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ARTICLE

# Managing Traumatic Stress Using a Mental Health Care Mobile App: A Pilot Study

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**ABSTRACT**

This study aims to contribute to improving mental health services and establishing a direction for disaster survivors by verifying the effectiveness of the TLS (Training for Life Skills) app, a mental health management mobile application. Altogether, 22 disaster survivors received access to the app (with guidance) for eight weeks; we analyzed its effectiveness by examining each participant's electroencephalography data, which were collected while they were utilizing the app. The results of this study show that the use of the TLS app had a significant positive effect on emotional quotient, basic rhythm quotient (left brain, right brain), alpha blocking rate (left brain, right brain), and brain quotient of disaster survivors. The TLS mobile app is expected to not only provide psychological first aid to disaster survivors but also to improve their life skills, which may allow them to gain information about their emotions; hence, it may provide the appropriate conditions needed to enable effective self-control and health management for disaster survivors.

**KEYWORDS**

Mobile applications; trauma; disasters; mental health

## 1 Introduction

Owing to the recent surge of disasters, the demand for "post-disaster psychological assistance" is growing, and the number of people who need such assistance is increasing. If disaster survivors are given sufficient and effective support systems and show resilience (e.g., are able to endure temporary pain that they may suffer and use appropriate coping strategies), they may be able to, eventually, return to their normal functioning levels, but many will still experience mental health disorders such as post-traumatic stress disorder (PTSD), depression, and anxiety [1]. Although disaster survivors who continuously experience mild or intermittent psychological symptoms (for several weeks or months post-disaster) may not meet the criteria for receiving a mental health disorder diagnosis, most still have to endure a certain degree of pain, which can interfere with their normal functioning in various aspects of their lives and subsequently increase the risk of mental breakdowns among this population group [2].

Recently, whenever a major disaster has occurred, the importance of providing appropriate psychological support for traumas owing to such situations has been raised; nonetheless, in Korea, such

importance started being highlighted in particular after the Korean Sewol ferry accident [3]. According to the Jeju Sewol Compensation Center, 17 out of 24 Sewol ferry survivors are experiencing PTSD; reportedly, they complain about sleep disorders, lethargy, depression, nervousness, paranoia, and alcoholism, and many have been unable to return to their daily lives (e.g., some quit their jobs) [4].

One of the most appropriate ways to address the basic medical, mental, and social needs of disaster survivors immediately after the event is through "psychological first aid" (PFA) interventions; these are based on securing the individuals' safety and bonding after such events and on the provision of information/practical resources to allow them to manage the outcomes of the disaster [5]. The "Skills for Psychological Recovery" (SPR) program was developed for the psychological recovery of children, adolescents, adults, and families exposed to traumatic events owing to disasters; it is technical training that is intended to be provided after the provision of appropriate PFA interventions. It is used to deliver psychological support to disaster victims [6], and it is a crisis counseling service program applicable to various types of disasters (hurricanes, tornadoes, earthquakes, floods, etc.). Various studies have provided education for mental health practitioners on how to utilize this program; notwithstanding, to this date, no research has been conducted on the effects of SPR in Korea [7,8].

Overall, Korea lacks the human and physical infrastructure necessary for the provision of post-disaster psychological assistance; its corresponding field of research is also poor. Additionally, there is no around-the-clock professional manpower—mainly because Korea depends on a volunteer system—and the budget is insufficient for the development of research on manuals and education related to disaster psychology support [9,10]. Therefore, there is an urgent need to develop educational programs and practical manuals suitable for disaster situations to provide practical help to the complex symptoms related to disaster trauma [10].

Recently, the proliferation of smart devices has led to the development of mobile healthcare services that allow for health self-management through people's smartphones [11]. These services are characterized by the performance of health management through checking the amount of exercise people have performed, electrocardiograms, and heart rates by using a health measuring device linked to a mobile device (such as a smartphone) and/or apps (smartphone applications) within the device [12]. Previous research has shown that mobile-app-based education demonstrated more positive effects on self-directed learning, motivation to learn, state commitment, and interaction between learner interfaces than did computer web-based education [13]. Further, mobile apps aimed at aiding people with alcoholism treatment have been shown to reduce alcohol consumption and promote psychological well-being [14,15]. Therefore, this study aimed to develop a mental health management mobile app, called "Sound of Mind," for disaster survivors through the use of Training for Life Skills (TLS); we intended to create an effective disaster mental health management strategy for this population group. The app provides relevant information, such as how to cope with disasters, and comprises contents that can help heal the mind and change a mood; thus, it is expected to be useful in emergencies during disasters.

"Brain wave" refers to the number of electrical signals generated during information exchanges between brain cells; these are measured by attaching electrodes to one's scalp and analyzing the combinations of the changes occurring, in a given moment, in dendrites during neuronal activity of the cerebral cortex [16]. The first electroencephalography (EEG) was performed in 1969 by Hans Berger, who pioneered taking notes on the electrical properties of nerves [17]. Recently, EEGs have been used to provide feedback to practitioners to confirm the outcome after treatment for a variety of patients with cognitive and behavioral problems [18].

Therefore, in this study, to measure the effect of our psychological support service, we used EEG measurements. This study aims to collect basic data on whether the proposed psychological intervention can help improve the mental health of disaster survivors by measuring the brain waves of disaster survivors.

The purpose of this study is as follows. By measuring the participants' EEG readings after the disaster survivors run the TLS app, we want to determine whether its psychological support service is effective.

A further aim is to examine the possibility of using the TLS app for psychological support for disaster survivors. Thus, the following hypotheses are proposed:

Hypothesis 1. Disaster survivors' use of the TLS app will improvement their emotional quotient.

Hypothesis 2. Disaster survivors' use of the TLS app will improvement their basic rhythm quotient (left brain, right brain).

Hypothesis 3. Disaster survivors' use of the TLS app will improvement their alpha blocking rates (left brain, right brain).

Hypothesis 4. Disaster survivors' use of the TLS app will improvement their brain quotients (BQ).

## 2 Methods

### *2.1 Research Design*

This pilot study was designed as a single group post-experiment to evaluate the efficacy of the TLS mobile app as a psychological first aid program for disaster survivors.

### *2.2 The TLS Mobile App*

The TLS app was developed by Choi et al. [19] to support people affected by traumatic experiences. Choi et al. [19] provided the app for free downloads at the ONE store, a Korean mobile app store, as part of their professional obligation to offer their research product to the public, as it was funded by a public foundation. The content of the app, as shown in Fig. 1, is divided into three categories: information, psychological healing, and mood change. The information category consists of self-assessment (PTSD, depression, anxiety, sleep disorder), post-disaster responses, coping mechanisms (anger, sleep disorder, addiction), and guidance on how to utilize information from specialized institutions (consultation centers, medical institutions, administrative support organizations). Psychological healing consists of breathing, butterfly hug, meditation, positive affirmations, healing music, 108 bows, yoga, and writing. Ventilation and diversion (mood change category), find the same picture game, fruit slot machine, bubble shot, coloring book, and Tetris. We informed participants that they can freely select the desired function.

### *2.3 Participants*

Research participants were first recruited via purposive sampling. Researchers explained the purpose of the study to a disaster support expert and asked for help in recruiting participants. After that, disaster support experts provided the researchers with information on the study participants. Then, snowball sampling was used to recommend additional participants. In this study, we conducted a pilot experiment with 22 participants who self-reported experiencing post-traumatic stress, one year after a natural, social, or artificial disaster.

### *2.4 Procedures*

Before the experiment, all participants were fully informed of the purpose and method of the study; they were informed that they could withdraw at any time without any prejudice. All participants voluntarily provided written informed consent to participate. Before the start of the experiment, participants were informed of the purpose and method of using the TLS mobile app, after which the experiment was initiated. During the experiment period, from June 03 to July 28, 2019, participants were instructed to access the mobile app at least five times a week for eight weeks. Once a week, the researcher would call the participants, check their self-reports, and record the app usage time and functions used. After eight weeks, the researcher conducted a post-test on the participants. EEG measurements were performed on July 29. Since EEG can be sensitive and affected by other external stimuli, it was conducted on participants as they sat unmoving in a quiet place. Participants wore a hairband-type EEG measuring device and looked comfortably at the monitor screen; the measurement time was five minutes.

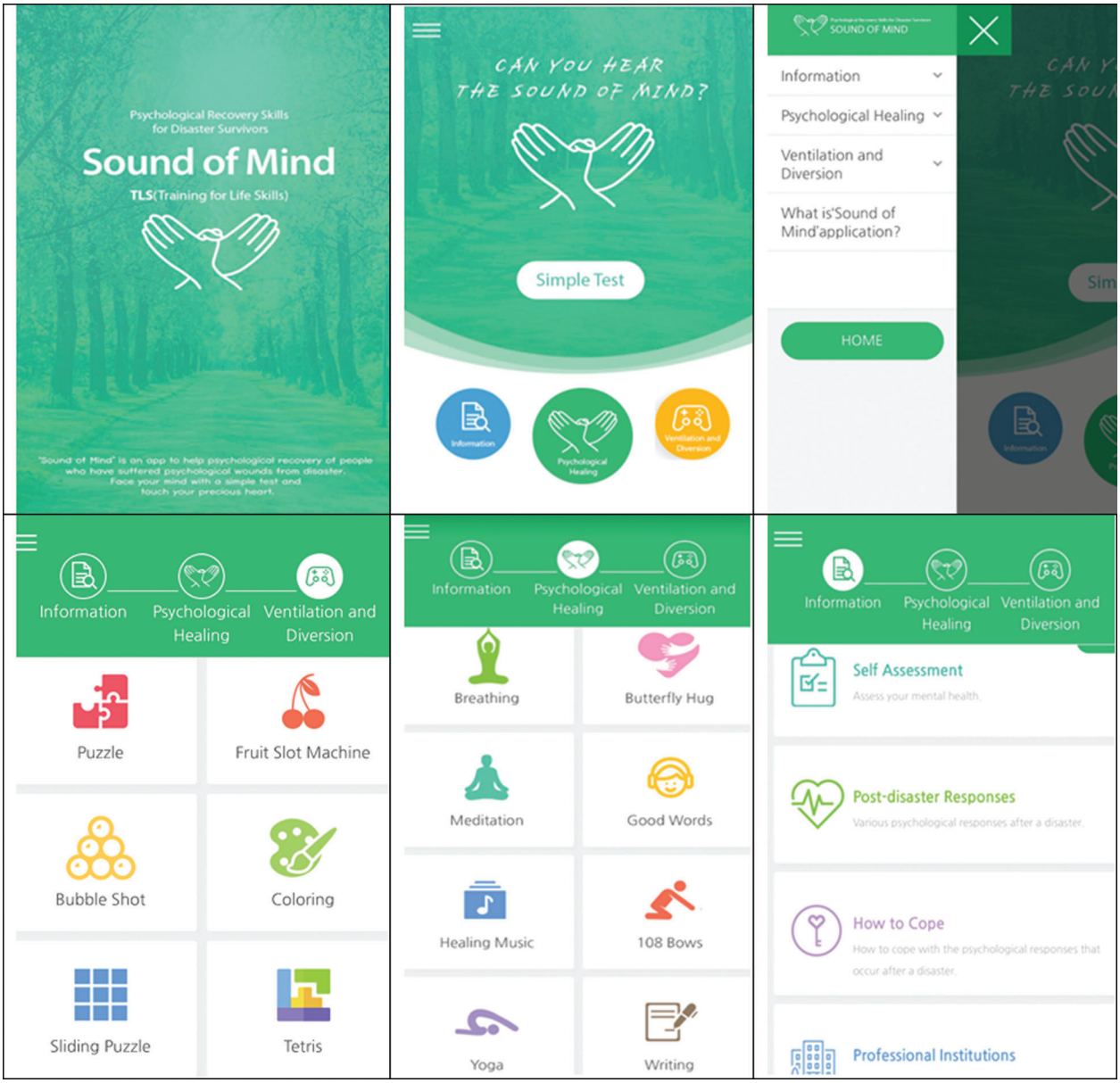


**Figure 1:** Images of the actual TLS mobile app

### *2.5 Materials*

NeuroHarmony, a handheld EEG measurement instrument, was used; it was developed by BrainTech, a subsidiary of the Korea Institute of Psychiatry [20]. NeuroHarmony uses a mixture of the Monopolar Reference Montage and the Sequential Bipolar Montage based on a 2-channel EEG. It is a portable device that has a 2-channel headband type [20]. It can be connected to a computer via a USB port and uses a dry electrode with a convenient, non-invasive headband method. In addition, participants' self-reported total app usage time over the eight weeks was digitized. The EEG measurements by NeuroHarmony software were automatically extracted into Excel by requesting the EEG analysis server.

In this study, emotional quotient, basic rhythm quotient (left brain, right brain), alpha blockings rate (left brain, right brain), and BQ were analyzed. The emotional quotient was calculated by subtracting the right

alpha wave from the left alpha, and it indicates emotional stability or instability [18]. The basic rhythm quotient was calculated as the ratio of closed eye alpha wave to open eye alpha wave; both, the left and right brains were measured. This factor is often used as a standard for determining brain stability and agility [21]. The alpha blocking rate refers to the rate at which alpha waves disappear when opening the eye; both the left and right brains were measured [18]. Higher alpha blocking rates correspond to clear changes in the EEG during times of open and closed eyes, while lower alpha blocking rates refer to little change [21]. BQ is calculated as $\sum w \cdot q$ (w = weight by index, q = {whole brain index}) and allows for comprehensive judgment of brain function [20].

### *2.6 Data Analysis*

Collected data were analyzed using the SPSS/WIN 25.0 program. Participants' general characteristics were analyzed using descriptive statistics, and simple regression analysis was performed to verify the effects of the TLS mobile app on people's brains.

### *2.7 Ethical Approval*

Researchers informed participants of the purpose, method, and research ethical considerations of the study (e.g., retractable, confidentiality, and anonymity), and the participants provided informed consent. Data were collected for research purposes and were discarded after the time required for the study. Participants were provided their EEG results with an explanation. This research was approved by Chung-Ang University's Bioethics Committee (IRB No. 1041078-2018060-HR-135-01C).

## 3 Results

### *3.1 General Characteristics*

The study participants consisted of 22 disaster survivors. Results of the investigation of general characteristics, age, gender, marital status, religion, type of disaster, and app usage time are as follows. Twelve participants were under the age of 32, eight were between 32 and 43, and two were over 45. There were three men and 19 women; 11 were married and 11 were unmarried. In terms of religion, four were Christians, six were Catholics, two were Buddhists, and 10 reported "other". Two of the participants had experienced earthquakes, three had experienced fires, four had been through hazardous chemical disasters, and 11 had been in traffic accidents. Four of the participants used the app for a total of 0–199 min over the eight weeks; nine used it for 200–399 min; three for 400–599 min; two for 600–799 min; one for 800–999 min; and three for 1000–1680 min.

### *3.2 Effect of TLS Mobile App Usage Time on Emotional Quotients, Basic Rhythm Quotients (Left, Right), Alpha Blocking Rates (Left, Right) and BQ*

In this study, the results were obtained by measuring the participants' EEG (emotional quotient, basic rhythm quotient, alpha blocking rate, BQ) after using the app for eight weeks, to determine the effect of the mobile psychological support service, TLS app, on disaster survivors. The results are presented in Tab. 1.

The effects of the use of TLS apps on disaster survivors are as follows. The use of TLS mobile apps had a significant effect on the emotional quotients ($\beta = 0.550$, $p < 0.008$), and the explanatory power was 30%. It also had a significant positive effect on the basic rhythm quotient (left brain) ($\beta = 0.598$, $p < 0.003$), and the explanatory power was 35%; and on the basic rhythm quotient (right brain) ($\beta = 451$, $p < 0.035$), and the explanatory power was 20%. Furthermore, it had a significant positive effect on the alpha blocking rate (left brain) ($\beta = 0.510$, $p < 0.015$), and the explanatory power was 26%; and on the alpha blocking rate (right brain) ($\beta = 0.463$, $p < 0.035$), and the explanatory power was 21%. In addition, it had a significant positive effect on the BQ ($\beta = 0.451$, $p < 0.035$), and the explanatory power was 20%. In other words, the use of the TLS app had a significant positive effect on the disaster survivors' emotional quotient, basic rhythm quotient (left brain, right brain), alpha blocking rate (left brain, right brain), and BQ.

**Table 1:** Effect of TLS mobile app usage time on emotional quotients, basic rhythm quotients (left, right), alpha blocking rates (left, right), and BQ

| Variable | *B* | *SE* | *β* | *t* | *p* | $R^2$ | *F* |
|---|---|---|---|---|---|---|---|
| **Emotional quotients** | (Intercept) 71.53 | 1.39 | 0.000 | 51.14 | 0.001 | 0.302 | 8.672 |
| | 0.006 | 0.002 | 0.550 | 2.94 | 0.008 | | |
| **Basic rhythm quotient (left)** | (Intercept) 61.66 | 0.221 | 0.000 | 287.83 | 0.001 | 0.358 | 11.136 |
| | 0.010 | 0.003 | 0.598 | 3.330 | 0.003 | | |
| **Basic rhythm quotient (right)** | (Intercept) 61.49 | 2.64 | 0.000 | 23.28 | 0.001 | 0.204 | 5.115 |
| | 0.009 | 0.004 | 0.451 | 2.26 | 0.035 | | |
| **Alpha blocking rate (left)** | (Intercept) –35.06 | 10.18 | 0.000 | –3.44 | 0.003 | 0.260 | 0.042 |
| | 0.042 | 0.010 | 0.510 | 2.65 | 0.015 | | |
| **Alpha blocking rate (right)** | (Intercept) –38.49 | 9.75 | 0.000 | –3.941 | 0.001 | 0.214 | 5.458 |
| | 0.035 | 0.015 | 0.463 | 2.33 | 0.030 | | |
| **Brain quotient** | (Intercept) 52.70 | 2.30 | 0.000 | 22.85 | <0.001 | 0.203 | 5.104 |
| | 0.008 | 0.004 | 0.451 | 2.250 | 0.035 | | |

## 4 Discussion

This study aimed to develop the TLS mobile app to help disaster survivors deal with the psychological issues evoked by disaster trauma and to determine its effectiveness through an analysis of how the app's usage time affected participants' brainwaves. First, disaster survivors' use of the TLS app was found to have a positive effect on their emotional quotient (left brain, right brain), which judges emotional balance and stability. A higher emotional quotient corresponds to more emotional stability [20]. Another study found that light, low intensity exercise of about 10 minutes can positively change a low emotional index [22]. Furthermore, a horseback riding therapy program for elementary school students resulted in improved emotional quotient [23], suggesting that these interventions affect specific functions of the brain. In the present study, it can be inferred that the TLS app is also involved in influencing functions of the brain. Our findings indicate that the more you use the TLS mobile app, the more stable will be.

Second, it was found that the use of the TLS app by disaster survivors has a positive effect on the basic rhythm quotient (left and right brain), which occurs when the eyes are closed; it is stabilized in a state of awakening, and can indicate brain stability. In addition, the basic rhythm quotient can determine the degree of development and stability of the brain as well as the degree of aging. A high basic rhythm index indicates that the brain's activity speed is fast and stable. Therefore, from the results of this study, it can be inferred that the more the TLS app is used, the more active the basic rhythm EEG in humans is, and the more it responds to the brain function of the app's use. Prior studies have shown that a three-month program (mobile or computer-based) for patients with depression improved brain activity and symptoms [24], which is in line with the results of this study.

Third, the use of the TLS app by disaster survivors was also found to have a positive effect on the alpha blocking rate (left and right brain). Alpha waves are the most fundamental waves of the brain, and reflect neurophysiological stability and emotional state; human mental stability is considered most efficient when alpha waves are produced. Alpha waves appear predominantly due to a synchronization phenomenon, in which multiple cells of the cerebral cortex are active almost simultaneously, when they are at rest in a comfortable state, such as relaxation [25]. The better the activity of the alpha wave, the stronger the alpha wave is generated when the eyes are closed; when the eyes are opened, the alpha wave is reliably blocked. This ratio is called the alpha blocking rate. Ekkekakis et al. [26] reported that walking exercise affects the activation of alpha waves by generating a sense of calm and relaxation. In a study on the effect of yoga on brain waves, it was reported that the alpha value increased significantly before and after the program [27]. Alpha wave activity is also found to increase during interactions with animals, as they lead to a feeling of a stable mood, which increases vitality and leads to a positive state of mind [23]. These findings are in line with those of Gabriel et al. [28] who analyzed the image training of athletes and found that it reduced anxiety and activated alpha brain waves. In this study, it is believed that the alpha blocking rate was increased through the use of the app because the vitality, indicating a positive mood state, was increased.

Finally, the use of TLS apps by disaster survivors has been shown to have a positive impact on BQ, a quotient that synthesizes the functions of the brain. In addition, BQ provides accurate and comprehensive information to determine the brain's response and control capabilities. It is closely related to mental and physical health, and BQ can be developed through one's own efforts [20]. In a previous study comparing the EEG differences between Baduk players and the general population, the BQ was found to be significantly higher for the players [29]. This suggests that Baduk is involved in a specific function of the brain, and it can be inferred that the TLS mobile app is also involved in this function. Further corroborating our results, a systematic review on the effectiveness of mobile mental health apps suggested that these can be effective and significantly improve treatment accessibility [30].

## 5 Conclusions

This is a single group post-test experimental study conducted to provide psychological support services by applying a TLS mobile app to disaster survivors and to confirm the effects. The participants of the study were 22 disaster survivors who used the mobile app for eight weeks and then underwent EEG measurements. The analysis showed that the use of mobile apps had a positive effect on the emotional quotients, basic rhythm quotients (left, right), alpha blocking rates (left, right), and BQ. The conclusions are thus as follows.

First, it is necessary for disaster survivors to increase their security, their adaptive coping skills, and to connect to various community resources to adapt well in society. Therefore, the TLS mobile app is expected to not only provide psychological first aid to disaster survivors but also play a role in improving their life skills, which may allow for this group to know more about themselves and their emotions, subsequently allowing for greater and more efficient health control and self-management.

Second, mobile-app-based psychotherapy for disaster trauma can be a good alternative to traditional therapy because it can compensate for the usual limitations that the latter posit, such as cost burden, distance, and being socially stigmatized as a person that needs in-person psychotherapy. Additionally, through the app, there is the possibility of early diagnosis and prognostic observations before receiving professional treatment. This may, thereby, enable the early observation of symptoms related to disaster trauma and the provision of immediate intervention, whenever necessary. Therefore, this study verified the effectiveness of mobile-app-based psychotherapy, which has the advantages of being user-friendly (performed through a device), having high accessibility, and being cost-effective.

Third, the TLS mobile app was developed through expert consultation and the performance of a pilot experiment, which was based on sufficient clinical experience and evidence of the mental health

specialists in charge of this research (and those who contributed to it). Thus, unlike apps developed for commercial uses, our proposed and developed app contains deep and practical content that can be applied for disaster survivors as an alternative to standard therapy. Thus, when the TLS mobile app starts being commercialized, we expect it effectively reduce and prevent symptoms among its target population.

However, this study has some limitations. First, generalization must be done with caution because of the small sample size. Second, we performed only a single group one-time post-test, which is poor validation compared to studies using pre-post tests and experiment-control designs. Third, to increase the desire for users to participate and utilize the app, it will be necessary to develop a practical manual for self-management to increase its applicability. Future research will require a study of mobile application intervention approaches through comparison with controls. In addition, studies on various diagnostic groups and on the effectiveness of adults and the older population, as well as children, are needed. Despite these limitations, this pilot study showed that the TLS mobile app was effective for increasing positive and decreasing negative psychological factors according to app usage time. Therefore, we expect the app to be used to provide psychological stability and to provide the appropriate conditions to enable of effective self-control and management for disaster survivors.

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