Journal of Community Medicine & Health Education

Moriyama et al., J Community Med Health Educ
2017, 7:3
DOI: 10.4172/2161-0711.1000528

Research Article OMICS International

Effect of Two month Intervention to Improve Physical Activity of Evacuees in Temporary Housing after the Great East Japan Earthquake: Pilot Study

Moriyama N[1*], Urabe Y[1], Onoda S[2], Maeda N[1] and Oikawa T[2]

[1]*Graduate School of Biomedical and Health Sciences, Sports Rehabilitation, Hiroshima University, Hiroshima, Japan*

[2]*Minamisoma Municipal General Hospital, Fukushima, Japan*

[*]**Corresponding author:** Nobuaki Moriyama, PT, MHSc, Graduate School of Biomedical and Health Sciences, Sports Rehabilitation, Hiroshima University, Hiroshima, Japan, Tel: +81-82-257-5405, Fax: +81-82-257-5405; E-mail: n-moriyama@hiroshima-u.ac.jp

Received date: May 19, 2017; **Accepted date:** June 12, 2017; **Published date:** June 14, 2017

Abstract

Objective: This study aims to clarify effects of intervention to improve the physical activity of elderly evacuees in temporary housing after The Great East Japan Earthquake, which occurred on March 11, 2011.

Methods: A total of 15 subjects (5 men and 10 women) underwent a two-month intervention program, which consisted of multiple techniques including education, practice, and feedback, all of which were aimed to increase patients' physical activity levels. Changes in physical activity levels were gauged according to the number of walking steps recorded with a triaxial accelerometer, or pedometer. Age, gender, and stage of self-efficacy were analyzed to determine which characteristics made it more likely for respondents to add more than 10% to their number of steps in the first 2 weeks and in the last 2 weeks of the study.

Results: Three out of fifteen subjects (20.0%) increased their number of steps by more than 10% in post-intervention. Males, and those who had smaller levels of physical activity pre-intervention were more likely to improve their number of steps ($p<0.05$).

Conclusion: Multiple-strategy intervention for elderly evacuees in temporary housing is effective at improving the level of physical activity for males and individuals with low initial levels of physical activity.

Keywords: Older evacuees; Temporary housing; Great East Japan earthquake; Physical activity; Self-efficacy; Intervention

Introduction

Physical activity is defined as "any bodily movement produced by the skeletal muscles that result in energy expenditure" [1]. Lack of physical activity has been identified as the fourth leading risk factor of global mortality [2]. Furthermore, particularly among older individuals, a lack of physical activity may cause frailty [3] and poor physical functions, such as reduced mobility and muscle strength [4].

On March 11, 2011, the Great East Japan Earthquake (GEJE) hit the northeast region of Japan, and the subsequent tsunami and accident that occurred at the Fukushima Daiichi Nuclear Power Plant caused severe damages. In order to prevent exposure of radioactive material emitted from the damaged power plants, local citizens who lived there were forced to evacuate-many of them are still living in temporary housing. Many of these evacuees, particularly the older ones, have had trouble maintaining a healthy physical activity level.

Survivors of the GEJE lost their routine work schedules, and their physical activity levels generally decreased. One previous study found that survivors living in temporary housing had 33% less daily walking steps than similarly aged individuals living in their own houses located in the same district in 2015 [5]. This is in keeping with evidence that one's amount of physical activity is subject to the environment of surrounding areas [6] and Hirai et al.'s suggestion that access to daily needs is essential to prevent homebound status in the community after GEJE [7].

Another study suggested that survivors of GEJE who have experienced evacuation were more likely to develop non-communicable diseases [8]. One consequence of the disaster was that it caused a break of social linkages, which may trigger health issues in survivors [9,10]. Tsubokura points out the possibility that financial difficulties also might cause health deterioration after the GEJE [11].

Self-efficacy, which is described as confidence in the ability to be physically active in specific situations, is a determinant of an individual's physical activity level [12]. Recently, there have been efforts to develop intervention methods to improve physical activity self-efficacy and various techniques for behavior change (behavior change techniques; BCTs)-these methods are reported to be effective for those who have had less motivation to increase physical activity [13,14].

In this study, researchers developed a two-month intervention program for residents of one temporary housing complex in Minamisoma city, Fukushima Prefecture, Japan, with the aim of improving their levels of physical activity. The original total population of Minamisoma city was approximately 72,000 before the disaster, but it plummeted to approximately 10,000 immediately following the GEJE because many local residents temporarily evacuated the city, following an order from the national government not to enter or maintain residence there [15]. After evacuation, adolescents and their mothers were less likely to return to their home, while a larger portion of older individuals aged 65 or older have returned. The percentage of citizens

over the age of 65 increased from 25.92% on March 11, 2011 to 32.88% on March 10, 2014 [16]. Thus, following the GEJE, age distribution in Minamisoma has dramatically changed, and the aging rate has increased. Given that a higher percentage of the population is elderly, and therefore more susceptible to declining health conditions, there is a need to pay careful attention to their physical activity, in order to maintain community health. Although previous studies have attempted to improve the physical function and quality of life of elderly survivors after the GEJE [17], no study has specifically investigated maintenance of their physical activity levels. Development of methodology for improving their physical activity level can be one means of improving their overall health.

This study aims to clarify the effectiveness of a newly developed intervention strategy to improve the physical activity levels of older persons living in temporary housing after the GEJE. Daily walking steps, measured by a triaxial accelerometer, were used to determine the physical activity level of each subject. This study's findings could provide policy makers or municipality officers in the areas affected by great disasters with some information that could be used to promote the health of survivors.

Methods

Study design

This study was conducted on a single group, with a comparison between pre-intervention and post-intervention conditions. The increase of daily walking steps was used to determine level of physical activity pre and post-intervention.

Subjects

In this study, we collected data from evacuees who lived in one temporary housing complex in Kashima ward, Minamisoma city, whose municipal branch office is 32 km north of the Fukushima Daiichi Nuclear Power Plant. The subjects in this study began residing in the temporary housing complexes 6 months after the GEJE.

Individuals 55 years and older who were able to independently perform daily activities were eligible to participate in the study. Residents living at the study sites were informed that a walking session would be conducted. Residents who had received nursing care insurance service and those who were unable to appropriately understand our instructions were excluded from the study. A total of 18 eligible residents agreed to participate in this study. After eliminating the data of three participants who dropped out due to scheduling conflicts, a total of 15 residents participated and had their data analyzed (Figure 1 and Table 1).

Intervention details

Protocols: On the first day of the study, the subjects were gathered at an assembly site inside the temporary housing complex and were provided with a detailed explanation of the study objective and schedule of the intervention. On the same day, the subjects' age, gender, height, and body weight were recorded. Physical activity and self-efficacy were also measured, as outlined below.

Intervention methodology

Previous studies have suggested that intervention with a combined strategy is an effective technique for improving physical activity self-efficacy [13,14]. Following these studies, authors developed the intervention program in order to reflect conditions at the site. Techniques used in this intervention included: 1. Feedback on physical activity level; 2. Education; 3. Instruction; 4. Goal setting; 5. Barrier identification; and 6. Practice (Figure 2).

Subject number	Gender	Age (years)	Height (cm)	Weight (kg)	Body mass index (kg/m^2)	Self-efficacy
1	Male	84	155	61	25.4	3
2	Male	64	165	71	26.1	2
3	Female	74	146	54	25.3	3
4	Female	71	157	69	28.0	5
5	Male	72	160	67	26.2	3
6	Female	65	154	64	27.0	3
7	Female	59	156	68	27.9	3
8	Female	67	158	57	22.8	3
9	Female	72	147	51	23.6	3
10	Female	72	137	58	30.9	4
11	Female	62	150	80	35.6	4
12	Male	82	161	71	27.4	4
13	Female	74	141	51	25.7	4
14	Female	78	153	69	29.5	5
15	Male	66	166	79	28.7	5

Self-efficacy: 1. No intention to take action in the near future (precontemplation); 2. Intention to take action in the next six months (contemplation); 3. Intention to take action in the next 30 days (preparation); 4. Sustained behavior change for six months or less (action); 5. Behavior change for more than six months (maintenance)

Table 1: Characteristics of subjects.

Subjects were gathered every two weeks, beginning on May 27, 2016. At each meeting, participants' average daily steps during the latest two weeks were recorded by calculating data from the triaxial accelerometer (technique #1), and they were provided a lecture on the benefits of physical activity by a professional physical therapist (technique #2). Subjects were encouraged to increase their number of daily steps at least 10% from the baseline they established at first measurement [18], and the therapist advised subjects to give themselves more time to walk than they did at present (techniques #3,4). In the lecture, the therapist also explained that the surrounding environment at temporary housing complexes was insufficient to motivate residents to do much physical activity, and that previous research had determined that the physical activity levels of temporary housing residents were lower than those of similarly aged individuals residing at their own houses (technique #5) [5]. At the end of the meeting, subjects participated in a walking session led by the physical therapist. In this walking session, subjects performed warm-up exercises and then walked approximately 1 km together (technique #6).

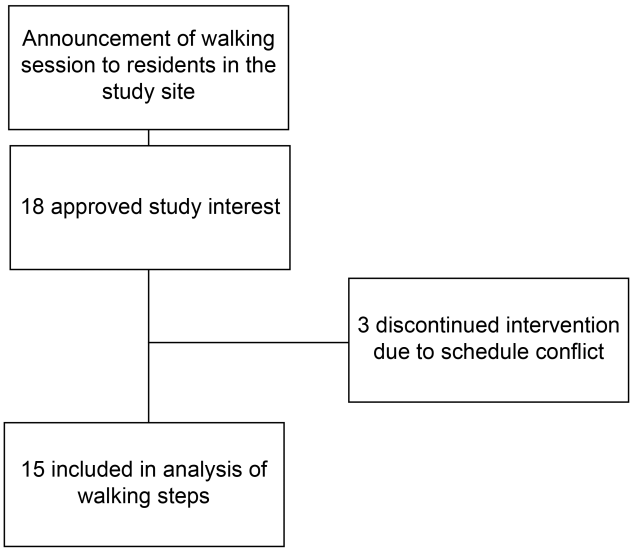

Figure 1: Flowchart indicating stages in participant recruitment.

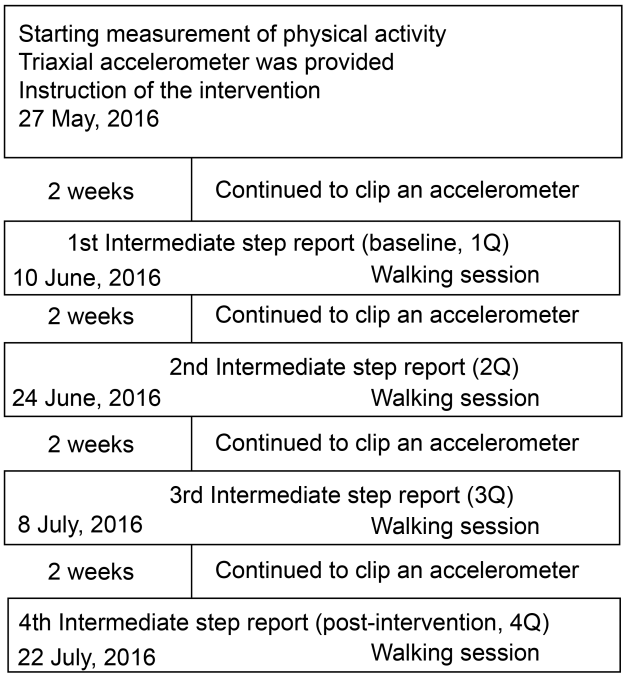

Figure 2: Intervention flowchart.

Physical activity

The number of steps walked daily was measured using a triaxial accelerometer (Mediwalk, TERUMO Co., Ltd., Japan), the validity of which has already been established, as the waist is close to the center of gravity, and is therefore highly sensitive to physical activity [19,20]. All subjects were instructed to wear a triaxial accelerometer clipped on their waists throughout the test period except while sleeping, showering, or bathing, and to perform daily activities as usual. The number of steps walked daily was automatically recorded on the device. The number of steps walked between the day after the previous gathering and the day before the next gathering were averaged and used for data analysis.

Subjects were divided into 2 groups according to the change in their number of daily steps-those who increased their number of daily steps by more than 10% were considered the "effective group," and those who did not were placed in the "not-effective group."

Self-efficacy

Each participant's self-efficacy was measured using the "Stage of change" [21] which describes individuals' progression through a series of steps marking their readiness to change. Each subject selected one appropriate answer from five choices regarding his/her attitude to doing physical activity in a daily life. The five possible responses to each question are: No intention to take action in the near future (precontemplation, Stage 1); Intention to take action in the next six months (contemplation, Stage 2); intention to take action in the next 30 days (preparation, Stage 3); sustained behavior change for six months or less (action, Stage 4); and behavior change for more than six months (maintenance, Stage 5). Following a previous study that reported that "Stage of change" is associated with steps in daily life [22], these values were supposed to affect the outcome of the intervention.

Statistical analysis

The Shapiro-Wilk normality test was used to check the normality of the distribution of number of daily steps. At baseline, the significance probability (p-value) was 0.64. Since the normal distribution was confirmed, the significance of the differences in daily steps between pre- and post-intervention was assessed using a paired t-test. An increase over 10% of the baseline in post-intervention was regarded as indicating that intervention was effective. To clarify which variables were efficacious in the intervention, characteristics in subjects between two groups were compared using a student's t-test for parametric variables (age, walking steps in pre-intervention), a chi-square test for gender differences, and a Mann-Whitney's U test for stage of self-efficacy. The parametric data are presented as mean and standard deviation. All the data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21(IBM, Japan). A p-value<0.05 was considered statistically significant.

Ethical consideration

This study was approved by the ethics committee of Minamisoma Municipal General Hospital (ID: 28-04). Written informed consent was obtained from each subject, and all intervention and measurement activities were conducted according to the principles expressed in the Declaration of Helsinki.

Results

Physical activity

To verify the effect of this intervention, we examined changes in daily steps between pre- and post-intervention, and calculated rates of subjects who achieved a greater than 10% increase of daily steps in baseline. Figure 3 shows chronological change of subjects' daily steps,

categorized by gender. Since there were 4 measurements (each 2 weeks apart), each measurement point is presented as 1st Quarter (1Q=baseline, pre-intervention) through 4th Quarter (4Q=post-intervention), in chronological order. No significant difference was observed in the number of steps walked daily between baseline and post-intervention for either men or women (Figure 3). In the post-intervention, three of the fifteen subjects (20.0%) increased their number of steps by more than 10%. The highest rate of increase for a subject was 122% (from 2,411 steps/day to 5,344 steps/day), followed by 80% (from 5,309 steps/day to 9,578 steps/day), and then 34% (from 3,693 steps/day to 4,940 steps/day).

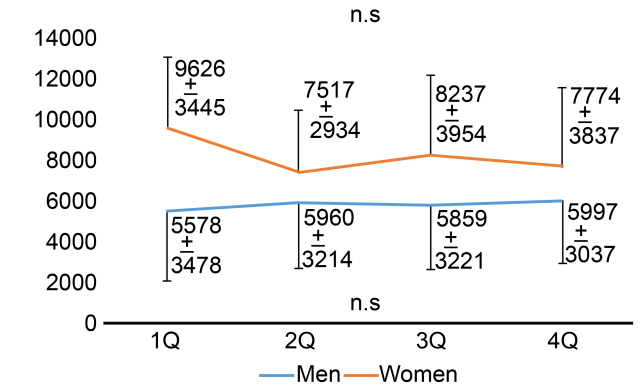

Figure 3: Average walking steps of all subjects (N=15) in each measurement period (1Q=baseline, pre-intervention, from 27 May to 9 June; 2Q=from 10 June to 23 June; 3Q=from 24 June to 7 July; 4Q=post-intervention, from 8 July to 22 July).

Differences in other variables between groups

To clarify what characteristics made subjects more likely to find intervention effective, we compared differences in variables between the effective group and the not-effective group. Significant differences in gender were observed between two groups (p=0.02; Table 2). Daily steps in baseline in the effective group and the not effective group were 3,805 steps/day and 9,395 steps/day, respectively, and they were significantly different (p=0.02; Table 2). The average ages of subjects in the effective group and the not effective group were 73.3 years and 70.2 years, respectively, and this was not a significant difference between the two groups (p=0.51). Distribution of stage of self-efficacy in the effective group was 2 in stage 3, and 1 in stage 2. In the not-effective group, the value was 3 in stage 5, 4 in stage 4, and 5 in stage 3-there was therefore not a significant difference between both groups (p=0.10) (Table 2).

In summary, males, and those who had a smaller amount of physical activity in the pre-intervention phase were most likely find intervention effective.

Discussion

Interruption of physical activity due to situation change after the disaster may exacerbate chronic disease and disturb the general well-being of survivors. Since it is reported that physical activity level was lower in temporary housing residents than with those who lived in their own houses after GEJE [5], support for evacuees should include encouraging them to improve their physical activity levels.

Variables	Effective group (N=3)	Not-effective group (N=12)	p-value
Gender	Male 3 Female 0	Male 2 Female 10	0.02
Age (years)	73.3 ± 10.0	70.2 ± 6.6	0.51
Daily steps in baseline (steps/day)	3805 ± 1451	9395 ± 3446	0.02
Self-efficacy stage	Stage 3: N=2 Stage 2: N=1	Stage 5: N=3 Stage 4: N=4 Stage 3: N=5	0.10
Effective group includes subjects who increased their number of daily steps by more than 10% from baseline; Not-effective group includes subjects who failed to increase their number of daily steps by more than 10% from baseline; Data on age and daily steps in baseline are expressed in mean ± standard deviation			

Table 2: Difference in measured variables in two groups according to changes in daily steps after intervention.

Further, 20% of respondents increased their number of steps more than 10% over their baseline rates. However, subjects' overall number of walking steps did not increase, and in this respect, the results of this study did not support the hypothesis. One possible reason for this inconsistent result has to do with weather conditions and ambient temperature during the testing period. Previous studies in Japan have suggested that climate and temperature can affect physical activity level, and that the optimal temperature for conducting physical activity is approximately 17°C [22]. The testing period for this study began in early March, when the weather was relatively comfortable-however, by late June and early July, when the final measurements were being taken, there was substantial rain and the temperature was high. According to data from Japan Meteorological Agency of the Ministry of Land, Infrastructure, Transport and Tourism, the average maximum temperature in the study area during the first and last two weeks of the testing period were 22°C and 28°C, respectively. Temperatures as high as 28°C could conceivably limit subjects' motivations to participate in outside physical activities. Nevertheless, the fact that there were some subjects who raised their physical activity level warrants discussion.

Being male and having lower daily steps at baseline were the features that made it more likely for individuals to significantly improve their number of daily steps. Meanwhile, stage of self-efficacy did not affect likelihood of increased physical activity level. This does not follow our hypothesis and is out of keeping with previous studies, which reported that habitual physical activity level was correlated with self-efficacy for physical activity in Japanese pupils [23,24] The cause of this discrepancy may have to do with the environment of the area surrounding the temporary housing complex. Temporary housing complexes were built at sites not originally intended for housing, and so there were limited number of parks or other recreational facilities nearby. As is reported in a recent study which found a positive relationship between physical activity in adults in rural areas and the physical environment (such as pleasant aesthetics, trails, safety, parks, and walkable destinations) [25], physical activity level in older residents in temporary housing might also be determined by the

physical environment of the surrounding area, as well as their self-efficacy.

In addition to improving participants' physical activity, this intervention was valuable in providing subjects with the opportunity to gather together for a purpose, which may strengthen ties among temporary housing residents. The participants in this intervention had various levels of physical activity. For those who had lower levels of physical activity, the opportunity to interact with neighbors who had higher levels of activity may encourage them to exercise more.

Furthermore, as it is reported that women receive more benefit from their social participation than men [26], it was difficult to get men involved in the social gathering constituted by this intervention program. However, since this intervention program seemed to be more effective for men than for women, men should be all the more encouraged to join this program. In Japan, men generally seek key roles in organizations, and participation in such roles is associated with low risk for mental depressive symptom [27]. Thus, to provide the opportunity to hold significant roles, such as being the chairperson responsible for the intervention event, may attract more men to intervention programs.

To illustrate the effectiveness the intervention had for men, here the authors describe the story of one male subject (subject number 1). Before GEJE, he had a number of close friends with whom he frequently interacted. However, after moving to the temporary housing complex, although he lives with his son, his friends have moved elsewhere, and he lost the opportunity to spend quality time outdoors. His daily walking steps have changed the most dramatically among the all subjects in this study. His self-efficacy was categorized in stage 3, indicating that he intended to take action in his daily life in the next 30 days. As he wanted to do physical activity in the near future, participation in this program was especially effective for him. Although no statistical difference was observed in distribution of stage of self-efficacy, it is suggested that those with lower stages may benefit more from this intervention.

Another way of describing the potential benefits of the intervention process is in terms of social capital, which is defined as the features of social organization – such as networks, norms and social trust-that facilitate coordination and cooperation for mutual benefit [28]. Displaced survivors of the GEJE were randomly assigned to temporary housing, disrupting social ties [29]. As indicated in previous studies, low social capital is associated with increased risk of psychological distress in the aftermath of GEJE [30], and so social capital is a key factor for recovery from devastating disasters. Although it was beyond the scope of our analysis to evaluate the effectiveness of the intervention on strengthening social ties in the newly built community, it arguably did so by bringing together residents for a common purpose and encouraging them to participate in a group activity.

This study has a number of limitations. First, the authors did not set the control groups for which no intervention was provided in this research design, and so were unable to determine to what extent the increase or decrease of daily steps had to do with the intervention. The small sample size and fact that the study was conducted at only one temporary housing complex means that the results may be skewed by outliers, and that the particular demographic distribution found in the complex's respondents may not be indicative of all elderly residents living in temporary shelters. Therefore, future studies should incorporate a wider sample of individuals from multiple temporary shelters. That the authors chose number of steps walked daily as the sole determinant of physical activity is also a limitation. In future studies, all physical activity by temporary housing residents, such as cleaning, laundry, cooking, and fitness exercises should be measured in order to gain an accurate understanding of the effect of this intervention on improving overall physical activity level.

It is important to note that the intervention strategy was most effective for the very people who most needed to improve their activity levels. It can also be said that the study functioned as a facilitator, teaching participants the importance of maintaining physical activity level-this improved the participants' social capital and so could also constitute successful health promotion.

It would be advisable for further studies to feature a larger sample of participants from a wider variety of environment types, in order to gain stronger evidence of the effectiveness of this intervention and to allow results to be more generalizable to post-disaster conditions.

Conclusion

Intervention composed of multiple strategies, including 1. Feedback of physical activity level using pedometers; 2. Goal setting; 3. Education; 4. Instruction; 5. Practice; and 6. Barrier identification/problem solving for elderly individuals residing in temporary housing was effective in improving the physical activity level of certain groups of subjects. This intervention may be more effective for males, those who had relatively low physical activity levels, and those who fell within the lower stages of self-efficacy.

Acknowledgments

We would like to thank Editage (www.editage.com) for English language editing and Publication Support.

Sources of Support

This study was funded by the "Phoenix Leader Education Program (Hiroshima Initiative) for Renaissance from Radiation Disaster," from the graduate school program of Hiroshima University, Japan.

Author Contributions

YU, TO, and NM contributed to study conception and design; SO was involved in data acquisition; NM performed data analysis and interpretation, and drafted the manuscript. All the authors revised the article critically and approved the final version for publication.

References

1. Caspersen CJ, Powell KE, Christenson GM (1985) Physical activity, exercise and physical performance: Definitions and distinctions for health-related research. Public Health Rep 100: 126-131.
2. World Health Organization (2010) Global recommendation on physical activity for health.
3. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, et al. (2001) Frailty in older adults: Evidence for a phenotype. J Gerontol A Biol Sci Med Sci 56: 146-156.
4. Matta J, Mayo N, Dionne IJ, Gaudreau P, Fülöp T, et al. (2014) Interrelated factors favoring physical performance and activity in older adults from the NuAge cohort study. Exp Gerontol 55: 37-43.
5. Moriyama N, Urabe Y, Onoda S, Maeda N, Oikawa T (2017) Effect of residence in temporary housing after the Great East Japan earthquake on

the physical activity and quality of life among older survivors. Disaster Med Public Health Prep.

6. Moran M, Cauwenberg VJ, Linnewiel HR, Cerin E, Deforche B, et al. (2014) Understanding the relationships between the physical environment and physical activity in older adults: A systematic review of qualitative studies. Int J Behav Nutr Phys Act 11: 79.
7. Hirai H, Kondo N, Sasaki R, Iwamuro S, Masuno K, et al. (2015) Distance to retail stores and risk of being homebound among older adults in a city severely affected by the 2011 Great East Japan Earthquake. Age Ageing 44: 478-484
8. Nomura S, Blangiardo M, Tsubokura M, Ozaki A, Morita T, et al. (2016) Postnuclear disaster evacuation and chronic health in adults in Fukushima, Japan: A long-term retrospective analysis. BMJ 6: e010080.
9. Ozaki A, Leppold C, Tsubokura M, Tanimoto T, Saji S, et al. (2016) Social isolation and cancer management after the 2011 triple disaster in Fukushima, Japan: A case report of breast cancer with patient and provider delay. Medicine (Baltimore) 95: e4027.
10. Morita T, Tanimoto T, Hori A, Kanazawa Y (2015) Alcohol use disorder due to social isolation after a nuclear disaster in Fukushima. BMJ Case Rep.
11. Tsubokura M (2016) Exposure and current health issues in Minamisoma. Ann ICRP.
12. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, et al. (2012) Correlates of physical activity: Why are some people physically active and others not? Lancet 380: 258-271.
13. Williams SL, French DP (2011) What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behaviour and are they the same? Health Educ Res 26: 308-322.
14. French DP, Olander EK, Chisholm A, Mc Sharry J (2014) Which behaviour change techniques are most effective at increasing older adults' self-efficacy and physical activity behaviour? A systematic review. Ann Behav Med 48: 225-234.
15. Ishikawa K, Kanazawa Y, Morimoto S, Takahashi T (2012) Depopulation with rapid aging in Minamisoma City after the Fukushima Daiichi nuclear power plant accident. J Am Geriatr Soc 60: 2357-2358.
16. Zhang H, Yan W, Oba A, Zhang W (2014) Radiation-driven migration: The case of Minamisoma City, Fukushima, Japan, after the Fukushima nuclear accident. Int J Environ Res Public Health 9: 9286-9305.
17. Greiner C, Ono K, Otoguro C, Chiba K, Ota N (2016) Intervention for the maintenance and improvement of physical function and quality of life among elderly disaster victims of the Great East Japan Earthquake and Tsunami. Appl Nurs Res 31: 154-159.
18. Ministry of Health Labour and Welfare (2017) Physical activity exercise.
19. Hendelman D, Miller K, Baggett C, Debold E, Freedson P (2000) Validity of accelerometry for the assessment of moderate intensity physical activity in the field. Med Sci Sports Exerc 32: 442-449.
20. Mathie MJ, Coster AC, Lovell NH, Celler BG (2003) Detection of daily physical activities using a triaxial accelerometer. Med Biol Eng Comput 41: 296-301.
21. Prochaska JO, Velicer WF (1997) The transtheoretical model of health behavior change. Am J Health Promot 12: 38-48.
22. Aoyagi Y, Shephard RJ (2009) Steps per day: The road to senior health? Sports Med 39: 423-438.
23. Uechi H, Takenaka K, Suzuki H (2003) The relationship between the stage of physical activity and self-efficacy among higher graders in elementary school. Japanese J Health Educ Prom 11: 23-30.
24. Bandura A, Adams NE (1997) Analysis of self-efficacy theory of behavioral change. Cogn Ther Res 1: 287.
25. Frost SS, Goins RT, Hunter RH, Hooker SP, Bryant LL, et al. (2010) Effects of the built environment on physical activity of adults living in rural settings. Am J Health Promot 24: 267-283.
26. Kavanagh AM, Bentley R, Turrell G, Broom DH, Subramanian SV (2006) Does gender modify associations between self-rated health and the social and economic characteristics of local environments? J Epidemiol Community Health 60: 490-495.
27. Takagi D, Kondo K, Kawachi I (2013) Social participation and mental health: Moderating effects of gender, social role and rurality. BMC Public Health 13: 701.
28. Aldrich DP (2016) Building resilience: Social capital in post-disaster recovery (2011) The University of Chicago Press, USA.
29. Putnam RD (1995) Bowling alone: America's declining social capital. J Democracy 6: 65.
30. Tsuchiya N, Nakaya N, Nakamura T, Narita A, Kogure M, et al. (2017) Impact of social capital on psychological distress and interaction with house destruction and displacement after the Great East Japan Earthquake of 2011. Psychiatry Clin Neurosci 71: 52-60.