longitudinal study, Adams et al.
298 examined the factors associated with PTSD based on the DSM-IV in individuals who
299 were living in New York during the September 11 attacks. The authors surveyed a
300 cohort of adults in New York (aged 18 years and above), obtaining data from 2,368 and
301 1,681 individuals one year and two years after the event, respectively. The authors
302 found that PTSD decreased between year 1 and year 2 among females, but not among
303 males. (19) If symptoms are more likely to become protracted in males than in females,
304 it may explain the association between anxiety and panic, and psychological distress in
305 males.

306 We also found that anxiety and panic significantly predicted psychological
307 distress among respondents aged 12–14 years. However, the significance disappeared
308 when adjusted for disaster exposure. Thus, this association could be explained by
309 disaster damage. A similar finding was reported by Silwal et al. in their study on
310 survivors of the Nepal earthquake. Specifically, when ≤ 15 years was used as the
311 reference category, the univariate analysis indicated increased odds for depressive
312 symptoms in the > 15 years category. However, the significance disappeared when the
313 authors controlled for age and trauma exposure. (1) This may be because older survivors
314 understand the severity of the damage better than younger survivors; thus, older
315 survivors with relatively high trauma exposure are more likely to develop psychological

316 distress.

317 This study had several limitations. First, the respondents included in our study
318 were limited to individuals who responded to both surveys; therefore, the data may not
319 entirely represent the population affected by the 2011 disaster. Children and adolescents
320 with poor mental health may have been less likely to participate in the study, or more
321 likely to withdraw from the study. Thus, our results may be underestimated compared to
322 the true prevalence and odds ratio for psychological distress. Second, the respondents
323 included only Japanese people who were survivors of a specific disaster event in Japan.
324 Thus, caution is required when attempting to extrapolate the findings to other
325 populations and disasters. Third, we did not consider the psychological conditions of
326 parents. Given that mental health conditions of parents can affect the mental health of
327 their children (5), there might be misclassification bias on mental and behavioral
328 changes in some cases. Fourth, the validity and reliability of the scale used in this study
329 were not confirmed. It is necessary to confirm these so that this scale can be used in
330 future studies. Fifth, psychological distress was not investigated in wave 1; therefore, its
331 effect in wave 2 could not be evaluated.

332 In conclusion, our study demonstrated that children and adolescent survivors of
333 the GEJE were more likely to experience psychological distress three years after the
334 disaster if they had experienced interpersonal issues six months after the disaster. The
335 finding suggests that interpersonal issues can be used as an indicator for identifying
336 children and adolescents who are at risk of developing psychological distress.

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Acknowledgments

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424 Table 1: Respondents' basic characteristics (n = 462)

Age at the start of 2011 survey (%)	
9	14.3
10	14.9
11	18.8
12	16.9
13	18.4
14	16.7
Gender: Male (%)	51.3
Damage to home (%) [†]	
No damage	51.3
Medium damage	14.5
Major damage	34.2
Living environment (%) [†]	
No change	65.8
Temporary housing	16.0
Rebuilt house	13.2
Other	5.0
Lost family or friends: Yes (%) [†]	40.9
Psychological distress: Yes (%) [†]	23.4

425 [†] Surveyed in 2014(wave 2)

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427 Table 2: The distribution of responses to items on mental and behavioral changes (n = 462)

Question item (%)	Agree	Somewhat agree	Disagree ⁴²⁸
Panics unnecessarily and is easily startled	3.7	16.5	79.9
Becomes restless and agitated, and can no longer concentrate	3.9	14.3	81.8
Has become scared of certain locations	5.6	10.4	84
Appears anxious and sad without reason	1.5	5.8	92.6
Appears unfocused on studies	6.3	22.9	70.8
Appears unmotivated	6.7	22.3	71
Dislikes going to school	1.7	6.5	91.8
Bullies siblings or a pet, or struggles to play with friends	2.6	8.7	88.7
Has become less talkative	1.7	6.3	92
Sometimes engages in self-harm	0	0.4	99.4
Often acts defiantly	8.9	28.4	62.8
Often quarrels with friends	1.3	4.8	93.9

429 Table 3: Results of factor analysis performed on mental and behavioral changes

	Factor loadings			All factors
	Interpersonal issues	Brain fog	Anxiety and panic	
Bullies siblings or a pet, or struggles to play with friends	0.82	0.00	-0.11	0.61
Has become less talkative	0.69	-0.08	-0.02	0.41
Often quarrel with friends	0.56	0.02	0.05	0.35
Dislikes going to school	0.54	0.10	-0.09	0.33
Appears anxious and sad without reason	0.45	0.01	0.25	0.36
Appears unfocused on studies	-0.06	0.96	-0.08	0.82
Appears unmotivated	0.02	0.88	-0.03	0.78
Becomes restless and agitated, and can no longer concentrate	0.04	0.51	0.27	0.46
Often acts defiantly	0.30	0.36	0.10	0.42
Has become scared of certain locations	0.00	-0.11	0.91	0.77
Panics unnecessarily and is easily startled	-0.08	0.13	0.58	0.36
Inter-factor correlations				
	Interpersonal issues	Brain fog	Anxiety and panic	
Interpersonal issues	1.00	0.59	0.41	
Brain fog	0.59	1.00	0.37	
Anxiety and panic	0.41	0.37	1.00	

430 † We used unweighted least squares, promax rotation ($Kappa = 4$).

431 ‡ Bold font indicates factor loadings of > 0.4 .

432 Table 4: Factors of mental and behavioral changes by respondents' characteristics

	No. of respondents	Interpersonal issues		p-value	Brain fog		p-value	Anxiety and panic		p-value	
		No (n = 345)	Yes (n = 117)		No (n = 308)	Yes (n = 154)		No (n = 360)	Yes (n = 102)		
Age at the start of 2011 survey	9	66	47 (71.2)	19 (28.8)	0.968	45 (68.2)	21 (31.8)	0.376	48 (72.7)	18 (27.3)	0.003
	10	69	50 (72.5)	19 (27.5)		46 (66.7)	23 (33.3)		46 (66.7)	23 (33.3)	
	11	87	65 (74.7)	22 (25.3)		58 (66.7)	29 (33.3)		63 (72.4)	24 (27.6)	
	12	78	59 (75.6)	19 (24.4)		52 (66.7)	26 (33.3)		60 (76.9)	18 (23.1)	
	13	85	65 (76.5)	20 (23.5)		63 (74.1)	22 (25.9)		74 (87.1)	11 (12.9)	
	14	77	59 (76.6)	18 (23.4)		44 (57.1)	33 (42.9)		69 (89.6)	8 (10.4)	
Gender	Male	237	176 (74.3)	61 (25.7)	0.834	152 (64.1)	85 (35.9)	0.236	190 (80.2)	47 (19.8)	0.232
	Female	225	169 (75.1)	56 (24.9)		156 (69.3)	69 (30.7)		170 (75.6)	55 (24.4)	
Damage to home	None	237	192 (81.0)	45 (19.0)	0.001	173 (73.0)	64 (27.0)	0.009	191 (80.6)	46 (19.4)	0.307
	Medium damage	67	51 (76.1)	16 (23.9)		43 (64.2)	24 (35.8)		52 (77.6)	15 (22.4)	
	Major damage	158	102 (64.6)	56 (35.4)		92 (58.2)	66 (41.8)		117 (74.1)	41 (25.9)	
Living environment	No change	304	239 (78.6)	65 (21.4)	0.053	213 (70.1)	91 (29.9)	0.197	242 (79.6)	62 (20.4)	0.474
	Temporary housing	74	48 (64.9)	26 (35.1)		45 (60.8)	29 (39.2)		54 (73.0)	20 (27.0)	
	Rebuilt home	61	42 (68.9)	19 (31.1)		36 (59.0)	25 (41.0)		48 (78.7)	13 (21.3)	

	Other	23	16 (69.6)	7 (30.4)		14 (60.9)	9 (39.1)		16 (69.6)	7 (30.4)	
Loss of family or friends	No	273	217 (79.5)	56 (20.5)	0.004	193 (70.7)	80 (29.3)	0.027	224 (82.1)	49 (17.9)	0.010
	Yes	189	128 (67.7)	61 (32.3)		115 (60.8)	74 (39.2)		136 (72.0)	53 (28.0)	

433 Values show number and percentage of responses. The p-values were determined by chi-squared test.

434 Mean of factor scores of “Interpersonal issues” is 4.6×10^{-17} .

435 Mean of factor scores of “Brain fog” is 5.1×10^{-17} .

436 Mean of factor scores of “Anxiety and panic” is -6.9×10^{-17} .

437 Table 5: Respondents' characteristics by psychological distress outcome

		No. of respondents	Psychological distress		p-value	
			No	Yes		
Age at the start of 2011 survey	9	66	56 (84.8)	10 (15.2)	0.017	
	10	69	59 (85.5)	10 (14.5)		
	11	87	71 (81.6)	16 (18.4)		
	12	78	54 (69.2)	24 (30.8)		
	13	85	57 (67.1)	28 (32.9)		
	14	77	57 (74.0)	20 (26.0)		
	9-11	222	186 (83.8)	36 (16.2)		<0.001
	12-14	240	168 (70.0)	72 (30.0)		
Gender	Male	237	192 (81.0)	45 (19.0)	0.022	
	Female	225	162 (72.0)	63 (28.0)		
Damage to home	None	237	180 (75.9)	57 (24.1)	0.938	
	Medium damage	67	52 (77.6)	15 (22.4)		
	Major damage	158	122 (77.2)	36 (22.8)		
Living environment	No change	304	232 (76.3)	72 (23.7)	0.657	
	Temporary housing	74	63 (85.1)	19 (25.7)		
	Rebuilt home	61	47 (77.0)	14 (23.0)		
	Other	23	12 (52.2)	3 (13.0)		
Loss of family or friends	No	273	220 (80.6)	53 (19.4)	0.016	

	Yes	189	134 (70.9)	55 (29.1)	
Interpersonal issues	No	345	278 (80.6)	67 (19.4)	0.001
	Yes	117	76 (65.0)	41 (35.0)	
Brain fog	No	308	242 (78.6)	66 (21.4)	0.162
	Yes	154	112 (72.7)	42 (27.3)	
Anxiety and panic	No	360	282 (78.3)	78 (21.7)	0.103
	Yes	102	72 (70.6)	30 (29.4)	

438 Values show number and percentage of responses. The p-values were determined by chi-squared test.

Table 6: The odds ratios (95% confidence intervals) for psychological distress stratified by each of the three factors of mental and behavioral changes.

	Psychological distress		Model 1		Model 2		Model 3	
	Number of respondents	Number of cases	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Total participants	Yes /No	Yes /No						
Interpersonal issues	117 /345	41 /76	2.24	(1.41 - 3.56)	2.43	(1.51 - 3.92)	2.39	(1.46 - 3.92)
Brain fog	154 /308	42 /112	1.37	(0.88 - 2.15)	1.40	(0.89 - 2.22)	1.37	(0.86 - 2.19)
Anxiety and panic	102 /360	30 /72	1.51	(0.92 - 2.47)	1.77	(1.05 - 2.97)	1.67	(0.98 - 2.83)
Boys								
Interpersonal issues	61 /401	19 /42	2.61	(1.32 - 5.17)	2.63	(1.32 - 5.22)	2.61	(1.27 - 5.33)
Brain fog	85 /377	20 /65	1.56	(0.81 - 3.02)	1.54	(0.79 - 2.99)	1.49	(0.75 - 2.94)
Anxiety and panic	47 /415	15 /32	2.50	(1.21 - 5.17)	2.89	(1.36 - 6.17)	2.89	(1.32 - 6.32)
Girls								
Interpersonal issues	56 /406	22 /34	2.02	(1.06 - 3.84)	2.34	(1.20 - 4.57)	2.26	(1.13 - 4.52)
Brain fog	69 /393	22 /47	1.31	(0.71 - 2.44)	1.31	(0.69 - 2.46)	1.24	(0.65 - 2.39)
Anxiety and panic	55 /407	15 /40	0.95	(0.48 - 1.88)	1.17	(0.58 - 2.39)	1.07	(0.52 - 2.23)
Ages 9–11 years								
Interpersonal issues	60 /402	15 /45	2.24	(1.06 - 4.70)	2.26	(1.07 - 4.78)	2.33	(1.08 - 5.01)
Brain fog	73 /389	14 /59	1.37	(0.65 - 2.86)	1.39	(0.66 - 2.92)	1.37	(0.64 - 2.92)
Anxiety and panic	65 /397	13 /52	1.46	(0.69 - 3.09)	1.45	(0.68 - 3.08)	1.44	(0.67 - 3.09)
Ages 12–14 years								
Interpersonal issues	57 /405	26 /31	2.50	(1.35 - 4.64)	2.66	(1.41 - 5.00)	2.45	(1.27 - 4.74)
Brain fog	81 /381	28 /53	1.38	(0.78 - 2.45)	1.50	(0.83 - 2.71)	1.50	(0.82 - 2.75)
Anxiety and panic	37 /425	17 /20	2.29	(1.12 - 4.68)	2.13	(1.02 - 4.44)	1.87	(0.88 - 3.99)

440

441 Model 1: unadjusted.

442 Model 2: adjusted for gender and age.

443 Model 3: adjusted for gender, age, damage to home, living environment, and loss of family or friends.

444 In Models 2 and 3, the gender variable is excluded in the gender-stratified analysis.

445

Figure legends

446 Figure 1: Flowchart showing the recruiting of respondents.

447 Figure 2: Histogram of the Kessler Psychological Distress Scale-6 scores
448 K6: the Kessler Psychological Distress Scale-6

Figure 1

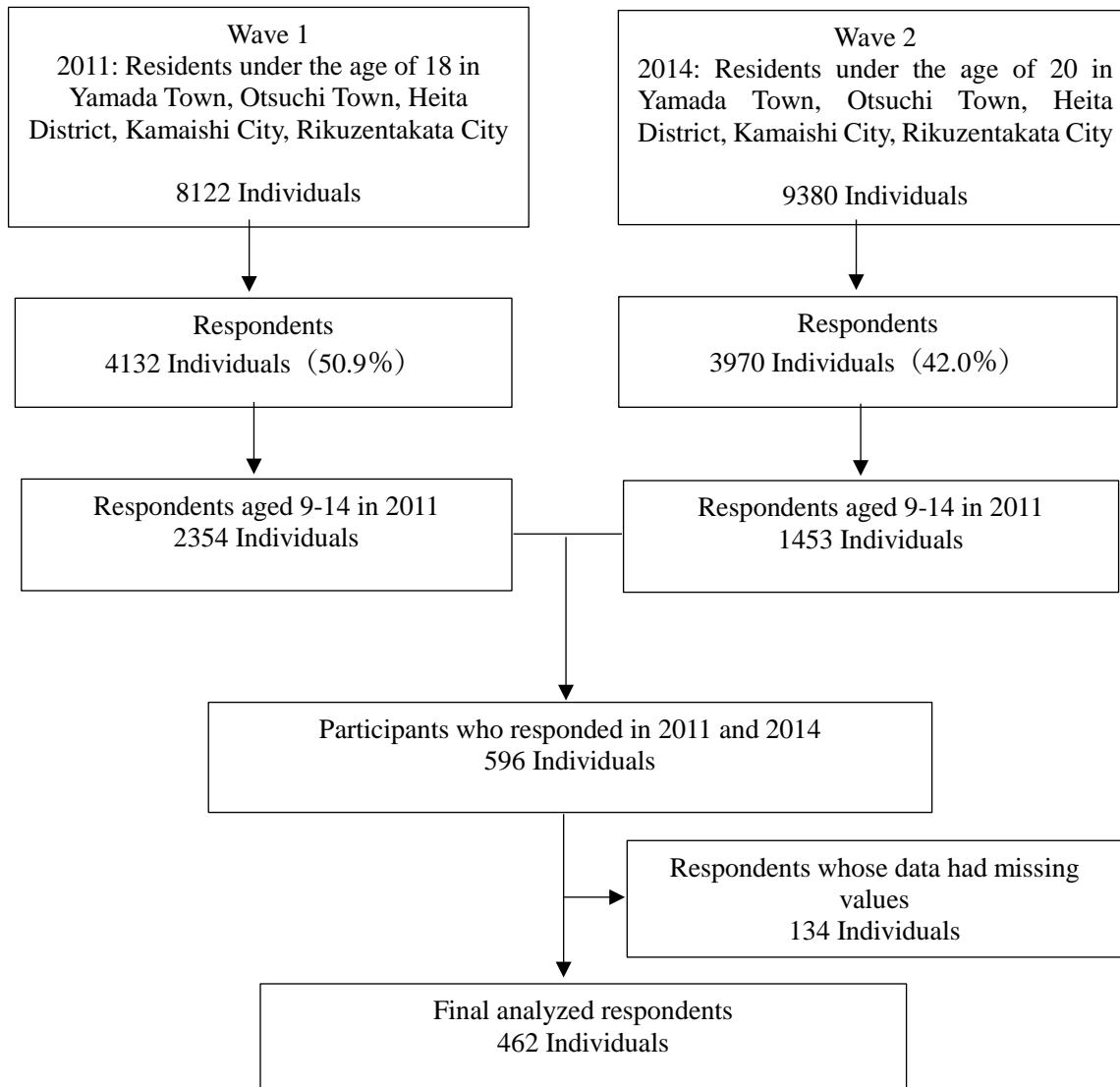


Figure 2

