

Picture Sound Book with Ninja-Essence Targeting Older People Affected by the Fukushima Daiichi Nuclear Plant Accident: Development and Evaluation Before-after Pilot Clinical Trial

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Abstract

Health and well being are critical concerns for the older people affected by the 2011 Fukushima Daiichi Nuclear Power accident, particularly those who experienced evacuation. This study investigates the feasibility of utilizing a picture sound book infused with Ninja elements to sustain or enhance physical well being among this demographic. A pre-post intervention study was conducted to assess the efficacy of the picture sound book among returnees and evacuees after the lifting of evacuation restrictions. A total of 29 participants took part in the study, divided into returnees and evacuees groups, both of whom were provided with the tool. Analysis of pre-post changes involved descriptive statistics, including Fisher's exact test and t-test. Significant improvements were observed in both groups, particularly in left and right hand-grip strength, maximum phonation time among participants regularly engaging in exercise, and in activities related to swallowing exercises and vocal practices ($p < 0.013$ and 0.033). Furthermore, 16 out of 29 participants reported enjoyment of the program. These results suggest promising avenues for further investigation with larger sample sizes, indicating potential for enhanced outcomes.

Keywords: Fukushima Nuclear Accident; Aged; Feasibility Studies; Hand Strength; Singing Exercises

1. Introduction

Health and well being have posed significant challenges for the population of older people affected by the Fukushima Daiichi Nuclear Power plant accidents of March 11, 2011. Following the explosions of units 1, 3, and 4 of the Fukushima Daiichi Nuclear Power Plant subsequent to the Great East Japan earthquakes [1], residents within the evacuation zones were compelled to relocate due to evacuation orders. This displacement led residents to transition from the evacuation area to temporary housing, relatives' residences, and subsequently to new or restored dwellings within or outside the Fukushima Prefecture [2,3]. Despite initial expectations of temporary relocation, individuals were unable to return until evacuation orders were gradually lifted between 2013 and 2022 [2,3]. The prolonged duration of evacuation, coupled with resettlement in new locales, rendered it challenging for individuals to return to their original residences. For instance, in a survey conducted in Namie Town of Futaba Province in Fukushima, 54.9% of respondents expressed no intention of returning [4]. Of

the 1400 residents surveyed, nearly 1000 were returnees, reflecting a return rate of less than 5% among the 21,500 individuals who resided in the affected area before the accident [4]. Irrespective of their post evacuation residence, individuals who experienced evacuation likely encountered varying degrees of mental, physical, and social stress [5]. Prior research has indicated a heightened risk of stress-related disorders, including post traumatic stress disorder (PTSD), among individuals subjected to traumatic stressors [6]. Disasters linked to nuclear power plants exacerbate the risk of PTSD due to concerns regarding radiation exposure [7]. Evacuees and returnees have grappled with fear, depression, familial separation, and persistent apprehensions regarding radiation exposure, loan repayments, frequent relocations, bereavement, and community disintegration [8]. Although a majority of older returnees maintained good physical health, they confronted challenges such as community breakdown, uncertain prospects for future care, and loss of livelihoods, particularly in agriculture. Furthermore, potential shortages in medical and nursing care

services exacerbated the situation, with some areas witnessing closures of mental healthcare facilities due to evacuation mandates. Research has underscored the correlation between residing in evacuation zones in Fukushima and heightened demands for long term care services [9]. A survey conducted in Namie Town revealed that 84.1% and 59.1% of respondents expressed a need for expanded medical and nursing care services and welfare facilities, respectively [4].

In response to these challenges, the main author developed a worldwide initiative health oriented tool termed the “Picture sound book with Ninja-essence” (hereafter referred to as the “the picture book”) targeting older people individuals affected by the Fukushima Nuclear Power accident. The integration of Ninja elements into the book holds several rationales. Firstly, Ninjas are associated with overcoming fear, disregarding adversaries, and contemplation, concepts resonant with the experiences of victims who endured anxiety and fear during the nuclear accident [10]. Secondly, Fukushima Prefecture’s scenic beauty, once synonymous with lush mountains and bountiful vegetation, was marred by the nuclear disaster, depriving older people residents of activities such as foraging for mushrooms and wild vegetables. The imagery of Fukushima residents and Ninjas navigating mountains intersected, prompting the inclusion of Ninja motifs in the picture book. Thirdly, preceding exercise routines with stretching and stimulation is imperative.

The main author created kamishibai (paper theater) for users of day services and daycare as part of an intervention program in previous study. Through the reaction of participants, the main author considered to develop an easy exercise picture sound book that frail elderly individuals can enjoy and engage with, thereby enhancing their physical activity [11]. While there are picture books available for children that offer enjoyment through the use of pens and buttons, picture books with sound aimed at improving physical activity among older people have yet to be developed. Although there are studies on the effectiveness of kamishibai and storytelling for infants domestically [12]. However, the reports targeting older people individuals with declining cognitive function or those in the terminal stage are limited in number. There is a possibility that picture books, similar to Kamishibai, could be effective for older people. The picture book is designed to enable physical exercises including facial, mouth, throat, diaphragm, upper body, hand, and hip muscles. toe, finger exercise. The book incorporates Ninja inspired techniques, including gentle tapping on the face, hands, and feet to invigorate muscles, aligning with traditional with the press of a button, eliminating the need for Wi-Fi connectivity. It’s made simple for anyone to engage in full body exercises. Incorporating the essence of ninjas not only makes it enjoyable. It also psychologically effective, as it reflects the spirit of ninja perseverance which may lead to enhance motivation of exercise.

Chronic exercise has been reported to contribute to the improvement

of mood in frail older people [13]. The association between fitness and depression has been reported [14]. There is a report that suggests the act of tying a ninja hand sign helps alleviate anxiety [15]. While there are numerous reports on interventions targeting frailty such as exercise, oral frailty, and frailty in the legs, there is no existing worldwide example of a picture book embodying the spirit of a ninja, which enabling full-body exercise. In the future, if this picture book is translated and spread worldwide, we believe it could also contribute to the maintenance of the health of individuals who have experienced trauma from disasters or wars around the world. The unique feature of the picture book including swallowing function. It is associated with other health issues such as oral, digestive, and respiratory system problems. Therefore, as significant implications for overall health, swallowing exercise was included in the book. There have been previous studies focusing on physical performance and oral health [16,17].

The definition of health adopted in the WHO Constitution in 1947 states in its preamble that “health” is not merely the absence of disease or infirmity, but a state of complete physical, mental, and social well being [18]. This program is applicable in any region and across all age groups, offering a reproducible framework. In the future, nurses will be able to contribute to community health using this book, regardless of age or whether trauma is present.

This study aimed to assess the feasibility of the “Picture sound book with Ninja-essence” in maintaining or improving physical conditions among older people individuals affected by the Fukushima Daiichi Nuclear Power plant accident. Additionally, it explored the delivery method of the tool. The research questions guiding the investigation were as follows:

1. Has the development of the book’s feasibility concerning effectiveness in maintaining physical conditions for the target population been supported by data?
2. What is the suitable delivery method for the book?

2. Materials and Methods

2.1. Study Design

Non-randomized, parallel group comparative studies in randomly selected facilities and offices using cluster sampling methods. Randomization was not feasible due to logistical constraints due to time constraints and sample size and ethical consideration. Randomization often requires larger sample sizes to achieve statistical power compared to non randomized designs. This is a feasibility evaluation with an intervention study. Before and after pilot clinical trial this study followed the TREND statement

2.2. Conceptual Framework

The “Picture sound book with Ninja-essence” offered various exercises drawing inspiration from the spirit and techniques of Ninja practices [19]. The study explores a wide array of exercises aimed at diverse anatomical regions, encompassing facial, mouth, throat, diaphragm, upper body, hand, and hip muscles. toe, finger

exercise. These exercises include ball crushing, facial and mouth exercises mimicking sour ingestion, throat exercises, such as swallowing forehead, chin lifting. Additionally, upper body exercises, towel exercises, hand exercises, ninja exercises, slow standing, hip shifting exercises.

For physical effects the evaluation of outcomes focused on prepost changes in scores of the toe grip force, handgrip strength, and maximum phonation time. Handgrip strength is an indicator of overall body strength and muscle [20].

The measurement of toe grip forces compound movement involving the action of the flexor pollicis brevis, flexor pollicis longus, adductor pollicis, flexor digitorum superficialis, and flexor digitorum profundus muscles, which are related to lower limb strength, enabling assessment of the condition of the feet [21]. Maximum phonation time is the method used to measure cough reflex during aspiration and swallowing function [22,23].

The study was conducted from July 2021 to March 2022. We designed a study comparing two groups; one exercising solely at home and the other exercising both at home and in group settings. Participants in both groups experienced evacuation due to Fukushima Daiichi Nuclear Plant Accident:

2.2.1. Setting and Study Population

Study participants were recruited from home-based older adults, commonly referred to as the older people, who either returned to the area within the evacuation zone post the lifting of restrictions in Namie Town (referred to as returnees) or those who evacuated and resided in the disaster complex in Nihonmatsu (referred to as evacuees). The author received referrals from residents and visited social welfare councils and day services to ask about the possibility of conducting a survey. Because it was under covid-19, day care services were not acceptable, but the Council of Social Welfare referred us to a local circle that would be the subject of the survey.

Those who returned to the area rebuilt or renovated their homes. Namie Town is situated in Hamadori, Fukushima Prefecture, and falls under Futaba County. Following the Fukushima Nuclear Power Plant accident, residents of the entire town of Namie were evacuated. A temporary town office was established in Naomitsu, approximately 1.5 hours away from Namie Town.

The main author visited various locations, including the Council of Social Welfare, geriatric groups, day service centers, local pension and guest houses, and the disaster reconstruction complex for evacuees from the 12 evacuation zones or the nearest area outside the zones where evacuees lived after the accident. In Namie, the Council of Social Welfare introduced the study to a geriatric social group. The main author explained the study's contents to several residents, including the head of the geriatric social group, who then informed other members about the study. In Nihonmatsu, the pension owner introduced the autonomous chairman of the disaster

reconstruction complex. One of his roles was to assist or manage the geriatric social group in the disaster reconstruction complex. The main author explained the study's contents to the chairman and other staff members. The chairman helped circulate the notice within the disaster reconstruction complex for study recruitment.

Older adults were eligible to participate if they (1) experienced evacuation due to the Fukushima nuclear disaster, regardless of whether they returned to the area, and (2) were living in an area where the evacuation order was lifted, or an area evaluated within Fukushima Prefecture. Individuals with severe cognitive impairment, at risk of engaging in risky behavior by reading the book, or unable to understand the study instructions, were excluded.

Based on power analysis using G Power (test family: t-test, Statistical test: mean difference between two independent means [two groups], Effect size: 0.8, Power: 0.8), the sample size was determined to be 21 for each group. Initially, the study was planned to include the day-service center and a parallel group with control and non control groups. However, due to various COVID-19 restrictions, all day service centers rejected participation in the study. Nonetheless, participants from the two geriatric groups of two areas and one person from a different area were willing to participate. After the main author explained the study to the candidate participants, signed informed consent forms were obtained from 30 participants. One participant with a particular health concern and another who could not participate in the planned intervention were excluded. Therefore, 29 participants were finally included in the study.

2.3. Instruments and Study Procedure

Herein, the main tool was the author developed picture sound book with Ninja essence. The idea of the book was based on the previous research of author [11].

This picture book has several unique features. First, it contains colorful pictures with attractive exercise content. Second, it is easy to obtain exercise instruction by only pushing the bottom. At present, many researchers and companies have developed healthcare programs using information and communication technology, artificial intelligence, and robots that target people living at home. Nevertheless, only a limited number of people benefit from such devices because they are troublesome to use, and the hurdles are high. Third, it contains the Ninja-essence. NJ refers to "Ninja." Even after 10 years, survivors of the nuclear accident have complicated feelings that cannot be expressed in words. The essence of the term Ninja is considered to provide an encouraging message to them. In addition, participants can enjoy exercise by introducing the extraordinary existence of a Ninja.

The picture sound book with the Ninja consists of seven pages with seven colored pushbuttons. When the participant pressed the button shown on each page, a voice could be heard, providing

instructions for the respective exercise. The sound is stopped by pressing the button again; when pressed again, the instruction for the exercise on the next page begins. In total, a single book contains 20 exercises and two songs.

The content of the exercises in the book went beyond the regular exercise, including stimulation via tapping, moving, or voicing. Stimulating the ends of the body, such as the tips of the hands, feet, and ears, enhances the internal organ functions. Swallowing exercises were also included.

After creating the draft, the author discussed the tool at a

professional meeting consisting of two university researchers with physical therapist qualifications, two with nurse qualifications, and one with social welfare qualifications. The main author also contacted an otorhinolaryngologist and plastic surgeon specializing in feet. The main author engaged in discussions with the company staff involved in manufacturing to refine the book's contents, iterating through multiple revisions to ensure its user friendliness for readers. This collaborative process likely included several rounds of feedback exchanges aimed at enhancing the content's clarity and practicality for the intended audience. The main author finally developed a picture sound book with Ninja essence.



Figure 1: Cover of the book



Figure 2: Ninja exercise

2.3.1. Supplement Materials

Ninja cipher text tracing and daily notes, as well as softball, were provided as supplemental tools. A softball was provided for swallowing exercises, used by the participant while doing Adam's apple squat, placing the ball between their neck and chin [24].

We introduced Ninja cipher text tracing notes, published by the Ueno Printing Company. Ninja used it to communicate among themselves. It motivates exercise by activating the brain by tracing complicated shapes and providing fun.

2.3.2. Demographic and PTSD Checklists

Basic characteristics and PTSD-related variables were used to obtain the characteristics and current situation. At the beginning of the intervention, the participants completed questionnaires related to baseline data, including sex, age, and existing diseases. The PTSD level was evaluated using the "Impact of event scale revised (IES-R)" questionnaire, developed by Weiss et al. in the United States [25]. IES-R has been used in various studies [26]. In this study, PTSD was checked during preintervention to understand the overall mental and physical condition of participants.

2.3.3. Outcome Pre–post Intervention

Before and after the study, scores of the toe-grip force, hand-grip strength, maximum phonation time were measured.

The toe grip force was measured using the toe muscle strength measuring device (TKK) of Takei Scientific Instrument [27]. Previous literature mentioned the importance of toes in the lower limb muscle strength and postural stability and prevention of all, etc [28]. Hand grip strength was used to measure the physical strength of the entire body. A previous study reported that hand grip strength correlates with physical function [20,29]. Maximum phonation time is the method used to measure cough reflex during aspiration. The participants were asked to utter the vowel "ahh," the time was recorded, and the strength of the voice was evaluated according to the participant's natural tone. The length of vocalization was measured using a stopwatch. The maximum vocalization time has been reported to be associated with swallowing function [23].

2.3.4 Program Satisfaction Sheet

Post intervention, self reported questionnaires related to program satisfaction were answered by the participants.

2.3.5 Intervention for Program Evaluation

Participants of the control group (Group A) were returnees after the evacuation order was lifted, and participants of the intervention group (Group B) lived in a reconstruction complex in the closest city, Nihonmatsu City. The same tools were provided to both groups. Participants in the control group were instructed to use tools at home, while the intervention group regularly (once a week) performed exercises at a geriatric club meeting. At home, participants were encouraged to use it daily, although they were not specifically required to record anything.

The autonomous chairman of the reconstruction complex made motion pictures based on the picture book and used them during regular meetings. The intervention period was 3 months. We conducted a picture book explanation session during the orientation, providing a comprehensive overview before participants used it at home.

In particular, the main author explained that pressing a button would activate the exercise instructions, and pressing it again would stop the instructions. Since the flow of pressing the button to advance to the next exercise explanation might be challenging, the main author demonstrated the process while participants interacted with the button.

2.4. Data Analysis

Data collection was conducted by two teams independently, with descriptive analysis used for basic characteristics. We measured IES-R scores before the intervention and satisfaction after the intervention. Student's t test was applied for the score change between the intervention and control groups at a 5% significance level. In the intervention group and control group, there were potential biases in health status. Therefore, we compared the before and after conditions of both groups, but we decided not to statistically validate the comparison between the two groups.

For toe-grip force, maximum phonation time, and hand grip strength, t-tests were conducted to analyze score changes within the study groups after the intervention. Data were categorized into two groups and analyzed using IBM SPSS version 24 (IBM Corp., Armonk, NY, USA) with descriptive statistics (t-test) at a 5% significance level.

2.5. Ethical Approval

The study received ethical approval from the Ethical Committee of the Tokyo University of Information Sciences (2021-003) and was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants, outlining the study's purpose, privacy measures, and the right to discontinue participation.

3. Results

Table 1 presents the characteristics of the study participants, indicating an average age of 77 years (SD 7.618) for returnees and 82 years (SD = 7.014) for evacuees, with 6 males and 15 females in the returnee group and 2 males and 5 females in the evacuee group. The most commonly reported diagnosed disease among participants was back pain.

Table 2 displays the results of the IES-R scores, indicating that 4 of 19 participants in the returnee group expressed sleeping concerns. Significant differences were observed between the groups in items related to irritability, anger, and concentration.

Table 3 presents the results of toe-grip force, hand grip strength, and maximum phonation time measurements. Analysis included data from 20 participants, with significant differences observed in hand grip strength between the right and left hands in both cities. While no significant difference was found in toe grip force, improvements were noted in mean values. Significant differences in maximum phonation time were observed in Nihonmatsu.

Table 1. Subject characteristics.

	Returnees (Nami Town)	%	Evacuees (Nihonmatsu City)	%
Male	6	29	3	37.5%
Female	15	71	5	62.5%
Age	77		82	
High blood pressure	8	38	1	12.5
Diabetes	2	9.5	1	12.5
Heart disease	1	4.8	3	37.5
Cerebrovascular disease	1	4.8	0	0
Back pain	5	23.8	3	37.5

Table 2: Impact of events scale-revised results.

	Returnee					Total	Evacuee					Total	P-value
	Not at all	A little bit	Moderately	Quite a bit	Extremely		Not at all	A little bit	Moderately	Quite a bit	Extremely		
	0	1	2	3	4		0	1	2	3	4		
Any reminder that brought back feelings about it	7 38.9%	8 44.4%	2 11.1%	1 5.6%	0 0.0%	18 100.0%	2 28.6%	5 71.4%	0 0.0%	0 0.0%	0 0.0%	7 100.0%	0.946
I had trouble staying asleep	4 21.1%	8 42.1%	3 15.8%	4 21.1%	0 0.0%	19 100.0%	0 0.0%	3 42.9%	3 42.9%	1 14.3%	0 0.0%	7 100.0%	0.361
Other things kept me thinking about it	9 45.0%	8 40.0%	2 10.0%	1 5.0%	0 0.0%	20 100.0%	3 42.9%	2 28.6%	2 28.6%	0 0.0%	0 0.0%	7 100.0%	0.743
I felt irritable and angry.	9 45.0%	10 50.0%	1 5.0%	0 0.0%	0 0.0%	20 100.0%	7 100.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	7 100.0%	0.013 *
I avoided letting myself get upset when I thought about it or was reminded of it.	7 35.0%	9 45.0%	4 20.0%	0 0.0%	0 0.0%	20 100.0%	5 71.4%	1 14.3%	1 14.3%	0 0.0%	0 0.0%	7 100.0%	0.169
I thought about it when I did not intend to.	5 26.3%	12 63.2%	2 10.5%	0 0.0%	0 0.0%	19 100.0%	2 33.3%	2 33.3%	2 33.3%	0 0.0%	0 0.0%	6 100.0%	0.669
I felt as if it was unreal.	10 52.6%	8 42.1%	1 5.3%	0 0.0%	0 0.0%	19 100.0%	4 66.7%	1 16.7%	1 16.7%	0 0.0%	0 0.0%	6 100.0%	0.746
I stayed away from reminders about it.	13 65.0%	5 25.0%	2 10.0%	0 0.0%	0 0.0%	20 100.0%	6 85.7%	0 0.0%	0 0.0%	1 14.3%	0 0.0%	7 100.0%	0.449
Pictures of it popped into my mind	8 40.0%	10 50.0%	2 10.0%	0 0.0%	0 0.0%	20 100.0%	1 14.3%	3 42.9%	3 42.9%	0 0.0%	0 0.0%	7 100.0%	0.071
I was jumpy and easily startled	7 35.0%	11 55.0%	1 5.0%	0 0.0%	1 5.0%	20 100.0%	2 28.6%	3 42.9%	1 14.3%	1 14.3%	0 0.0%	7 100.0%	0.465
I tried not to think about it.	8 42.1%	8 42.1%	2 10.5%	1 5.3%	0 0.0%	19 100.0%	4 66.7%	0 0.0%	0 0.0%	1 16.7%	1 16.7%	6 100.0%	0.810
I was aware that I still had many feelings about it, but I did not deal with them.	10 50.0%	6 30.0%	4 20.0%	0 0.0%	0 0.0%	20 100.0%	3 42.9%	2 28.6%	0 0.0%	2 28.6%	0 0.0%	7 100.0%	0.512
My feelings about it were numb.	11 55.0%	7 35.0%	2 10.0%	0 0.0%	0 0.0%	20 100.0%	4 57.1%	2 28.6%	0 0.0%	1 14.3%	0 0.0%	7 100.0%	0.950
I found myself acting or feeling like I was back in that time.	13 65.0%	5 25.0%	2 10.0%	0 0.0%	0 0.0%	20 100.0%	3 60.0%	1 20.0%	0 0.0%	1 20.0%	0 0.0%	5 100.0%	0.690

I had trouble falling asleep.	11 55.0%	7 35.0%	0 0.0%	2 10.0%	0 0.0%	20 100.0%	4 66.7%	1 16.7%	0 0.0%	1 16.7%	0 0.0%	6 100.0%	0.756
I had waves of strong feelings about it.	11 55.0%	7 35.0%	1 5.0%	1 5.0%	0 0.0%	20 100.0%	4 57.1%	2 28.6%	0 0.0%	1 14.3%	0 0.0%	7 100.0%	0.975
I have tried forgetting about it.	11 55.0%	7 35.0%	1 5.0%	1 5.0%	0 0.0%	20 100.0%	3 50.0%	1 16.7%	2 33.3%	0 0.0%	0 0.0%	6 100.0%	0.590
I had trouble concentrating.	14 70.0%	5 25.0%	1 5.0%	0 0.0%	0 0.0%	20 100.0%	1 14.3%	2 28.6%	2 28.6%	2 28.6%	0 0.0%	7 100.0%	0.003 *
Reminders of it caused me to have physical reactions, such as sweating, trouble breathing, nausea, or a pounding heart.	13 65.0%	6 30.0%	0 0.0%	1 5.0%	0 0.0%	20 100.0%	3 50.0%	2 33.3%	0 0.0%	1 16.7%	0 0.0%	6 100.0%	0.436
I had dreams about it.	12 60.0%	7 35.0%	1 5.0%	0 0.0%	0 0.0%	20 100.0%	5 71.4%	2 28.6%	0 0.0%	0 0.0%	0 0.0%	7 100.0%	0.556
I felt watchful or on guard.	9 45.0%	9 45.0%	1 5.0%	1 5.0%	0 0.0%	20 100.0%	2 28.6%	2 28.6%	1 14.3%	2 28.6%	0 0.0%	7 100.0%	0.162
I tried not to talk about it.	9 45.0%	9 45.0%	2 10.0%	0 0.0%	0 0.0%	20 100.0%	3 42.9%	1 14.3%	1 14.3%	1 14.3%	1 14.3%	7 100.0%	0.340

Format was downloaded from www.onlinecbtresources.co.uk. N = 29.

Table 3: Toe-grip force, hand-grip strength, and maximum phonation time.

	N	Returnees (Nemie Town)	<i>p-value</i>	N	Evacuees (Nihonmatu City)	<i>p-value</i>
		Average ± SD (pre-post intervention difference)			Average ± SD (pre-post intervention difference)	
Toe-grip force (R)	14	0.2 ± 2.4	0.816	6	1.1 ± 1.2	0.058
Toe-grip force (L)	14	0.1 ± 1.5	0.838	6	0.9 ± 1.7	0.545
Hand-grip strength	14	4.5 ± 7.7	0.048*	6	1.4 ± 2.2	0.000*
Hand-grip strength	14	4.6 ± 6.7	0.023*	6	0.6 ± 0.8	0.000*
Maximum phonation time	13	0.8 ± 7.7	0.728	6	0.8 ± 3.6	0.033*

* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$. N = 29

Table 4 shows the results of the self-reported 20-item questionnaires. The p-value of the chi-square test was used to verify whether there was a difference in the subjects' condition and exercise behavior pre-post intervention. Participants answered the questions considering the current situation; 1. Applicable, 2. Somewhat

applicable, 3. None of the above, 4. Slightly applicable, 5. Not at all. For returnees, there were significant differences in two questions: "Do you sing a song or practice that word?" and "Do you perform swallowing exercises?"

Table 4: Self-reported 20-item questionnaires

	Returnees' (Nami Town) <i>p</i> -value	Evacuees' (Nihonmatsu City) <i>p</i> -value
Do you experience difficulty breathing or coughing while eating?	0.622	0.182
Do you cough while eating?	0.6	1
Does your saliva secretion increase during meals?	1	0.455
Do you experience difficulties while swallowing tablets?	0.792	1
Do you cough when you drink water?	0.711	1
Do you bend your neck forward when swallowing?	0.326	0.455
Does your phlegm accumulate in the throat?	0.067	0.455
Did you get a fever every time you ate?	1	1
Do you have a slight fever?	1	1
Do you feel food is tasty?	0.466	1
Do you sleep well at night?	0.232	1
Are you frustrated? (Answer is reverse scored)	0.273	1
Do you sing a song or practice a word?	0.013*	1
Do you perform swallowing exercises?	0.033*	0.212
Do you stretch your posture?	0.732	1
Do you take deep breaths?	1	0.455
Do you move your fingers?	0.408	0.455
Do you exercise by raising and lowering your ankles?	0.24	1
Do you move your toes?	0.451	0.134
Do you move your shoulders using a towel?	0.067	1

* $p < 0.05$ Fisher's exact probability test. N = 29.

The satisfaction survey regarding the program experience is presented in Table 5. A total of 24 residents from both areas responded to the questions; among them, 16 respondents indicated, "I enjoyed the program," while 6 responded with, "I relatively enjoyed it." Regarding the question, "Was it easy to use for exercising at home?", 9 respondents answered "yes,"

and 10 responded with "relatively yes." Regarding one of the supplementary tools, Ninja cipher text letter tracing notes, 7 out of 19 respondents found it somewhat challenging, while 5 respondents commented that it was difficult. Free responses are listed below.

Table 5: Satisfaction survey about picture books.

<p>What do you think should be improved about picture sound books?</p>	<ul style="list-style-type: none"> - It is fine the way it is (1) - I enjoyed it (16) - I relatively enjoyed (7) - I cannot really judge (1) - I hope we can make a home video together (1) - It would be nice to be able to do it freely (1) - I would like the sound to be a little louder (2)
<p>Any feedback on the Ninja cipher text letter tracing notes would be appreciated.</p>	<ul style="list-style-type: none"> - Nothing in particular (1) - It was quite difficult (1) - I enjoyed understanding the flow of letters (1) - Difficult (3) - A little difficult (1)

4. Discussion

This study assesses the strengths, limitations, and potential benefits of integrating a picture sound book with Ninja-essence into exercise programs for older people impacted by the Fukushima Daiichi Nuclear Power Plant accident. The book used the program provided well balanced exercises which leads to well being of the older people participants.

The intervention demonstrated several strengths. Firstly through exercises found in picture books imbued with the essence of ninjas, one can achieve balanced full body workouts. These exercises incorporate movements such as toe exercises and swallowing exercises, which have not been extensively addressed in traditional Japanese older people exercise programs. Secondly, implementation of the program resulted in increased participation in regular exercise at geriatric club meetings and encouraged habitual exercises among participants using the book at home.

There was significant differences observed in hand-grip strength between the right and left hands in both cities. While no significant difference was found in toe grip force, improvements were noted in mean values. Significant differences in maximum vocalization time, which associated with swallowing function were observed in participants who practiced at group sessions. Encouraging group exercise among individuals could potentially yield a synergistic effect, enhancing the overall impact of exercise routines.

Improving toe grip strength and grip strength enhances the body's muscle strength and flexibility, leading to improved everyday movements and physical abilities. This, in turn, contributes to better posture, balance maintenance, and even injury prevention. Enhancing toe grip strength also has positive effects on the circulatory system. Specifically, strengthening the muscles in the feet promotes blood circulation and enhances peripheral circulation.

Enhancing contributes to better nutrient intake. Adequate swallowing function ensures proper ingestion of food, facilitating

appropriate nutrient supply to the digestive organs, thus swallowing function enhancing nutrient absorption and maintaining overall health. Although previous studies have explored the link between frailty and oral or swallowing function [30-32], the research related to the issue has been limited. Toe exercise leads to improvement in lower limb strength and walking status, which in turn contributes to overall physical improvement [33]. When overall physical condition improves, one gains the strength to expel even if they accidentally swallow. Improvement of swallowing function by exercise leads to prevent aspiration pneumonia. Reducing the risk of aspiration pneumonia contributes to maintaining the quality of life for the elderly.

Despite their potential benefits, swallowing exercises remain underutilized in Japan due to their perceived complexity. However, with the increasing the population of older people, there is a growing recognition of the importance of oral care. The scarcity of otolaryngologists (n = 9831) compared to dentists (n = 107,443) may contribute to this underutilization [34]. Notably, in Japan, pneumonia and aspiration pneumonia rank as the fifth and sixth leading causes of death, respectively, with pneumonia overall ranking fourth among causes of death [35]. Compared to global statistics, there is a heightened risk of death from aspiration pneumonia in Japan. Looking ahead, we posit that the dissemination of swallowing exercises could be facilitated through the use of instructional videos, as well as group exercise sessions outlined in this book.

Individuals, who exercised using picture books alone, as opposed to in groups, exhibited a significant difference in behaviors such as singing and practicing swallowing before and after the intervention. It can be inferred that using picture books allowed for a focus on physical activities that had not been previously addressed. The decline in these abilities is common with aging, potentially leading to a deterioration in daily functional activities. Therefore, enhancing these functions can be beneficial for improving the quality of life in older adults.

Considering these aspects collectively, the enhancement of hand grip strength, toe grip strength, and swallowing function contributes to improving overall health and quality of life.

In this study, there were potential limitations. Firstly, the medical infrastructure has not yet been sufficiently developed, so only healthy older people were able to return. Therefore, confounding factors such as age, underlying health conditions, and frailty may be considered, but they were not analyzed in this study. Secondly, there was the small size of participants. Increasing the participant count within a short timeframe proved difficult. Thirdly, to assess the overall effects on the body, we may have needed additional items beyond partial investigations of hand grip strength, toe grip strength, and swallowing function. For instance, there are several indicators for swallowing [36]. However, to minimize the burden on the older people during the survey, we kept the research items to a minimum. Fourthly, we were unable to conduct pre- and post-measurements for PTSD as the fourth point. While pre-study PTSD status was assessed to understand the current mental conditions resulting from the accident, post-study PTSD status was not queried to prevent heightened fear of flashbacks among participants. Therefore, it is not clear whether short-term interventions could impact PTSD status. Minimum data analysis indicated that some participants still experienced sleep disturbances. Future research should investigate how the intervention with the book affects changes in sleep status among evacuees.

Incorporating elements of Ninja culture into the book was meaningful for participants who had experienced the Fukushima Nuclear Power accident. While the initial aim of introducing Ninja concepts was to inspire and motivate participants with the Ninja spirit, residents began associating the term “Ninja” with extraordinary abilities. Consequently, the program was dubbed “Ninja exercise” by the chairman of the recovery complex, and participants have continued engaging in group exercises since then. Fundamental exercises like “tapping” techniques employed by ninjas or adopting specific poses have served as pre-paratory measures, priming muscles before more strenuous exercises. The study results have demonstrated the feasibility of further developing the program for future implementation, aiming to enhance physical health among evacuees. Considering the global trend of aging populations, simple and enjoyable exercise picture books with Ninja essence can be expected to be used worldwide. Additionally, nurses involved in local communities can present these exercise picture books to older residents based on them.

Many people around the world are living with trauma due to disasters, wars, and other events. In this study, it is believed that by using the picture books developed, particularly among residents of various regions, one can maintain not only physical but also mental health by continuing enjoyable whole body movements with the spirit of unwavering determination akin to that of a ninja. Nurses learning the breathing techniques and way of life of ninjas and promoting exercise programs incorporating the essence of

ninjas can be expected to enhance the motivation and effectiveness of exercise among elderly residents in the community.

Moving forward, the study suggests several avenues for future research. Further investigation into the long term effects of the exercise program with the picture sound book with ninja-essence with larger sample sizes and sustained interventions, is explored. Future studies should explore the association between frailty and integrated functions of the foot and oral swallowing. Additionally, supplemental tools such as Ninja cipher text letter tracing notes may hold potential for combined use with physical exercises and warrant further exploration.

5. Conclusions

In conclusion, the integration of Ninja-essence into the exercise program for individuals affected by the Fukushima Nuclear Power accident demonstrated meaningful outcomes, promoting regular exercise participation and fostering health conscious behaviors. The unique features of the book, coupled with the introduction of Ninja-essence, facilitated enjoyable and engaging exercise routines for participants. The study results showed that the development of the program is feasible for future use to improve the motor and exercise habits for evacuees. The introduction of Ninja elements into the program holds significance for Fukushima Nuclear Power accident survivors although the necessity for continued research and development in this domain is highlighted.

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Institutional Review Board Statement

The study was conducted in compliance with the Declaration of Helsinki and approved by the Institutional Review Board of the Ethics Committee of the Tokyo University of Information Sciences (Approval No. 2021-003, Approval Date: July 28, 2021).

Clinical Trial Registration

This study was retrospectively registered with the University Medical Information Network on February 12, 2024, under registration number UMIN000053603.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Public Involvement Statement

No public involvement was sought or engaged in any aspect of this research.

Guidelines and Standards Statement

This manuscript adheres to the TREND statement guidelines for reporting non-randomized controlled trials.

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Conflicts of Interest

The authors declare no conflicts of interest.

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