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Abbreviations:
CCHL, communicative and critical health literacy; DNA, deoxyribonucleic acid; FHMS, Fukushima Health Management Survey; GEJE, Great East Japan Earthquake; HL, health literacy; SPSS, Statistical Package for the Social Sciences

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Effectiveness of an Intervention Program to Enhance the Self-Confidence of Kindergarten Teachers Dealing with Radiation-Related Health Concerns from Parents of Young Children: A Quasi-Experimental Study

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Abstract

Objective: This study examined the effectiveness of an intervention program to enhance the self-confidence of kindergarten teachers who address radiation-related health concerns among parents following the Fukushima Daiichi Nuclear Power Plant accident in March 2011, wherein radiation anxiety among mothers with young children was high. Kindergarten teachers are expected to address the concerns of these parents

Methods: Participants from 2 private kindergartens in Fukushima City were assigned to either the intervention group (n = 10), which received an intervention program comprising lectures, group discussions, and presentations, or the control group (n = 16), which received only written materials used in the intervention program. Changes in the measured scores post-intervention were calculated, and the mean values were compared between both groups using the Student's t-test.

Results: The primary outcome was self-confidence, and the difference-in-differences approach was used to assess the effectiveness of the intervention program. The study found a more significant difference between pre- and post-intervention self-confidence in the intervention group compared to the control group ($P < 0.01$).

Conclusions: The intervention program effectively enhanced the self-confidence of kindergarten teachers in dealing with radiation-related health concerns of parents with young children.

On March 11, 2011, the Great East Japan Earthquake (GEJE) and subsequent tsunami caused the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant accident, which resulted in radioactive contamination of the surrounding areas. Although no radiation exposure-related health effects occurred in residents,[1] the disaster had indirect effects.[2] Notably, mothers with young children were recognized as an "at-risk group" for symptoms of post-traumatic stress disorder following a radiation accident,[3] which can be primarily explained by their continued concerns regarding the physical health risks associated with radiation exposure.[4]

Mothers of young children are reported as a vulnerable population with deteriorated psychological status, as in the Fukushima accident.[5] The Fukushima Health Management Survey (FHMS)[6] was planned and implemented to monitor the physical and psychological health status of all Fukushima Prefecture residents following the disaster. The FHMS showed a remarkably high rate of depressed mothers with young children and claimed that improving mental health support for mothers should be a high priority in the acute phase of nuclear disaster responses.[7] As radiation anxiety is reported to be associated with poor mental health outcomes, especially in mothers,[8] managing their anxiety has been recognized as an essential public health measure.

A possible factor contributing to radiation anxiety among the public is confusion concerning relevant information. The extensive and complicated accident in Fukushima resulted in significant media coverage from various contemporary media sources, causing residents to become distressed and confused.[9] Notably, residents of the Fukushima Prefecture were confounded by information disseminated by the mass media.[10]

Health literacy (HL), defined as the cognitive and social skills that determine the motivation and ability of individuals to gain access to, understand, and use information in ways that promote and maintain good health,[11] is vital to avoiding confusion caused by unfamiliar information. Nutbeam[12] classified HL into 3 categories: functional (the ability to obtain relevant health information and apply that knowledge to a limited range of prescribed activities), communicative (the ability to extract information and apply it to changing circumstances), and

critical (the ability to critically analyze information and use it to exert greater control over life events and situations). A previous study showed that high communicative and critical health literacy (CCHL) is associated with low radiation anxiety among Fukushima residents,[13] suggesting that improved CCHL effectively reduced radiation anxiety. Additionally, Nutbeam[14] claimed the importance of prior knowledge in acquiring HL.

After the Fukushima accident, mothers with young children were most worried about food as a possible source of internal contamination[15] and frequently consulted kindergarten teachers about radiation-related health issues.[16] Thus, kindergarten teachers were expected to be good advisers for parents regarding these issues. Although the significance of support for kindergarten teachers in increasing their self-confidence has been acknowledged, no previous study has attempted an intervention targeting them. Based on this background, an intervention program was developed to enhance the self-confidence of kindergarten teachers in dealing with radiation-related health concerns of parents with young children. This program was designed to improve the participants' HL and self-confidence by providing appropriate knowledge regarding radiation and its health effects. Notably, a previous study ascertained that the intervention program was acceptable and feasible regarding the participants' acceptance of the program.[17] This study aimed to examine the effectiveness of the intervention program in enhancing the self-confidence of kindergarten teachers who deal with radiation-related health concerns of parents.

Methods

Study Design

This study employed a quasi-experimental, nonrandomized group design that followed the guidelines for reporting nonrandomized studies. The feasibility of the intervention's acceptability, recruitment, and delivery has been tested previously.[17]

Participants

The participants were kindergarten teachers working in 2 private kindergartens in Fukushima. After an ethics review and approval, we recruited participants by asking a representative from each kindergarten to encourage the staff to participate in this study.

Sample Size

A significance level of 0.05 and a power of 0.80 were used in the relevant 2-sample t-tests. To calculate the effect size, we used a standard deviation of 0.7 for the pre- and post-intervention difference in the "confidence" value (the result of the feasibility study conducted by the applicants) and a difference of 0.7 to be detected.[17] According to the calculations, the required sample size was approximately 17 participants in 1 group and 34 in total for the 2 groups.

Participant Flow

Twenty-seven workers employed at the selected kindergartens agreed to participate in the study. Participants were informed that the intervention program would be held on 2 separate days (October 16 and 24, 2022) and that they could choose either at their convenience. Those who chose the earlier day were categorized into the intervention group, and the remaining participants formed the control group. Ten participating kindergarten teachers were assigned to the intervention group, and 17 were assigned to the control group. One control group participant who did not participate in the program was excluded from the analysis. Thus, data were collected and analyzed from 10 and 16 participants in the intervention and control groups, respectively (Figure 1).

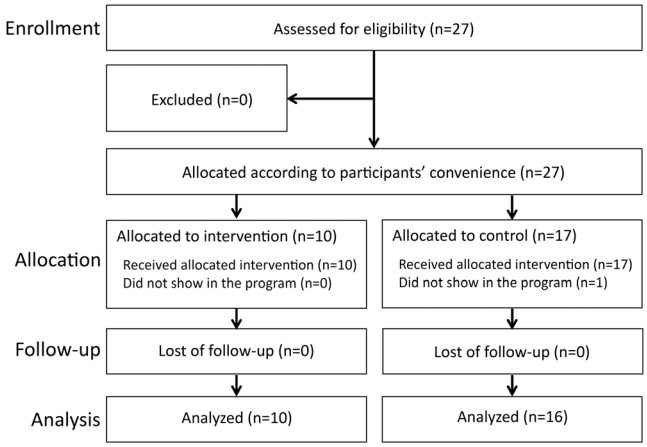

Figure 1. Participant flow.

Intervention Details

Participants were asked to participate in the intervention program via Zoom, a videoconferencing tool. This intervention was performed once for approximately 120 minutes. The intervention program, which was the same in both face-to-face and online formats, consisted of (1) an introduction (10 min), (2) lecture (50 min), (3) group discussion (40 min), (4) a presentation (10 min), and (5) summary (10 min) (Table 1). The introduction aimed to explain the purpose of the intervention program to the target audience, and the lectures were divided into 2 parts: "Radiation and health effects" (20 minutes) and "Media literacy" (30 minutes) (see Table 1).

The lecture on radiation and health effects aimed to provide knowledge regarding radiation and its health effects. The topics chosen from what was unclear and what increased public anxiety included the radiation properties, the association of radiation exposure with the incidence of cancers, the genetic effects of radiation exposure, the mechanism of deoxyribonucleic acid (DNA) repair following damage by irradiation, and food reference values. This part of the intervention program aimed to provide participants with appropriate knowledge regarding radiation and its health effects, notably as Nutbeam[14] claimed in his conceptual model, the importance of prior knowledge to enhance HL. The lecture on media literacy aimed to improve participants' media literacy by demonstrating reading an article in a newspaper from a certain point of view. Group discussions were conducted in small groups, and participants shared their experiences on how they counseled people who asked for advice after the GEJE, including ideas on how else they could have done it at that time. Following the group discussion, participants were asked to choose a presenter, summarize what was discussed, and deliver a presentation on what they had discussed within their group. The key take-home message was that accessing information released from the government, ministries, or relevant academic societies as reliable sources is essential. This idea is derived from a previous study suggesting that unreliable information is a risk

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Table 1. Contents of each part of the intervention program

Item	Contents
1) Introduction (10 min)	Explanation of the purpose of the intervention program
2) Lecture (50 min)	■"Radiation and Health Effects": Delivery of appropriate knowledge regarding radiation and its health effects (20 min) ■"Media Literacy": Enhancement of participants' media literacy through a demonstration of the reading of an article (30 min)
3) Group discussion (40 min)	Discussion regarding the participant's experiences and challenges in dealing with parents after the Great East Japan Earthquake and their awareness of what they wish they had been able to do at that time
4) Presentation (10 min)	Presentation on what the participants discussed within each group
5) Summary (10 min)	Summary of the program and delivery of the take-home messages

Table 2. List of questions for assessing knowledge regarding radiation and its health effects

Items	Questions and answers
Properties of radiation	Once the body receives radiation, it remains in the body forever. (False)
Association of radiation exposure with the incidence of cancers	International standards have adopted the idea that the higher the radiation exposure, the higher the probability of dying from cancer. (True)
Genetic effects of radiation exposure	According to a study on the health effects in the second and third generations of atomic bomb survivors in Hiroshima and Nagasaki, no genetic effects have been observed. (True)
Mechanism of DNA repair following damage by irradiation	Once damaged by radiation, a cell's DNA cannot be repaired. (False)
Food reference values	According to the government's standard values for radioactive materials, the strength of radioactivity in general food products is set not to exceed 100 becquerels per kilogram. (True)

DNA, deoxyribonucleic acid.

factor for worse mental fatigue in residents of the Fukushima Prefecture following the disaster.[18]

The series of activities in the intervention program was designed to enhance HL, which involves various skills. During the intervention program period, the participants allocated to the control group were provided with the same materials used in the intervention program via email. Approximately 1 week after the intervention group received the intervention, participants in the control group were invited to participate in the same program to provide them with the same opportunities as those received by the intervention group.

Data Measurement

Participants responded to an online questionnaire, and data were obtained from participants in both groups before and after they attended the intervention program (or received the material, as in the control group).

The primary outcome of this program was self-confidence in response to questions on radiation health effects (self-confidence). Participants were asked, "Are you confident in answering questions about radiation and its effects on health?" Their responses were assessed using a 4-point Likert scale (4 = yes, 3 = somewhat yes, 2 = not very much, 1 = not at all).

Secondary outcomes included acquiring knowledge to address radiation health effects and HL questions. Participants' knowledge was assessed through questions to evaluate their optimum understanding of the following 5 topics: radiation properties, an association of radiation exposure with the incidence of cancers, genetic effects of radiation exposure, mechanism of DNA repair following irradiation, and food reference values (Table 2). Participants responded with either "true," "false," or "not certain" to 5 short-sentence questions related to facts that were well-known and often misunderstood. Correct answers were scored as 1 point for each question, and points were summed as knowledge (scores: 0–5).

To assess HL, we used the 5-point HL scale developed by Ishikawa et al.,[19] a publicly accessible scale constructed to measure CCHL. This scale determines whether respondents can (1) collect health-related resources from various sources, (2) extract the desired information, (3) understand and communicate the obtained information, (4) consider the credibility of the information, and (5) make decisions based on health-related issues. Each item was rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The individual HL status of each respondent was numerically assessed by obtaining average scores for all 5 items.

Data on demographic characteristics (age, sex, and education), subjective health, mental health, and HL status were collected. The validated Japanese version of the Kessler 6-item Psychological Distress Scale (K6)[20] was administered to assess participants' mental health. All items were measured on a 5-point scale from 0 (never) to 4 (all of the time), and the total score was calculated (range: 0–24), with higher scores representing a worse mental health status.

Data Analysis

The data for each outcome measure (mean ± standard deviation) are presented. The difference-in-differences approach was used to assess the effectiveness of the intervention program. Changes in the measured scores post-intervention in each individual were calculated, and the mean values were compared between the intervention and control groups, using the t-test. The variables analyzed in this study included self-confidence, knowledge, and literacy. A 2-sided probability value of < 0.05 was considered statistically significant. All data analyses were performed using the Statistical Package for the

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Table 3. Changes in outcome measure post-intervention in the intervention and control groups

	Intervention group			Control group			
	Pre	Post	Change Post–Pre	Pre	Post	Change Post–Pre	*P*
Self-confidence	1.4 ± 0.5	3.0 ± 0.5	1.6 ± 0.7	1.9 ± 0.4	1.8 ± 0.6	−0.2 ± 0.5	< 0.001
Knowledge	0.8 ± 0.9	4.8 ± 0.4	4.0 ± 0.8	1.1 ± 1.0	2.4 ± 1.7	1.3 ± 1.6	< 0.001
Literacy	3.0 ± 0.6	3.7 ± 0.5	0.7 ± 0.6	3.2 ± 0.7	2.8 ± 0.7	−0.3 ± 0.6	< 0.001

Variables are presented as the mean ± standard deviation.

Social Sciences (SPSS) for Windows, version 21 (IBM Corporation, Armonk, NY, USA).

Results

Participants' Characteristics

Data from 10 and 16 kindergarten teachers who participated in the intervention and control groups, respectively, were analyzed. All 26 participants were women. The mean age of the intervention group was 39.6 ± 12.2 years. Nine out of 10 (90%) graduated from junior colleges or vocational schools, and the remaining 1 (10%) graduated from a university or graduate school. The mean score of K6, representing psychological distress, was 4.4 ± 4.4. The mean age of the control group was 31.3 ± 11.9 years. A total of 15 out of 16 (94%) graduated from junior colleges or vocational schools, and the remaining 1 (6%) graduated from a university or graduate school. The mean K6 was 4.1 ± 5.8. Participants' baseline demographic characteristics and mental health status did not differ between the intervention and control groups.

Outcome Measures

The scores of the outcome measures are summarized in Table 3. The changes in self-confidence scores, the primary outcome, were more significant in the intervention group than in the control group ($P < 0.001$; see Table 3). Similarly, changes in knowledge and literacy scores were more significant in the intervention group than in the control group ($P < 0.001$; see Table 3).

Discussion

This study examined the effects of a program aimed at enhancing the self-confidence of kindergarten teachers when handling parents' radiation-related health concerns. A vital feature of this study was that the intervention program aimed to address disaster-specific health concerns concerning radiation exposure from the Fukushima Daiichi Nuclear Power Plant accident and instill confidence in dealing with these concerns. Furthermore, although both gatekeeper training programs that targeted counselors following the GEJE[21] and an on-site training workshop to enhance specialized knowledge and skills were developed,[22] there have been no studies targeting people who are not specialized in dealing with the anxiety of the public. Nevertheless, the results showed that participants' self-confidence improved following the intervention program, suggesting that the program was effective.

It has been reported that teachers' self-confidence in their instructional, management, and collaboration skills is related to their teaching efficacy.[23] At the core of the social cognitive theory, self-efficacy refers to an individual's judgment of their capability to perform actions at the designated level.[24] In particular, self-efficacy in preschool teachers refers to their belief that they can bring about desirable changes in pupils' behaviors and achievements.[25] One's sense of self-efficacy has been reported to be a characteristic of preschool teachers associated with higher-quality classroom instruction and more outstanding achievements in children.[26] Thus, the self-confidence of kindergarten teachers is recognized as an essential factor related to their work performance.

Following the Fukushima disaster, kindergarten teachers faced the challenge of dealing with mothers' anxieties, which they would typically not experience, and this is thought to have been a factor in shaking their self-confidence. According to 1 conceptual model of HL, "health literacy as an asset," HL improves due to the acquisition of relevant knowledge and communication skills and enhancing participants' support skills.[14] Thus, the program developed here is considered to have contributed to increasing teachers' confidence in supporting the target population through acquiring knowledge and communication skills regarding radiation-related health effects. Furthermore, the critical goal of encouraging participants to access information released from the government, ministries, or relevant academic societies as reliable sources could contribute to enhancing teachers' HL and self-confidence levels.

Levels of knowledge improved in the control group, whereas self-confidence and literacy levels did not. This result suggests interpersonal communication is more critical than delivering the necessary information to enhance HL and subsequent self-confidence. Psychological safety, described as "being able to show and employ one's self without fear of negative consequences to self-image, status, or career," [27] might have played a vital role in developing self-confidence in this program. Kessel et al.[28] reported that a high level of psychological safety within a team significantly predicts creative team performance, mediated by sharing 2 types of knowledge: information and know-how. In this intervention program, psychological safety delivered through interpersonal communication enhanced the effect of knowledge acquisition on self-confidence. However, interpersonal communication can be harmful to the development of radiation anxiety. For instance, a previous study suggested that interpersonal interactions (eg, acquiring information about radiation through word of mouth) rather than gaining information from media sources may increase radiation anxiety.[29] Thus, communication of reliable information is essential to prevent radiation anxiety induced by communication.

The tool used in this study is generally employed to evaluate HL. Furthermore, the present study addressed radiation health concerns, which differ from general health concerns. Notably, HL can be measured at different levels corresponding to more incredible HL skills related to acquiring, understanding, and applying context-specific knowledge.[30] Thus, in this study, participants could raise their self-confidence by acquiring general HL, which could help them identify accurate sources of

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information on radiation and its health effects from various information sources in the public domain.

Limitations

This study had some limitations. First, as participants within the same kindergartens were divided into intervention and control groups, possibly, the participants assigned to the control group were informed of the content of the intervention program by participants in the intervention group, which might have affected the results of this study. However, the intervention included activities accessed only by participating in a live program. Thus, if present, the effect on the results of discussions between groups is likely to be sufficiently small. Second, the generalizability of this study was limited. The participants of this study comprised only 2 out of 17 kindergartens in Fukushima City. Therefore, it is possible that the kindergartens to which the participants belonged were relatively more cooperative in participating in this program, and the effect of the intervention program could have been overestimated. Moreover, most of the participants of this study experienced the GEJE in Fukushima Prefecture, and their positions were different; that is, some participants were already kindergarten teachers, and some were students of colleges or high schools at the time of the disaster. Nevertheless, all were somehow affected by this disaster. During the group discussions in this program, participants talked about their own experiences with the disaster. Thus, it is doubtful whether the same results would have been achieved in those who were unaffected. Finally, random allocation was not performed, and the sample size was small. Additionally, although demographic characteristics did not differ between the groups, there may have been confounding factors that affected the results of this study. Despite these limitations, this study confirmed the effectiveness of the intervention program in enhancing the self-confidence of kindergarten teachers who handle radiation-related health concerns of parents with young children. Based on these results, this intervention, which leads to increased self-confidence through knowledge acquisition, could be applied to a broader population similarly affected by nuclear disasters and in future unknown health risk cases (eg, new infectious disease outbreaks). Furthermore, considering that the dissemination of this intervention program includes time constraints related to participants and the recruitment of lecturers, future studies should develop further measures such as fostering the skills of program managers to hold the intervention program by themselves.

Conclusions

The intervention program effectively enhanced the self-confidence of kindergarten teachers in dealing with radiation-related health concerns of parents with young children.

Data availability statement. The data underlying the findings of this study cannot be made publicly available because of ethical approval for the study. Interested researchers may submit requests to Fukushima Medical University's ethics committee for access to confidential data (contact information via email: rs@fmu.ac.jp).

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Author contributions. The intervention was developed by KW and SY. The study design and protocol development were performed by NM, CN, KW, and SY. Authors NM, CN, KW, TK, and SY managed the study and were involved in data collection. NM and TK analyzed the data and drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

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Competing interests. Authors have no conflicts of interest to declare.

Ethical standards. The study protocol was approved by the Fukushima Medical University ethics committee (General 2021-146) and was conducted per the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all the participants.

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