

Short Communication

Combined associations of physical activity and dietary intake with health status among survivors of the Great East Japan Earthquake

Miho Nozue PhD, RD¹, Nobuo Nishi MD, PhD¹, Megumi Tsubota-Utsugi PhD, RD¹, Miki Miyoshi PhD, RD¹, Yuki Yonekura PhD², Kiyomi Sakata MD, PhD³, Seiichiro Kobayashi MD, PhD³, Akira Ogawa MD, PhD³

¹National Institute of Health and Nutrition, National Institutes of Biomedical Innovation, Health and Nutrition, Tokyo, Japan

²Department of Hygiene and Preventive Medicine Iwate Medical University School of Medicine, Iwate, Japan

³Iwate Medical University, Iwate, Japan

Background and Objectives: Each of the effects of physical activity and dietary intake on health is well known, but combined associations of physical activity and dietary intake on health has not been reported yet. Physical activity and dietary intake are key factors for maintaining health of survivors of the Great East Japan Earthquake in 2011. This study aimed to examine combined associations of physical activity and dietary intake with survivors' health status. **Methods and Study Design:** We used data from 6668 participants of a cross-sectional survey taken 3 years (2013) after the disaster. To evaluate combined associations of physical activity and dietary intake, answers to questions regarding these two variables were categorized into four groups: poor physical activity and poor dietary intake (Group 1), poor physical activity and good dietary intake (Group 2), good physical activity and poor dietary intake (Group 3), and good physical activity and good dietary intake (Group 4). Multiple logistic regression analyses were performed by sex, with good self-rated health and good mental health as dependent variables, and age, place of residence, living conditions and physical activity/dietary intake group (with Group 1 as the reference category) as independent variables. **Results:** Good self-rated health was associated with age in both sexes, and Groups 3 (male: odds ratios (ORs) 1.84 (95% confidence intervals (95% CIs) 1.32-2.57), female: OR 1.82 (95% CI 1.32-2.51)) and 4 (male: OR 1.96 (95% CI 1.39-2.76), female: OR 1.94 (95% CI 1.42-2.64)). Good mental health was associated with Groups 3 (OR 1.48 (95% CI 1.10-1.97)) and 4 (OR 1.86 (95% CI 1.37-1.97)) for male respondents; and living place (other than temporary housing) (OR 1.45 (95% CI 1.26-1.68)) was associated with Group 4 (OR 1.42 (95% CI 1.09-1.85)) for female respondents. **Conclusions:** Good physical activity alone or combined with good dietary intake was associated with good self-rated health and good mental health. Further interventions regarding physical activity and dietary intake are needed to improve the health status of survivors.

Key Words: physical activity, dietary intake, health status, survivor, Japan

INTRODUCTION

The effects of physical activity and dietary intake on health have often been investigated separately. Studies demonstrate that physical activity provides health benefits such as a lower risk of early death, coronary heart disease and stroke, as well as a lower risk of falling and reduced depression among adults.¹ Kuriyama et al reported a relationship between shorter daily walking time and higher prevalence of psychological distress.² Some studies have found a relationship between dietary intake and subjective health.^{3,4}

After the Great East Japan Earthquake (GEJE) on March 11, 2011, a prospective cohort study of survivors was established, and a follow-up study is currently ongoing.⁵ The health-related effects of promoting physical activity in the disaster area after the GEJE were examined in a prior study, and exercise intervention was found to

improve subjective health status and frequency of going outdoors.⁶ Another study of Fukushima prefecture reported that lower physical activity and mental quality of life scores compared with national standards values were shown in evacuees.⁷ Nutritional consideration after natural disaster was also pointed out.⁸ However, the combined associations of physical activity and dietary intake with health status among survivors have not been reported yet. The purpose of this study was to evaluate physical activi-

Corresponding Author: Dr Miho Nozue, Toyama 1-23-1, Shinjuku, Tokyo, 162-8636, Japan.

Tel: 81-03-3203-5721; Fax: 81-03-3202-3278

Email: mnozue@nih.go.jp; nozumiho@yahoo.co.jp

Manuscript received 13 December 2015. Initial review completed 27 December 2015. Revision accepted 22 January 2016.

doi: 10.6133/apjcn.042016.08

ty and dietary intake, and to examine the relationship between these factors and health conditions among survivors.

MATERIALS AND METHODS

Study design

This prospective cohort study repeats health checkups and a questionnaire every year. We used data from the third-year (2013) questionnaire survey after the GEJE. The survey was conducted in two cities and two towns on the Pacific coast of Iwate Prefecture. A total of 7,124 participants (2,646 men and 4,478 women) aged 20 years and over took part in the health checkups and completed the questionnaire. The study was reviewed and approved by the ethics committee of Iwate Medical University. The study protocol was fully explained to participants and written informed consent was obtained.

Questionnaire survey

The validated physical activity questionnaire comprised three questions regarding the participants' frequency of performing domestic and occupational physical activities, the frequency of leaving their residence and walking duration per day.⁹ Total point scores ranged from 1 to 15. A score ≥ 13.5 was used to define good physical activity because it is equivalent to 23 METs/h/w.⁹ A score below 13.5 was categorized as poor physical activity.

To assess dietary intake of survivors, we selected eight food groups: staple foods (rice, bread, noodles); meat; fish and shellfish; eggs; soybean products; vegetables; fruit; and dairy products.¹⁰ We asked, "How many times did you eat each food group per day during the previous several days?" Five response options were offered: less than once, once, twice, three times, and four times or more. In this study, respondents who met all of the following criteria were categorized as having good dietary intake: 1) three times or more for staple foods; 2) more than twice for the same food groups or a combination of more than two food groups of meat, fish and shellfish, eggs and soybean products; 3) twice or more for vegetables; 4) once or more for fruits; and 5) once or more for dairy products. Respondents who did not meet all these criteria were defined as having poor dietary intake.

To evaluate physical activity and dietary intake combined, each participant's data regarding physical activity and dietary intake were categorized into one of four groups: poor physical activity and poor dietary intake (Group 1), poor physical activity and good dietary intake (Group 2), good physical activity and poor dietary intake (Group 3), and good physical activity and good dietary intake (Group 4). Self-rated health and the Kessler Psychological Distress Scale (K6) were the two measures of health status used in this study. Self-rated health was assessed by asking, "How do you feel about your health condition?" with four options: very good, good, not very good, and not good at all. On the basis of respondents' answers, four options were categorized into two groups: good (very good, and good) and not good (not very good, and not good at all).

The K6 scale was used to assess psychological distress as mood and anxiety disorders.¹¹⁻¹³ Total points ranged from 0 to 24. In this study, good and poor mental health

were defined as scores from 0 to 4, and scores above 5, respectively.

We obtained data about living place and living conditions as relevant factors for self-rated health and psychological distress. Public housing for survivors and prefabricated temporary housing were defined as "temporary housing." Place of residence other than temporary housing was defined as "other." Living conditions were categorized into three groups: acceptable, somewhat poor, and poor (which included responses of "poor" and "very poor").

Statistical analysis

Only participants without missing values were included for analysis ($n=6,668$). A chi-square test was used to analyze physical activity, dietary intake, and age, by sex. Multiple logistic regression analyses were performed by sex. Dichotomous variables for self-rated health and psychological distress were used as dependent variables. Age (≥ 75 [reference], 65-74 years, 55-64 years, 45-54 years, and <45 years), place of residence (temporary housing [reference] or others), living conditions (acceptable [reference], somewhat poor, and poor), groups of physical activity and dietary intake (Group 1 [reference], and Groups 2, 3, and 4) were used as independent variables. A value of $p < 0.05$ (two-tailed) was considered significant. All statistical analysis was performed with SPSS software (version 22.0; IBM, Armonk, NY, USA).

RESULTS

Table 1 summarizes the characteristics of the subjects. Over half (57.8%) of participants were aged 65 years or over. About 30% of male and female participants lived in temporary housing. Almost 60% of both male and female participants whose living situation was other than temporary housing reported that their living conditions were acceptable, whereas just 40% of both male and female participants who lived in temporary housing reported that their living conditions were acceptable. Approximately 85% of male and female participants responded that their physical health was good, and 77.2% of male participants and 68.5% of female participants reported good mental health.

The percentage of participants having good physical activity was 83.0%, and of having good dietary habits was 54.2%. Physical activity, dietary intake and age divided by sex are shown in Table 2. Distributions of physical activity and dietary intake were significantly different among age groups when divided by sex (male: $p < 0.001$, female: $p < 0.001$). Group 4 (good activity and good diet) was represented in the various age categories as follows: male aged 65-74 years (42.1%) and ≥ 75 years (41.5%), and female aged 55-64 years (53.4%), 65-74 years (59.5%) and ≥ 75 years (55.7%). Group 3 (good activity and poor diet) had the highest number of participants from the following groups, in descending order: male aged <45 years (60.9%), 45-54 years (61.1%) and 55-64 years (49.9%), and female aged <45 years (50.3%) and 45-54 years (44.7%).

Table 3 shows good health status and related factors according to sex. Good self-rated health was positively associated with age and with membership in Groups 3

Table 1. Characteristics of participants

		Men (n=2,479)		Women (n=4,189)	
		n	%	n	%
Age	<45	197	7.9	439	10.5
	45-54	208	8.4	477	11.4
	55-64	455	18.4	1037	24.8
	65-74	934	37.7	1431	34.2
	≥75	685	27.6	805	19.2
Place of residence	Temporary housing	761	30.7	1280	30.6
	Others	1718	69.3	2909	69.4
Living conditions	Acceptable	1410	56.9	2514	60.0
	Somewhat poor	603	24.3	1001	23.9
	Poor	466	18.8	674	16.1
Self-rated health	Good	2134	86.1	3590	85.7
	Not good	345	13.9	599	14.3
Psychological distress	Good mental health [†]	1914	77.2	2871	68.5
	Poor mental health [‡]	565	22.8	1318	31.5

[†]Kessler Psychological Distress Scale (K6) scores was 0 to 4.

[‡]K6 scores was above 5.

Table 2. Combination of physical activity and dietary intake and age, by sex

		Group1 (Poor physical activity and poor dietary intake)		Group2 (Poor physical activity and good dietary intake)		Group3 (Good physical activity and poor dietary intake)		Group4 (Good physical activity and good dietary intake)		<i>p</i>	
		Total	n	%	n	%	n	%	n		%
		Men	<45	197	27	13.7	7	3.6	120		60.9
	45-54	208	27	13.0	8	3.8	127	61.1	46	22.1	
	55-64	455	61	13.4	29	6.4	227	49.9	138	30.3	
	65-74	934	95	10.2	83	8.9	363	38.9	393	42.1	
	≥75	685	108	15.8	89	13.0	204	29.8	284	41.5	
	Total	2479	318	12.8	216	8.7	1041	42.0	904	36.5	
Women	<45	439	54	12.3	15	3.4	221	50.3	149	33.9	<0.001
	45-54	477	49	10.3	20	4.2	213	44.7	195	40.9	
	55-64	1037	56	5.4	57	5.5	370	35.7	554	53.4	
	65-74	1431	76	5.3	106	7.4	398	27.8	851	59.5	
	≥75	805	63	7.8	101	12.5	193	24.0	448	55.7	
	Total	4189	298	7.1	299	7.1	1395	33.3	2197	52.4	

Chi square test.

(good activity and poor diet) and 4(good activity and good diet), and it was negatively associated with poor living conditions (somewhat poor and poor). Odds ratios (OR) were higher among younger ages than older ages. Good mental health was negatively associated with poor living conditions (rather difficult and difficult). Good mental health was positively associated with being in Groups 3 (good activity and poor diet) and 4 (good activity and good diet) for male participants. Residence (other than temporary housing) and being in Group 4 (good activity and good diet) were positively associated with good mental health for females.

DISCUSSION

This study examined the relationship of combined physical activity and dietary intake with the health conditions of survivors in Iwate Prefecture in the third year after the GEJE. We found that good physical activity and dietary intake were associated with good self-rated health and good mental health in both sexes. Several studies have found a relationship between physical activity and re-

duced psychological distress,^{1,2} and dietary intake and subjective health.^{3,4} The present study demonstrated associations between combined physical activity and dietary intake with self-rated health and psychological distress. However, good physical activity and poor dietary intake were associated with good self-rated health in both sexes and good mental health in males. Therefore, physical activity might be more important to self-rated health and psychological distress than dietary intake. Nevertheless it cannot be overlooked that difference between having good physical activity (83.0%) and good dietary habit (54.2%) might have influenced the results.

In this study, we examined the association of living in temporary housing with health status in a disaster area; OR for good mental health were higher for females whose place of residence was other than temporary housing. Additionally, living conditions subjectively rated as "acceptable" were positively associated with good self-rated health and good mental health among survivors. Recent research which investigated post-disaster distribution of oral health-related quality of life (OHRQoL) and related

Table 3. Odds ratios (ORs) and 95% confidence intervals (95% CIs) for good self-rated health, good mental health, and related factors, by sex; multiple logistic regression analyses

	Men		Women	
	OR	95% CI	OR	95% CI
Good self-rated health				
Age				
≥75	1.00		1.00	
65-74	1.45	[1.09-1.92]	1.42	[1.12-1.80]
55-64	1.64	[1.16-2.33]	1.78	[1.37-2.32]
45-54	2.14	[1.31-3.52]	1.78	[1.28-2.47]
<45	2.17	[1.30-3.63]	2.27	[1.59-3.24]
Place of residence				
Temporary housing	1.00		1.00	
Others	1.05	[0.82-1.35]	1.20	[0.99-1.45]
Living conditions				
Acceptable	1.00		1.00	
Somewhat poor	0.56	[0.42-0.74]	0.56	[0.45-0.69]
Poor	0.36	[0.27-0.48]	0.34	[0.27-0.43]
Physical activity and dietary intake [†]				
Group1	1.00		1.00	
Group2	1.13	[0.73-1.75]	1.23	[0.82-1.85]
Group3	1.84	[1.32-2.57]	1.82	[1.32-2.51]
Group4	1.96	[1.39-2.76]	1.94	[1.42-2.64]
Good mental health				
Age				
≥75	1.00		1.00	
65-74	0.97	[0.75-1.25]	0.98	[0.81-1.20]
55-64	1.24	[0.91-1.69]	0.82	[0.67-1.01]
45-54	0.91	[0.62-1.32]	0.91	[0.70-1.18]
<45	0.86	[0.58-1.25]	1.20	[0.91-1.57]
Place of residence				
Temporary housing	1.00		1.00	
Others	1.15	[0.93-1.42]	1.45	[1.26-1.68]
Living conditions				
Acceptable	1.00		1.00	
Somewhat poor	0.38	[0.30-0.48]	0.45	[0.38-0.53]
Poor	0.26	[0.20-0.33]	0.27	[0.23-0.33]
Physical activity and dietary intake [†]				
Group 1	1.00		1.00	
Group 2	1.07	[0.72-1.59]	1.03	[0.73-1.46]
Group 3	1.48	[1.10-1.97]	1.29	[0.98-1.69]
Group 4	1.86	[1.37-2.53]	1.42	[1.09-1.85]

[†]Physical activity and dietary intake: Group 1 (Poor physical activity and poor dietary intake), Group 2 (Poor physical activity and good dietary intake), Group 3 (Good physical activity and poor dietary intake), Group 4 (Good physical activity and good dietary intake)

factors in survivors of GEJE pointed out evacuation from home and poor self-rated health had negative impact on OHRQoL.¹⁴ It has been four years since the GEJE, but there were still 24,000 people living in temporary housing in Iwate Prefecture in September 2015.¹⁵ Further measures to improve the temporary residences and living conditions of survivors are needed. The present study revealed that physical activity and dietary intake are associated with better self-rated health and mental health. In addition, this study also revealed that age was related to physical activity and dietary intake. Murakami et al reported physical activity levels of the victims living in temporary housing in Iwate prefecture after GEJE after 1 year were lower than the other year of prefecture; but activity level of people aged 40-50 was better than older ones because it was thought of working activity.¹⁶ In this study, good physical activity and poor dietary intake group were more in people aged 44-54 than other age groups. There are some ongoing activities to support physical activity, good dietary intake and other needs of

survivors since the GEJE. The Miyagi prefectural government has released a report on such efforts.¹⁷ Cooking practice and dumbbell exercise for males and making one meal program for survivors who live in temporary housing are some of examples of the activities.¹⁷ Continuous efforts and programs that consider the age of survivors should be considered.

One of the limitations of this study was that we could not infer causal relationships because of the cross-sectional nature of the data collection. Health checkups and questionnaires have been implemented every year; therefore, it will be necessary to analyze longitudinal data in the future. Another limitation of this study was that we used short questionnaire to assess dietary intake. In the future study, using quantitative data for dietary intake will be more accurate to discuss situation about dietary intake of survivors.

In conclusion, this study examined the combined associations of physical activity and dietary intake on health, and suggested that both factors were associated with good

self-rated health and good mental health. Further interventions in physical activity and dietary intake are needed to improve health conditions of survivors.

ACKNOWLEDGMENTS

The authors wish to express their deepest appreciation to the study participants. The authors sincerely appreciate the efforts of the members of “The Project for the Health and Nutrition Survey after the Great Earthquake” of the National Institute of Health and Nutrition, National Institutes of Biomedical Innovation, Health and Nutrition. This study was supported by a Grant-in-Aid from the Ministry of Health and Labour Sciences Research Grants, Japan [H25-KENKI-Shitei-001].

AUTHOR DISCLOSURES

None of the authors has a personal or financial conflict of interest to declare.

REFERENCES

1. United States Department of Health and Human Services. Physical Activity Guidelines for Americans: Be Active, Healthy, and Happy! 2008. [cited 2015/12/10]; Available from: <http://health.gov/paguidelines/pdf/paguide.pdf>.
2. Kuriyama S, Nakaya N, Ohmori-Matsuda K, Shimazu T, Kikuchi N, Kakizaki M et al. Factors Associated With Psychological Distress in a Community-Dwelling Japanese Population: The Ohsaki Cohort 2006 Study. *J Epidemiol.* 2009;19:294-302. doi: 10.2188/jea.JE20080076.
3. Ansari WE, Suominen S, Berg-Beckhoff G. Is Healthier Nutrition Behaviour Associated with Better Self-Reported Health and Less Health Complaints? Evidence from Turku, Finland. *Nutrients.* 2015;7:8478-90. doi: 10.3390/nu7105409.
4. Kodama S, Fujii N, Furuhashi T, Sakurai N, Fujiwara Y, Hoshi T. Dietary quality and its structural relationships among equivalent income, emotional well-being, and a five-year subjective health in Japanese middle-aged urban dwellers. *Arch Public Health.* 2015;73:30. doi: 10.1186/s13690-015-0081-0.
5. Kobayashi S. Cohort Study for supporting survivors of Great East Japan Earthquake in Iwate Prefecture. Grant in Aid from the Ministry of Health, Labor and Welfare, Health and Labor Sciences Research Grants, Japan. [H25-Tokubutesu-Shitei-001(Fukkou)] 2015. (In Japanese)
6. Tomata Y, Sato N, Kogure M, Suto S, Imai Y, Aoki H, Sugiyama K, Suzuki R, Sugawara Y, Watanabe T, Nagatomi R, Tsuji I. Health effects of interventions to promote physical activity in survivors of the 2011 Great East Japan Earthquake. A longitudinal study. *Nihon koshu eisei zasshi.* 2015;62:66-72. doi: 10.11236/jph.62.2_66. (In Japanese)
7. Yabuki S, Ouchi K, Kikuchi S, Konno S. Pain, quality of life and activity in aged evacuees living in temporary housing after the Great East Japan earthquake of 11 March 2011: a cross-sectional study in Minamisoma City, Fukushima prefecture. *BMC Musculoskelet Disord.* 2015;16:246. doi: 10.1186/s12891-015-0711-2
8. Tsuboyama-Kasaoka N, Purba MB. Nutrition and earthquakes: experience and recommendations. *Asia Pac J Clin Nutr.* 2014;23:505-513. doi: 10.6133/apjcn.2014.23.4.23
9. Murakami H, Yoshimura E, Ishikawa-Takata K, Hasegawa Y, Kubota T, Tsuboyama-Kasaoka N et al. Validity and reproducibility of a physical activity questionnaire used for health surveying among victims of the Great East Japan Earthquake. *Nihon koshu eisei zasshi.* 2013;60:222-30. doi: 10.11236/jph.60.4_222. (In Japanese)
10. Yoshimura E, Hasegawa Y, Murakami H, Nozue M, Sarukura N, Nakade M et al. Dietary intake among survivors of the Great East Japan Earthquake live in temporary housing. *Iwate Journal of Public Health.* 2014;25:7-14. (In Japanese)
11. Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SL, Walters EE, Zaslavsky AM. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med.* 2002;32:959-76.
12. Furukawa TA, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. *Psychol Med.* 2003;33:357-62.
13. Furukawa TA, Kawakami N, Saitoh M, Ono Y, Nakane Y, Nakamura Y et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res.* 2008;17:152-58.
14. Kishi M, Aizawa F, Matsui M, Yokoyama Y, Abe A, Minami K, Suzuki R, Miura H, Sakata K, Ogawa A. Oral health-related quality of life and related factors among residents in a disaster area of the Great East Japan Earthquake and giant tsunami. *Health Qual Life Outcomes.* 2015;13:143. doi: 10.1186/s12955-015-0339-9
15. Iwate Prefectural Office. Situations of temporary housing among survivors. 2015. [cited 2015/12/10]; Available from: <http://www.pref.iwate.jp/saiken/sumai/023870.html>.
16. Murakami H, Yoshimura E, Takata K, Nishi N, Tsuboyama-Kasaoka N, Yokoyama Y, Yaegashi Y, Sakata K, Kobayashi S, Miyachi M. The longitudinal change in physical activity among Great East Japan Earthquake victims living in temporary housing. *Nihon Koshu Eisei Zasshi.* 2014;61:86-92. doi: 10.11236/jph.61.2_86. (In Japanese)
17. Miyagi Prefectural Government. Cases of efforts to support survivors of Great East Japan Earthquake. 2013. [cited 2015/12/10]; Available from: <http://www.pref.miyagi.jp/soshiki/hohusom/jirei.html#kenko>.