PSYCHIATRIA ET NEUROLOGIA JAPONICA

Original Article

Trajectories of Psychological Distress among Residents Affected by the Great East Japan Earthquake and Tsunami based on a Decade Cohort Study

Hitomi USUKURA[1,2], Yusuke UTSUMI[3], Moe SETO[3], Atsushi SAKUMA[3], Yumi SUGAWARA[4], Yasuto KUNII[5], Naoki NAKAYA[6], Atsushi HOZAWA[6], Ichiro TSUJI[4], Hiroaki TOMITA[2,5]

1 Department of Human Science, Faculty of Liberal Arts, Tohoku Gakuin University
2 Department of Psychiatry, Graduate School of Medicine, Tohoku University
3 Department of Psychiatry, Tohoku University Hospital
4 Department of Epidemiology, Graduate School of Medicine, Tohoku University
5 Department of Disaster Psychiatry, International Research Institute of Disaster Science, Tohoku University
6 Department of Preventive Medicine and Epidemiology, Tohoku Medical Megabank Organization, Tohoku University

Psychiatria et Neurologia Japonica 125: 266-274, 2023

Abstract

Several large-scale cohort studies have focused on the mental health of residents affected by the Great East Japan Earthquake (GEJE), but no study has clarified details of the long-term course of mental health after the disaster. Therefore, the present study investigated the long-term trajectories of psychological distress among residents of GEJE-affected areas using data from an annual cohort survey conducted over a 10-year period after the disaster. We used data from a community-based cohort study included in the Shichigahama Health Promotion Project for residents of the town of Shichigahama, Miyagi Prefecture, which was affected by the GEJE. Included in the analysis were 1,083 subjects aged ≥20 years at the time of the first survey and who had responded at least

five times between 2011 and 2020, including the first survey. Psychological distress was evaluated using the K6 scale. Group-based trajectory modeling revealed the following four-trajectory model characterized by longitudinal alterations in psychological distress: resistant trajectory (n=275,25.4%), subthreshold trajectory (n=455,42.0%), moderately affected trajectory (n=291,26.9%), and severely affected trajectory (n=62,5.7%) (BIC=-25,159.5, log Bayes factor=309.4).

The overall psychological distress alterations showed a tendency to decrease gradually and suggested that the degree of psychological distress in the early phase of the disaster was maintained over a long time. Therefore, it is necessary to provide long-term, focused support to those who experience severe psychological distress in the early phase of a disaster.

Keywords: Great East Japan Earthquake, psychological distress, group-based trajectory modeling, disaster psychiatry, Shichigahama town

Introduction

Twelve years have passed since the Great East Japan Earthquake (GEJE), which occurred on March 11, 2011. In Miyagi Prefecture, one of the areas that suffered extensive damage, the number of deaths and missing persons has been reported as 11,784.[13] Searches for missing persons are still ongoing, and issues such as regional development and reorganization remain. Therefore, even more than a decade after the disaster, the process of recovery and restoration of the lives and physical and mental health of the affected residents is still underway.

It is well-known that the impact of disasters on the mental health of affected residents varies markedly among individuals. While some only experience nonspecific stress-related symptoms, others develop psychiatric problems such as post-traumatic stress disorder (PTSD), depressive, or anxiety symptoms.[20] Similarly, individual differences have been noted in how symptoms change following traumatic experiences. Bonanno, G.A. et al.,[2] through a review of previous studies, reported six typical patterns of change in the one to two years following exposure to a traumatic event: (1) “minimal-impact resilience”: a pattern in which functional levels slightly decline immediately after exposure but quickly return to the baseline (35–65% of the total); (2) “recovery”: a pattern in which moderate to severe dysfunction

appears immediately after exposure but gradually improves over one to two years (15–25%); (3) "improved": a pattern in which those with pre-existing dysfunction return to healthy levels after the traumatic experience (5–10%); (4) "chronic": a pattern in which severe dysfunction that appears immediately after exposure persists chronically (5–30%); (5) "continuous": a pattern in which pre-existing dysfunction continues unchanged after the traumatic experience (5–15%); and (6) "delayed": a pattern in which dysfunction is mild immediately after exposure but worsens over time (0–15%). Galatzer-Levy, I.R. et al.[4] also reported four main trajectories of symptom change following traumatic experiences: (1) "resilient" (65.7%), (2) "recovery" (20.8%), (3) "chronic" (10.6%), and (4) "delayed-onset" (8.9%).

Studies on changes in mental health among victims of natural disasters. have also partially confirmed these patterns. For example, Pietrzak, R.H. et al.,[23] targeting elderly residents affected by Hurricane Ike, assessed PTSD symptoms at three time-points: 3, 6, and 15 months after the disaster, and identified three trajectories: "resistant" (78.7%), "chronic" (16.0%), and "delayed onset" (5.3%). Johannesson, K.B. et al.,[6] targeting Swedish travelers affected by the Sumatra Earthquake and Indian Ocean Tsunami, tracked PTSD symptoms at 1, 3, and 6 years after the disaster, identifying four trajectories: "resilient" (72.3%), "recovery" (11.9%), "moderate chronic" (11.2%), and "severe chronic" (4.6%). These results suggest that 15.8% of affected residents exhibited chronic PTSD symptoms over a six-year period. Sakuma, A. et al.,[24] targeting municipal workers and healthcare professionals working in the affected areas of GEJE, tracked PTSD symptoms at four time-points: 14, 30, 43, and 54 months after the disaster, and classified five trajectories: "resistance" (62.7%), "subsyndromal" (24.3%), "recovery" (6.3%), "fluctuating" (3.5%), and "chronic" (3.2%). Similarly, a study by Oe, M. et al.,[21] which investigated changes in mental health following GEJE, targeted local residents from areas within Fukushima Prefecture designated as evacuation zones due to the Fukushima Daiichi Nuclear Power Plant accident, and tracked psychological distress at 10, 22, and 35 months after the disaster. They identified four trajectories: "resistant" (19.3%), "mild distress" (47.6%), "moderate distress" (27.4%), and "severe distress" (5.7%).

As shown, clarifying the trajectories of mental health changes among affected residents following natural disasters offers important insights into the kind of mental health and welfare support that is needed, and at which

stages following the disaster. However, the typical trajectory patterns presented in previous studies were often limited to relatively short-term changes for around two years following the traumatic event.[2)4)] While there are some relatively long-term studies, such as the six-year study by Johannesson et al.,[6)] follow-ups are still being conducted every two to three years, and changes on a yearly basis have not been sufficiently examined. In addition, although several large-scale cohort studies targeting local residents affected by GEJE have been reported,[5)9)16-18)27-30)] no studies have comprehensively clarified the long-term course and prognosis regarding mental health.

Therefore, the aim of this study was to elucidate the patterns of change in psychological distress, used as an indicator of mental health, based on data from a cohort survey conducted annually over a 10-year period with residents of affected areas following GEJE.

I. Methods

1. Participants

This study utilized data from a cohort survey conducted as part of the "Shichigahama Health Promotion Project," implemented based on an agreement between Tohoku University and Shichigahama Town. Shichigahama Town is located in the coastal area of Miyagi Prefecture, with an area of 13.19 km². Before the disaster (as of March 1, 2011), there were 6,568 households in the town. However, due to GEJE, 36.4% (4.8 km²) of the town's area was inundated by the tsunami, 3,929 households suffered residential damage, and 111 people were reported dead.[14)]

Within this cohort survey, self-administered questionnaire surveys were conducted annually from 2011 to 2020 over a period of 10 years, targeting residents of Shichigahama Town who experienced residential damage classified as major damage or worse as a result of GEJE. Data related to the physical and mental health status were collected. Details of the overall implementation of the 10 surveys are described in previous review articles (Table 1).[11)12)] The survey participants included men and women aged 18 or older who gave written consent, and guardians of infants, children, and adolescents under 18 who agreed to the purpose of the survey to assess children's health status and provided written consent (for those under 18, assessments were conducted by guardians). For the purposes of this study, the 10-year response data from 1,083 individuals who were aged 20 or older at the time of the first survey, participated in the first survey, and took

part in five or more surveys were used for analysis.

2. Survey Content

Psychological distress, the primary outcome measure, was assessed using the K6 scale.[3)10)] This consists of six items that inquire about one's condition over the past month, with responses recorded on a 5-point scale. The total score ranges from 0 to 24. For screening mood and anxiety disorders in the general population, a score of 5 or higher is considered the optimal cutoff value.[25)] Additionally, in the Comprehensive Survey of Living Conditions, K6 scores are categorized into four levels: "0–4," "5–9," "10–14," and "15 or more." Individuals with scores of 10 or more are regarded as experiencing psychological distress equivalent to mood or anxiety disorders. In this study, K6 was measured annually in all 10 surveys.

3. Analytical Methods

First, missing values in K6 were imputed. Considering that the missing data occurred at random (missing at random: MAR), missing values in each year's K6 scores were imputed using the multiple imputation method via the PROC MI procedure in the SAS package.[32)] Since the number of datasets to which reasonable values are assigned based on the distribution of the observed data needs to be set to a value greater than the missing rate,[31)] it was set to 40, exceeding the maximum missing rate observed in K6 (33% in the 9th survey). Age and sex, which may be related to the presence or absence of missing values, were included as auxiliary variables in the imputation. To minimize selection bias, one dataset was arbitrarily selected from the 40 created datasets, and all subsequent analyses were conducted using that dataset.

To clarify the annual changes in psychological distress over the 10-year period, group-based trajectory modeling was performed. This statistical technique identifies patterns of change in longitudinal data by incrementally increasing the number of trajectories and examining the function type for each group to determine the optimal model. The PROC TRAJ procedure in the SAS package was used for this analysis.[7)8)] Model selection was based on BIC (Bayesian Information Criterion), an indicator of model fit, and the log Bayes factor, which represents the degree of improvement. The log Bayes factor is equivalent to twice the BIC difference between two models (a simpler model and more complex model),[1)] and a value greater than 10 is considered strong evidence that the more complex model is superior.[7)] Additionally, it is recommended that the

number of participants in each trajectory group should be at least 5% of the total sample.[1)15)] Based on these criteria, this study adopted models that met the conditions of having a log Bayes factor value greater than 10 and a minimum proportion of at least 5% for each trajectory group.

4. Ethical Considerations

This study was conducted with the approval of the Ethics Committee of the Graduate School of Medicine, Tohoku University (Approval No.: 2021-1-618-1). In the 1st and 2nd surveys, all households that were classified as having suffered major or greater damage in the municipal residential damage assessment were visited. Face-to-face informed consent was obtained from residents who wished to participate in the study, and questionnaires were distributed and collected. From the 3rd survey onward, the research explanation document, consent form, and questionnaire were mailed to participants, and the completed forms were collected by mail after obtaining written consent.

II. Results

1. Basic Information on Analysis Participants and K6

Among the 1,083 individuals included in the analysis, 483 (44.6%) were male and 600 (55.4%) were female. The average age at the time of the first survey was 56.8 years (SD = 16.7).

The annual means and standard deviations of K6 scores are shown in Table 2. Cronbach's α coefficients for K6 in each year's survey ranged from 0.88 to 0.92, confirming sufficient internal consistency of the scale.

2. Patterns of Change in Psychological Distress Over the 10 Years Following GEJE

First, model selection was conducted to identify the 10-year change patterns of K6 scores. The results are shown in Table 3. The analysis began with Model 1, which assumed a single quadratic trajectory, and the number of trajectories was gradually increased while confirming the significance of each trajectory. However, in Model 5, the smallest group size fell below 5% of the total sample, failing to meet one of the model selection criteria. Therefore, Model 4, which showed a sufficient log Bayes factor and did not have any trajectory group comprising less than 5% of the total, was adopted as the final model (BIC = -25,159.5, log Bayes factor = 309.4).

The identified changes in patterns of K6 scores are illustrated in the figure. Based on the 10-year follow-up survey, four distinct groups were identified regarding the trajectory of psychological distress. First, the "Resilient group" (n

= 275, 25.4%) consistently maintained K6 scores below 3 points throughout the 10 years, recording the lowest scores among all groups. The maximum score was 2.6 in 2011, and minimum was 0.6 in 2018. Next, the "Subthreshold group" (n = 455, 42.0%) showed higher scores than the "Resilient group" across the entire period, but never exceeded the K6 cutoff of 5 points. The maximum was 4.4 in 2011, and the minimum was 2.4 in 2020. The "Mild group" (n = 291, 26.9%) consistently maintained scores at or above 5 points throughout the study period, although the scores gradually declined over time. The maximum was 8.1 in 2012, and minimum was 5.1 in 2020. Finally, the "Moderate or higher group" (n = 62, 5.7%) consistently scored in the range of 10 to 14 points throughout the entire period, indicating a level of psychological distress equivalent to mood or anxiety disorders according to K6. This group recorded the highest scores among the four groups, with a maximum of 13.2 in 2012 and minimum of 10.3 in 2020.

III. Discussion

The patterns of change in psychological distress among residents of areas affected by the earthquake and tsunami of GEJE from 2011 to 2020 were classified into four groups: "Resilient group," "Subthreshold group," "Mild group," and "Moderate or higher group." Across all groups, a general trend of symptom reduction over the 10-year period was observed.

The group with the largest number of participants was the "Subthreshold group," accounting for approximately 40% (42.0%). At the early stage after GEJE, the average K6 score of this group was 4.4 points, slightly below the cutoff value of 5 points, but over time, it became clear that they recovered to a level where they experienced little to no psychological distress. In the study by Oe et al.,[21] which illustrated the course of psychological distress based on changes in K6 scores across three time-points, about half of the participants were classified as having "mild distress" (average: 5.5 and 4.5 points in 2011 and 2013, respectively). The finding that the largest proportion of affected residents had K6 scores around the cutoff value of 5 points is consistent with the results of the present study. In addition, the "Resilient group," who exhibited little psychological distress from the early phase of the disaster and maintained this course, accounted for 25.4%, roughly one-fourth of the total. In the study by Oe et al.,[21] approximately 20% of participants were similarly classified as "resistant" (average: 1.2 and 0.8 points in 2011 and 2013, respectively), indicating a slightly larger proportion in the present study. Although both studies targeted GEJE, the participants

in the study by Oe et al.[21] were affected by the nuclear power plant accident, suggesting a difference in the nature of the trauma experienced. Disasters involving radioactive substances are classified as one of the emergencies caused by chemical, biological, radiological, nuclear, or high-yield explosives (CBRNE). Unlike natural disasters such as earthquakes, floods, and typhoons, these threats cannot be detected through the five senses and are therefore accompanied by extreme anxiety and uncertainty.[19][26] Considering the invisibility of such threats and potential for direct health impacts, it is considered that, compared with those affected by earthquakes or tsunamis, a greater proportion of people show some degree of psychological distress in the early phase after the disaster.

In this study, the second most populous group after the "Subthreshold group" was the "Mild group," accounting for 26.9%. This indicates that there are approximately equal proportions of disaster survivors who experienced little psychological distress over a 10-year period and those who, even after 10 years, still remain at or above the K6 cutoff score of 5. The "Moderate or higher group" accounted for 5.7% and exhibited persistent symptoms at a level corresponding to mood and anxiety disorders throughout the 10 years since the disaster. An important finding is that this study did not identify a distinct recovery trajectory in which individuals experiencing severe psychological distress in the early post-disaster stage recovered to a healthy level over the 10-year period. Thus, when the disaster-affected population was broadly categorized based on changes in psychological distress over time and the trajectories of each group were observed at the group level, it was suggested that those who experienced severe psychological distress in the early phase after the disaster tended not to show clear improvement in their symptoms and continued to struggle with mental health issues even after a long period of 10 years. In previous studies tracking the course of PTSD symptoms, "Recovery groups" were identified by Sakuma et al.[24] (followed up to 4.5 years post-disaster) and Johannesson et al.[6] (followed up to 6 years), whereas Oe et al.[21] (followed for about 3 years post-disaster) did not identify such a group. Even with the long-term 10-year follow-up in this study, a clearly recovering group that returned to healthy levels was not found. This may be mostly due to differences in the characteristics of PTSD symptoms and psychological distress symptoms being reflected, rather than the long follow-up period itself. PTSD is caused by specific traumatic events, whereas

psychological distress is more susceptible to a range of psychosocial stressors following a disaster and may continue to affect mental health even many years later.

Notably, the "Moderate or higher group" showed greater fluctuations in symptoms over the 10 years compared with the other groups. Increases in average K6 scores were observed in 2012, 2015, and 2017 compared with the previous year. This means that psychological distress worsened in the second year after the disaster (2012) compared with the first year, and despite some improvement by 2014, symptoms worsened again in 2015 and 2017 to levels similar to those in 2012, when distress was the most severe. These subtle changes in symptom trajectories were revealed for the first time through the year-by-year long-term follow-up implemented in this study. Orui et al.,[22] who examined trends in suicide mortality rates along the coast of Miyagi Prefecture after GEJE, noted that an increase in suicides coincided with the end of temporary housing provision. They suggested that the disbanding of communities formed in temporary housing may have worsened mental health among those who relocated. In Shichigahama Town, evacuation shelters were closed on the 100th day after the disaster, and all households had moved into temporary housing by that time. From fiscal year 2015 onward, relocation to public disaster housing and other accommodations progressed, and the provision of temporary housing officially ended on March 31, 2017, six years after the disaster.[14] When comparing these dates with the psychological distress trajectories observed in this study, from 2016 (survey conducted in November 2016, 68 months after the disaster) to 2017 (survey conducted in October 2017, 79 months after the disaster), particularly in the "Moderate or higher group," a worsening trend in psychological distress symptoms was observed. Therefore, using the survey data related to the residential environment obtained through this cohort study, an χ^2 test was conducted to examine whether the proportion of individuals who had lived in both temporary housing and disaster public housing differed among the four trajectory groups. When a significant result was found at the 5% level, post-hoc residual analysis was performed. If the adjusted standardized residuals (ASR) exceeded ±1.96, the result was considered significant at the 5% level; if it exceeded ±2.58, it was significant at the 1% level. As a result of the χ^2 test, a significant group difference was noted ($\chi^2 = 18.99$, $P < 0.001$). Residual analysis showed that the proportion of individuals who had lived in both

temporary and disaster public housing was significantly higher than expected in the "Moderate or higher group" (n = 12, 19.4%, ASR = 3.7), and significantly lower in the "Subthreshold group" (n = 25, 5.5%, ASR = -2.0). Thus, the "Moderate or higher group" was characterized by many individuals who continued to face instability in their living arrangements after the disaster due to moving from temporary to disaster public housing. These findings suggest that changes in the residential environment, linked to issues such as community reorganization, can be a significant factor affecting the long-term course of mental health among disaster-affected residents. For individuals who exhibited prominent psychological distress symptoms in the early post-disaster stage, even if those symptoms appeared to reduce after 2–3 years, it can be inferred that continued, targeted support over the long term is necessary and that support efforts should not be relaxed.

Conclusion

This study clarified in detail the year-by-year trajectories of psychological distress over a 10-year period following GEJE. The findings revealed that individuals who experienced high levels of psychological distress in the early stages of the disaster tended to maintain those levels over the long term. This suggests the necessity of continuing targeted support for those who display significant psychological distress in the immediate aftermath of a disaster.

However, this study focused on one of the regions affected by GEJE, a disaster caused by both a major earthquake and tsunami that resulted in widespread damage. Therefore, there are limitations to generalizing the findings of this study to all survivors of natural disasters. Future research should investigate the long-term psychological trajectories in other disaster-affected areas and in the context of different types of disasters. Additionally, because this study analyzed data from individuals who responded to at least five of the ten questionnaire surveys, the findings may reflect the conditions of a relatively stable group in terms of mental and social circumstances, suggesting the possibility that levels of psychological distress may be even higher in the broader disaster-affected population. It is also expected that future research will identify factors that predict or distinguish each trajectory pattern of psychological distress, thereby providing insights into effective approaches to support.

The authors declare no conflicts of interest related to this study.

Acknowledgements

We express our deep gratitude to the town of Shichigahama in Miyagi Prefecture and all residents who participated in this survey.

This research was supported by the Reconstruction Agency; Ministry of Education, Culture, Sports, Science and Technology (MEXT); Japan Agency for Medical Research and Development (AMED); Tohoku Medical Megabank Project; a Health and Labour Sciences Research Grant from the Ministry of Health, Labour and Welfare (Comprehensive Research on Health Security and Crisis Management: "A Study on the Health Status of Disaster Victims in Miyagi Prefecture after the Great East Japan Earthquake"); the International Research Institute of Disaster Science (IRIDeS) at Tohoku University; and World Premier International Research Center Initiative (WPI) for disaster science. The funders had no role in the design or execution of the study.

This paper includes reanalysis and formal publication of part of the content presented at the 117th Annual Meeting of the Japanese Society of Psychiatry and Neurology.

References

1) Andruff, H., Carraro, N., Thompson, A., et al.: Latent class growth modelling: a tutorial. Tutor Quant Methods Psychol, 5 (1); 11-24, 2009

2) Bonanno, G. A., Diminich, E. D.: Annual research review: positive adjustment to adversity-trajectories of minimal-impact resilience and emergent resilience. J Child Psychol Psychiatry, 54 (4); 378-401, 2013

3) Furukawa., T. A., Kawakami, N., Saitoh, M., et al.: The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. Int J Methods Psychiatr Res, 17 (3); 152-158, 2008

4) Galatzer-Levy, I. R., Huang, S. H., Bonanno, G. A.: Trajectories of resilience and dysfunction following potential trauma: a review and statistical evaluation. Clin Psychol Rev, 63; 41-55, 2018

5) Hozawa, A., Tanno, K., Nakaya, N., et al.: Study profile of the Tohoku Medical Megabank community-based cohort study. J Epidemiol, 31 (1); 65-76, 2021

6) Johannesson, K. B., Arinell, H., Arnberg, F. K.: Six years after the wave. Trajectories of posttraumatic

stress following a natural disaster. J Anxiety Disord, 36; 15-24, 2015

7) Jones, B. L., Nagin, D. S., Roeder, K.: A SAS procedure based on mixture models for estimating developmental trajectories. Sociol Methods Res, 29 (3); 374-393, 2001

8) Jones, B. L., Nagin, D. S.: Advances in group-based trajectory modeling and an SAS procedure for estimating them. Sociol Methods Res, 35 (4); 542-571, 2007

9) Katayanagi, M., Seto, M., Nakaya, N., et al.: Impact of the Great East Japan Earthquake on the employment status and mental health conditions of affected coastal communities. Int J Environ Res Public Health, 17 (21); 8130, 2020

10) Kessler, R. C., Andrews, G., Colpe, L. J., et al.: Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychol Med, 32 (6); 959-976, 2002

11) Kunii, Y., Usukura, H., Otsuka, K., et al.: Lessons learned from psychosocial support and mental health surveys during the 10 years since the Great East Japan Earthquake: establishing evidence-based disaster psychiatry. Psychiatry Clin Neurosci, 76 (6); 212-221, 2022

12) Kunii, Y., Usukura, H., Utsumi, Y., et al.: Review of mental health consequences of the Great East Japan Earthquake through long-term epidemiological studies: The Shichigahama Health Promotion Project. Tohoku J Exp Med, 257 (2); 85-95, 2022

13) 宮城県: 東日本大震災の地震被害等状況及び避難状況について—地震被害等状況及び避難状況（令和 4 年 10 月 11 日公表)—. 2022 (https://www.pref.miyagi.jp/documents/867/20221011.pdf) (参照 2022-10-19) (in Japanese)

14) 宮城県七ヶ浜町: 七ヶ浜町の復興概況 (令和 3 年 4 月 1 日現在). 2021 (https://www.shichigahama.com/town2/documents/①20210401_七ヶ浜町の復興概況.pdf) (参照 2022-10-19) (in Japanese)

15) Nagin, D. S., Odgers, C. L.: Group-based trajectory modeling in clinical research. Annu Rev Clin Psychol, (6)109-138, 2010

16) Nakaya, N., Nakamura, T., Tsuchiya, N., et al.: The association between medical treatment of physical diseases and psychological distress

after the Great East Japan Earthquake: the Shichigahama Health Promotion Project. Disaster Med Public Health Prep, 9 (4); 374-381, 2015

17) Nakaya, N., Nakamura, T., Tsuchiya, N., et al.: Prospect of future housing and risk of psychological distress at 1 year after an earthquake disaster. Psychiatry Clin Neurosci, 70 (4); 182-189, 2016

18) Nakaya, N., Nakamura, T., Tsuchiya, N., et al.: Psychological distress and the risk of withdrawing from hypertension treatment after an earthquake disaster. Disaster Med Public Health Prep, 11 (2); 179-182, 2017

19) 日本精神神経学会，日本児童青年精神医学会，日本災害医学会ほか：新型コロナウイルス感染症（COVID-19）流行下におけるメンタルヘルス対策指針第 1 版. 2020 (https://www.jspn.or.jp/uploads/uploads/files/activity/COVID-19_20200625r.pdf) (参照 2022-10-19) (in Japanese)

20) Norris, F. H., Friedman, M. J., Watson, P. J., et al.: 60,000 disaster victims speak: part I. An empirical review of the empirical literature, 1981-2001. Psychiatry, 65 (3); 207-239, 2002

21) Oe, M., Maeda, M., Nagai, M., et al.: Predictors of severe psychological distress trajectory after nuclear disaster: evidence from the Fukushima Health Management Survey. BMJ open, 6 (10); e013400, 2016

22) 大類真嗣，原田修一郎，佐伯涼香ほか：東日本大震災後 8 年間の宮城県沿岸部の自殺死亡率の動向. 精神経誌, 122 (8); 573-584, 2020 (in Japanese)

23) Pietrzak, R. H., Van Ness, P. H., Fried, T. R., et al.: Trajectories of posttraumatic stress symptomatology in older persons affected by a large-magnitude disaster. J Psychiatr Res, 47 (4); 520-526, 2013

24) Sakuma, A., Ueda, I., Shoji, W., et al.: Trajectories for post-traumatic stress disorder symptoms among local disaster recovery workers following the Great East Japan Earthquake: group-based trajectory modeling. J Affect Disord, 274; 742-751, 2020

25) Sakurai, K., Nishi, A., Kondo, K., et al.: Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. Psychiatry Clin Neurosci, 65 (5); 434-441, 2011

26) 重村 淳, 高橋 晶, 大江美佐里ほか: COVID-19 (新型コロナウイルス感染症) が及ぼす心理社会的影響の理解に向けて. トラウマティック・ストレス, 18 (1); 71-79, 2020 (in Japanese)

27) Sugawara, Y., Tomata, Y., Sekiguchi, T., et al.: Social trust predicts sleep disorder at 6 years after the Great East Japan earthquake: data from a prospective cohort study. BMC Psychol, 8 (1); 69, 2020

28) Takahashi, Y., Yoshizoe, K., Ueki, M., et al.: Machine learning to reveal hidden risk combinations for the trajectory of posttraumatic stress disorder symptoms. Sci Rep, 10 (1); 21726, 2020

29) Tsuchiya, N., Nakaya, N., Nakamura, T., et al.: Impact of social capital on psychological distress and interaction with house destruction and displacement after the Great East Japan Earthquake of 2011. Psychiatry Clin Neurosci, 71 (1); 52-60, 2017

30) Utsumi, Y., Nemoto, H., Nakaya, N., et al.: The impact of health consciousness on the association between walking durations and mental health conditions after a disaster: a cross-sectional study. Sports Med Open, 6 (1); 30, 2020

31) White, I. R., Royston, P., Wood, A. M.: Multiple imputation using chained equations: issues and guidance for practice. Stat Med, 30 (4); 377-399, 2011

32) Yuan, Y.: Multiple imputation using SAS software. J Stat Softw, 45 (6); 1-25, 2011

表１ 「七ヶ浜健康増進プロジェクト」におけるコホート調査実施状況

調査	実施年次	発災後経過月数	対象者数（人）	回答者数（人）	回答率（%）
1次	2011	8	2,801	2,144	76.5
2次	2012	19	3,019	1,867	61.8
3次	2013	31	3,084	2,041	66.2
4次	2014	44	2,876	1,668	58.0
5次	2015	55	2,831	1,442	50.9
6次	2016	68	2,802	1,553	55.4
7次	2017	79	2,726	1,490	54.7
8次	2018	91	2,694	1,492	55.4
9次	2019	103	2,506	1,311	52.3
10次	2020	114	2,442	1,361	55.7

18歳以上および18歳未満の対象者のいずれも含む全体数を示す．

Table 1. Status of Cohort Study in the Shichigahama Health Promotion Project

Survey	Year	Months Since Disaster	Target Population (n)	Respondents (n)	Response Rate (%)
1st	2011	8	2,801	2,144	76.5
2nd	2012	19	3,019	1,867	61.8
3rd	2013	31	3,084	2,041	66.2
4th	2014	44	2,876	1,668	58.0
5th	2015	55	2,831	1,442	50.9
6th	2016	68	2,802	1,553	55.4
7th	2017	79	2,726	1,490	54.7
8th	2018	91	2,694	1,492	55.4
9th	2019	103	2,506	1,311	52.3
10th	2020	114	2,442	1,361	55.7

Note: Includes both adults (18+) and individuals under 18 years of age.

表 2　各年次調査における K6 の平均値および標準偏差

	平均値	SD
2011 年（1 次調査）	5.34	4.66
2012 年（2 次調査）	4.95	4.58
2013 年（3 次調査）	4.03	4.36
2014 年（4 次調査）	3.63	3.98
2015 年（5 次調査）	3.77	4.13
2016 年（6 次調査）	3.90	4.04
2017 年（7 次調査）	4.02	4.17
2018 年（8 次調査）	3.63	4.27
2019 年（9 次調査）	3.50	3.77
2020 年（10 次調査）	3.14	3.64

欠損値補完手続き後の得点を用いて算出した（n＝1,083）.

Table 2. Mean and standard deviation of K6 scores in each survey year (n = 1,083; calculated using data after multiple imputation)

Year (Survey)	Mean	SD
2011 (1st)	5.34	4.66
2012 (2nd)	4.95	4.58
2013 (3rd)	4.03	4.36
2014 (4th)	3.63	3.98
2015 (5th)	3.77	4.13
2016 (6th)	3.90	4.04
2017 (7th)	4.02	4.17
2018 (8th)	3.63	4.27
2019 (9th)	3.50	3.77
2020 (10th)	3.14	3.64

表 3　混合軌跡モデリングに基づく K6 の軌跡パターンに関するモデルの比較

モデル	BIC	log BF	各軌跡に属する人数（%）				
			軌跡 1	軌跡 2	軌跡 3	軌跡 4	軌跡 5
1	−27310.4	—	1,083（100%）	—	—	—	—
2	−25751.9	3116.8	699（64.5%）	384（35.5%）	—	—	—
3	−25314.2	875.4	548（50.6%）	432（39.9%）	103（9.5%）	—	—
4	−25159.5	309.4	275（25.4%）	455（42.0%）	291（26.9%）	62（5.7%）	—
5	−25075.7	167.7	185（17.1%）	449（41.5%）	328（30.3%）	106（9.8%）	15（1.4%）

モデル 1 の場合の軌跡の形状は 2 次式．モデル 2 の場合の軌跡の形状は順に 2 次式，1 次式．モデル 3 の場合の軌跡の形状は順に 2 次式，1 次式，2 次式．モデル 4 の場合の軌跡の形状は順に 2 次式，1 次式，1 次式，1 次式．モデル 5 の場合の軌跡の形状は順に 2 次式，1 次式，3 次式，1 次式，3 次式．
BIC：Bayesian information criterion，log BF：log Bayes factor＝2×[(BIC of the current model) − (BIC of the previous model)]．

Table 3. Model comparison for trajectory patterns of K6 using group-based trajectory modeling

Model　BIC　　log BF　Members in Each Trajectory Group (%)
Traj. 1　Traj. 2　Traj. 3　Traj. 4　Traj. 5
1　−27310.4　—　1,083(100%)　—　—　—
2　−25751.9　3116.8　699(64.5%)　384(35.5%)　———
3　−25314.2　875.4　548(50.6%)　432(39.9%)　103(9.5%)　——
4　−25159.5　309.4　275(25.4%)　455(42.0%)　291(26.9%)　62(5.7%)　—
5　−25075.7　167.7185(17.1%)　449(41.5%)　28(30.3%)　106(9.8%)　15(1.4%)
In Model 1, the trajectory shape is quadratic. In Model 2, the trajectory shapes are, in order, quadratic and linear. In Model 3, the trajectory shapes are, in order, quadratic, linear, and quadratic. In Model 4, the trajectory shapes are, in order, quadratic, linear, linear, and linear. In Model 5, the trajectory shapes are, in order, quadratic, linear, cubic, linear, and cubic.
BIC: Bayesian Information Criterion, log BF: log Bayes Factor = 2 × [(BIC of the current model) − (BIC of the previous model)]

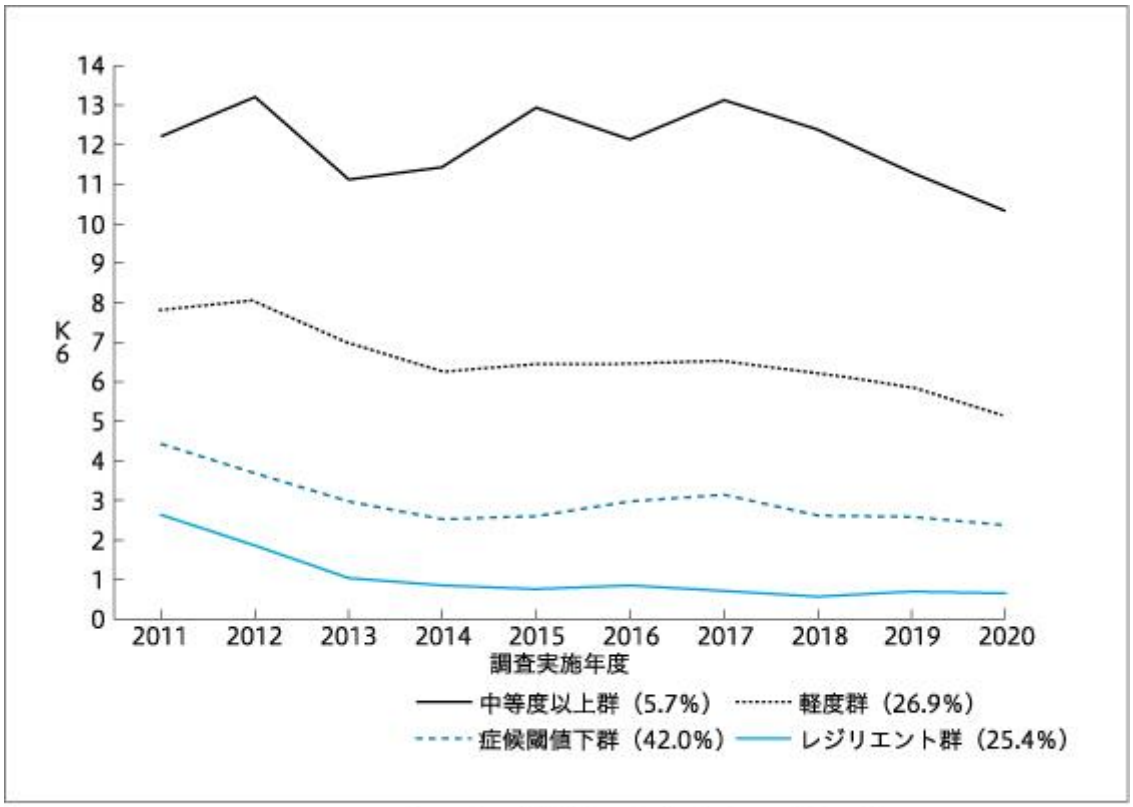

図　2011～2020 年の心理的苦痛（K6）得点の変化パターン

Figure. Change patterns of psychological distress (K6 scores) from 2011 to 2020