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#### Radiation-related Anxiety among Public Health Nurses in the Fukushima Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station

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Complete List of Authors:	Yoshida, Koji; Nagasaki University Graduate School of Biomedical Sciences, Health Sciences; Fukushima Medical University, Education Center for Disaster Medicine Orita, Makiko; Atomic Bomb Disease Institute, Nagasaki University, , Global Health, Medicine and Welfare Goto, Aya; Fukushima Medical University, Integrated Science and Humanities Kumagai, Atsushi; Fukushima Medical University, Education Center for Disaster Medicine Yasui, Kiyotaka; Fukushima Medical University, Education Center for Disaster Medicine Ohtsuru, Akira; Fukushima Medical University, Radiation Health Management Hayashida, Naomi ; Atomic Bomb Disease Institute, Nagasaki University, Promotion of Collaborative Research on Radiation and Environment Health Effects Kudo, Takashi; Atomic Bomb Disease Institute, Nagasaki University, Radioisotope Medicine Yamashita, Shunichi ; Atomic Bomb Disease Institute, Nagasaki University, Radiation Medical Sciences Takamura, Noboru; Atomic Bomb Disease Institute, Nagasaki University, Radiation Medical Sciences
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1	Radiation-related Anxiety among Public Health Nurses in the Fukushima
2	Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station
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4	Koji Yoshida <sup>1,2*</sup> , Makiko Orita <sup>3</sup> , Aya Goto <sup>4</sup> , Atsushi Kumagai <sup>2</sup> , Kiyotaka Yasui <sup>2</sup> , Akira
5 6	Ohtsuru <sup>5</sup> , Naomi Hayashida <sup>6</sup> , Takashi Kudo <sup>7</sup> , Shunichi Yamashita <sup>8</sup> , Noboru Takamura <sup>3</sup>
7	1 Department of Health Sciences, Nagasaki University Graduate School of Biomedical Sciences Nagasaki Japan
9	2 Education Center for Disaster Medicine, Fukushima Medical University, Fukushima,
10	Japan
11	3 Department of Global Health, Medicine and Welfare, Atomic Bomb Disease Institute,
12	Nagasaki University, Nagasaki, Japan
13	4 Center for Integrated Science and Humanities, Fukushima Medical University,
14	Fukushima, Japan
15	5 Department of Radiation Health Management, Fukushima Medical University School
16	of Medicine, Fukushima, Japan
17	6 Division of Promotion of Collaborative Research on Radiation and Environment
18	Health Effects, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan
19	7 Department of Radioisotope Medicine, Atomic Bomb Disease Institute, Nagasaki
20	University, Nagasaki, Japan
21	8 Department of, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan
	1

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- \*Corresponding author
- Koji Yoshida, R.N, Ph.D.
- Department of Health Sciences, Nagasaki University Graduate School of Biomedical
- Sciences, Nagasaki, Japan
- 1-7-1 Sakamoto, Nagasaki 850-8520, Japan
- Email: <u>koujiy@nagasaki-u.ac.jp</u> (KY)
- TEL: +81-95-819-7195 )5

### 31 Abstract

Objective: In Japan, public health nurses (PHNs) play important roles in managing the health of local residents, especially after a disaster. In this study, we assessed radiation anxiety and the stress processing capacity of PHNs in the Fukushima Prefecture in Japan, after the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS).

Methods: We conducted a questionnaire survey among the PHNs (n=430) in July of 2015 via mail by post. The questions included demographic factors (sex, age, and employment position), knowledge about radiation, degree of anxiety about radiation at the time of the FDNPS accident (and at present), when answering the questions about radiation, and the Sense of Coherence-13 (SOC-13). We classified the low and high levels of anxiety when answering questions about radiation, and compared the anxiety-negative (-) group with the anxiety-positive (+) group. BMJ Open: first published as 10.1136/bmjopen-2016-013564 on 24 October 2016. Downloaded from http://bmjopen.bmj.com/ on June 13, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

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Results: Of the PHNs, 269 (62.6%) were classified in the anxiety (-) group and 161 (37.4%) were in the anxiety (+) group. When the multivariate logistic regression analysis was conducted, the PHNs at the time of the accident (OR: 2.37, p=0.007), current general anxieties about radiation (OR: 3.56, p<0.001), current possession of materials to obtain knowledge about radiation (OR: 2.11, p=0.006), and knowledge of the childhood thyroid cancer increase after the Chernobyl accident (OR: 1.69, p=0.035) were significantly associated with anxiety after the FDNPS accident. The mean SOC-13 was  $43.0\pm7.7$ , with no significant difference between anxiety (-) group and anxiety (+) group (p=0.47).

52	Conclusions: Our study suggested that anxiety about radiation was associated with
53	materials and knowledge about radiation in the PHNs of Fukushima Prefecture four
54	years after the FDNPS accident. It is important for PHNs to obtain knowledge and
55	teaching materials about radiation, and radiation education programs for PHNs must be
56	established in areas that have nuclear power stations and other nuclear facilities.
57	
58	Keywords: public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power
59	Station, Sense of Coherence-13
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61	Strengths and limitations of this study
62	• We could assess radiation anxiety and the stress processing capacity of PHNs in the
63	Fukushima Prefecture in Japan, after the accident at the FDNPS.
64	• We believe that this study regarding the PHNs' situation in the Fukushima Prefecture
65	four years after the FDNPS disaster will be very important in the provision of future
66	support.
67	• We could not obtain sufficient information on the anxiety-related factors, such as
68	detailed consultation contents and other information.
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	<u>,</u>
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#### 71 Introduction

On March 11, 2011, the Great East Japan Earthquake struck the east coast of Japan. This large earthquake and tsunami caused immense damage, including that to the Fukushima Daiichi Nuclear Power Station (FDNPS) [1-4]. After the accident at the FDNPS, the Fukushima prefectural government immediately issued instructions for the evacuation of those areas within a 20 km radius of the FDNPS, and they also instructed sheltering in the areas between 20 km and 30 km from the FDNPS. Beyond the 30 km radius, additional areas were designated "deliberate evacuation areas" if there was concern that the cumulative doses of radiation might reach 20 mSy per year in those areas [2]. Despite the low estimated and measured external and internal exposure doses just after the accident, many residents of the Fukushima Prefecture evacuated inside or outside the prefecture [5-8]. 

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In the report by the World Health Organization (WHO) on the health impacts 20 years after the Chernobyl accident, mental health was described as the most serious public health problem resulting from that nuclear accident [9-11]. Based on the lessons learned from the Chernobyl accident, the Fukushima Health Management Survey (FHMS) was initiated to assess the health impacts, including mental health, of the residents by the Fukushima prefectural government and the Fukushima Medical University [12, 13]. According to the results of this survey, the residents of the Fukushima Prefecture were exposed to a higher risk of not only physical problems, such as diabetes and obesity, but also mental problems (including the risk perception of the

health effects of radiation) [14, 15].

93	In Japan, public health nurses (PHNs) play important roles in managing the health
94	of local residents, especially after this disaster. While they were themselves victims of
95	the radiation disaster, they had to respond to the residents' anxieties about radiation
96	exposure, despite their lack of professional knowledge on this topic.
97	In this study, we conducted a survey to clarify the radiation anxiety and stress
98	processing capacity of the PHNs in the Fukushima Prefecture, after the nuclear accident
99	at the FDNPS.
100	
101	Materials and Methods
102	Study population and data collection
103	We conducted a questionnaire survey among the PHNs in the Fukushima
104	Prefecture located in Northeastern Japan, which was severely affected by the earthquake,
105	tsunami, and FDNPS accident following the Great East Japan Earthquake in 2011. The
106	survey was conducted in July of 2015 via mail by post, and contained questions about
107	the demographic factors (sex, age, activity area, and employment position) and
108	knowledge of the PHNs about radiation before and after the accident at the FDNPS, as
109	well as their degree of anxiety about radiation at the time of the FDNPS accident (and at
110	present), and their mental health status. The degree of anxiety was rated on a 10-point
111	Likert scale ranging from no anxiety to having a lot of anxiety; we defined 1-5 as
112	"anxiety (-)" and 6-10 as "anxiety (+)."

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To measure the PHNs' stress management capability, we used the Japanese version of the Sense of Coherence-13 (SOC-13). The SOC-13 consists of three dimensions (comprehensibility, manageability, and meaningfulness) that are equally weighted to create an overall (total) score. The score ranges from 7-91, with a higher score representing a stronger sense of coherence [16].

#### 119 Statistical analysis

We classified the low and high levels of anxiety when answering the questions about radiation, and compared the anxiety (-) group and anxiety (+) group by using the chi-square test and t-test as univariate analyses. A multiple logistic regression analysis was then used to calculate the odds ratio (OR), and its 95% confidence interval (95% CI) was used to identify the factors independently associated with the anxiety level. A p-value of less than 0.05 was considered to be significant, and the statistical analysis was performed using SPSS Statistics 22.0 (IBM Japan, Tokyo, Japan).

#### 128 Ethics statement

129 This study was approved by the ethics committee of the Fukushima Medical 130 University (No. 2251), and conducted in accordance with the guidelines specified in the 131 Declaration of Helsinki.

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sults

134	A total of 458 PHNs responded to the survey, and 430 of those PHNs (93.9%)
135	completed all of the questions. The number of women was 416 (96.7%), and 153
136	(35.6%) were 50 years old or older. The number of PHNs with less than 10 years of
137	working experience was 124 (22.8%), and 306 (71.2%) had ten years or more. There
138	were 119 participants (27.7%) with managerial positions. At the time of the accident,
139	330 (76.8%) worked as PHNs and 62 (14.4%) were still in training. The number of
140	those in Hamadori, which became the evacuation area of the FDNPS accident, was 83
141	(19.3%) (Table 1).

#### Table 1. Basic characteristics of the study participants.

Variable		Number (%)
Gender	Women	416(96.7)
	Men	14(3.3)
Age	20-29 years old	92(21.4)
	30-39 years old	72(16.7)
	40-49 years old	113(26.3)
	≥50 years old	153(35.6)
Tenure as a public health nurse	<10 years	124(28.8)
	$\geq 10$ years	306(71.2)
Nursing experience in a hospital	Yes	149(34.7)
	No	281(65.3)
Activity area	Hamadori	83(19.3)
	Other area (Nakadori, Aizu et al.)	347(80.7)
Position in the workplace	Manager (director, chief)	119(27.7)
	Staff	311(72.3)
Occupation at the time of the	Public health nurse	330(76.8)
accident	Other occupations (mostly nurses)	38(8.8)
	Students	62(14.4)

145	Of the PHNs, 269 were classified in the anxiety (-) group and 161 were in the
146	anxiety (+) group (Table 2). A significantly higher ratio of PHNs younger than 40 years
147	old was observed in the anxiety (+) group (p<0.001, Table 2). Likewise, higher ratios of
148	PHNs with less than 10 years of working experience, staff positions, and nursing
149	licenses were observed in the anxiety (+) group (p<0.001, respectively, Table 2). On the
150	other hand, no significant differences were observed between the two groups in the
151	activity area, education curriculum, and seminars before or after the accident (p=0.62,
152	p=0.16, p=0.60, and p=0.13, respectively, Table 2). In addition, there was no significant
153	difference in the mean points in the SOC-13 observed between the two groups (p=0.47,
154	Table 2).

#### 156 Table 2. Participant's demographic factors, educational history, and mental health

		Anxiety (-)	Anxiety (+)	
Variable	Unit			p-values
		(n=269) (%)	(n=161) (%)	
Gender	Women/	262(97.4)/	154(95.7)/	0.32
	Men	7(2.6)	7(4.3)	0.52
Age	<40 years old/	77(28.6)/	87(54.0)/	<0.001
	$\geq$ 40 years old	192(71.4)	74(46.0)	<0.001
Working experience as a public	<10 years/	53(19.7)/	71(44.1)/	<0.001
health nurse	$\geq 10$ years	216(80.3)	90(55.9)	<0.001
Activity area	Hamadori/	54(20.1)/	29(18.0)/	0.62
	Other area	215(79.9)	132(72.0)	0.02
Position in the workplace	Manager/	88(32.7)/	31(19.3)/	0.003
	Staff	181(67.3)	130(80.7)	0.005
Occupation at the time of the	PHNs/	220(85 5)/	100(62 1)/	
accident	Others (nurses,	230(83.3)/	100(02.1)/	< 0.001
	students)	39(14.3)	01(37.9)	

#### 157 via anxiety with regard to questions about radiation after the FNPS accident.

Did you have children ≤15				
years old at the time of the	Yes	110(40.9)	59(36.6)	0.42
accident?				
Education history in	Yes	114(42.4)	80(49.7)	0 16
curriculum	105	111(1211)	00(19.7)	0.10
Education history in seminar	Vac	25(0,3)	12(7.5)	0.60
before the accident	105	23(9.3)	12(7.3)	0.00
Education history in seminar	V	247(01.8)	140(07.0)	0.12
after the accident	Yes	247(91.8)	140(87.0)	0.13
Frequency of participation in	Once/	47(19.0)/	42(29.6)/	0.02
seminars	Plural	200(81.0)	98(70.4)	0.02
SOC-13 total points	Mean	44.0	41.4	0.47
Frequency of participation in seminars SOC-13 total points	Once/ Plural Mean	47(19.0)/ 200(81.0) 44.0	42(29.6)/ 98(70.4) 41.4	0.02 0.47

In the anxiety (+) group, the ratio of those having current anxiety about radiation was significantly higher than that in the anxiety (-) group (p < 0.001, Table 3). On the other hand, in the anxiety (-) group, the ratios with difficulty answering the questions about radiation, currently having the materials to obtain knowledge about radiation, and having knowledge about childhood thyroid cancer increases after the Chernobyl accident were significantly higher than in the anxiety (+) group (p < 0.05, p < 0.01, and p < 0.05, respectively, Table 3). However, there were no significant changes between the two groups in the anxiety about radiation at the time of the accident and the recognition of health effects (such as late effects and genetic effects) due to radiation exposure (p=0.68, p=0.79, and p=0.20, respectively, Table 3).

Table 3. Participants' anxiety, recognition, and knowledge about radiation via
anxiety with regard to answering the questions about radiation after the FDNPS
accident.

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Question	Unit	Anxiety (-)	Anxiety (+)	n values
Question	Olin	(n=269) (%)	(n=161) (%)	p-values
Degree of anxiety about radiation at the time of the FDNPS accident	anxiety (-)/ anxiety (+)	99(36.8)/ 170(63.2)	56(34.8)/ 105(65.2)	0.68
Degree of anxiety about radiation currently	anxiety (-)/ anxiety (+)	251(93.3)/ 18(6.7)	130(80.7)/ 31(19.3)	< 0.001
Do you think that delayed effects such as malignancies occur due to radiation exposure following the Fukushima accident?	Yes	37(13.8)	33(20.5)	0.79
Do you think that genetic effects in offspring occur due to radiation exposure following the Fukushima accident?	Yes	33(12.3)	27(16.8)	0.20
Did you have a difficult time answering the questions about radiation?	Yes	216(80.3)	115(71.4)	0.04
Did you have the materials to obtain knowledge about radiation at the time of the accident?	Yes	87(32.3)	40(24.8)	0.10
Do you currently have the materials to obtain knowledge about radiation?	Yes	233(86.6)	118(73.3)	0.01
Did you know about the three principles of radiation protection?	Yes	64(23.8)	42(26.1)	0.64
Did you know about the annual dose limit for the general public?	Yes	20(12.4)	11(6.8)	0.99
Did you know about the half-life of radioactive substances?	Yes	129(48.0)	77(47.8)	0.99
Did you know about childhood thyroid cancer increases after the Chernobyl accident?	Yes	213(79.2)	109(67.7)	0.01

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When the logistic regression analysis was conducted, following the adjustment for confounding factors, being a PHN at the time of the accident (OR: 2.37, p<0.01), current general anxieties about radiation (OR: 3.56, p<0.001), currently having the materials to obtain knowledge about radiation (OR: 2.11, p<0.01), and having

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178 knowledge about childhood thyroid cancer increases after the Chernobyl accident (OR:
179 1.69, p=0.04) were all significantly associated with anxiety after the FDNPS accident

180 (Table 4).

## 182 Table 4. Odds ratios and 95% confidence intervals of the study variables for 183 anxiety (+) when answering questions about radiation, as assessed by the logistic

#### 184 regression analysis.

Variable	Unit	Odds ratio	95% confidence interval	p-value
Age	≥40 years old	0.64	0.36-1.15	0.13
Manager in the workplace	No	1.14	0.65-2.00	0.66
Public health nurse at the time of the accident	No	2.37	1.27-4.42	< 0.01
Current degree of anxiety about radiation	anxiety (+)	3.56	1.82-6.96	< 0.001
Difficulty answering radiation questions in the past	No	1.27	0.76-2.12	0.37
Currentlyhavematerialstoknowledgeaboutradiation	No	2.11	1.248-3.60	<0.01
Knowledge about childhood thyroid cancer increase after the Chernobyl accident	No	1.69	1.04-2.75	0.04

#### **Discussion**

This study was conducted four years after the FDNPS disaster to provide educational support for PHNs who receive many consultations from residents. In univariate analysis, younger and inexperienced PHNs had higher anxiety with regard to communicating with residents about radiation. When adjusting for other variables, those PHNs who were students at the time of the accident had higher anxiety when communicating with residents about radiation. Our results suggested that experience as a professional during the FDNPS accident is important. Although many of the PHNs had knowledge about the Chernobyl accident, they could not properly communicate the health effects of radiation with the residents, which caused anxiety in the residents after the accident at the FDNPS. In addition, our results showed that having the materials to obtain knowledge about radiation was independently associated with anxiety about the FDNPS accident. 

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These results suggest that continuous effort is necessary to provided education and materials among the PHNs in the Fukushima Prefecture for them to gain knowledge about radiation, including the health effects caused by radiation exposure [17]. Some education initiatives have been undertaken in the prefecture after the nuclear accident, which includes Fukushima Medical University's disaster education for undergraduates and health literacy training for public health nurses for field practitioners [18, 19]. Appropriate and sustainable allocation of financial and human resources is needed to continue and expand such activities.

The SOC-13 was employed to estimate the stress management capability of the

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PHNs in this study. There was no significant difference in the mean points in the SOC-13 observed between the anxiety (-) group and anxiety (+) group. This result, as well as other study, may suggest that factor of lifestyle related [20]. On the other hand, Eriksson et al. showed that individuals with high scores in the SOC-13 are better able to cope with chronic stress than those with low scores [21]. In other studies, the average points of the nursing students at two Japanese universities were  $50.2\pm7.7$  and  $53.8\pm10.7$ , respectively [22, 23], and the average score of elderly individuals in the Nagasaki Prefecture in Japan was 45.0 [24]. In this study, the average score ( $43.0\pm7.7$ ) was lower than those in other studies, and it was substantially lower when compared to those of nursing students. Accordingly, there is a need for planning of stress management capacity improvement for the PHNs in Fukushima Prefecture with low SOC score.

The correspondence of the disaster affected the stress management capability, and might cause a worsening of chronic stress. According to the FHMS, which includes monitoring the mental health and daily lives of Fukushima residents and providing proper care for them, the mental health status of the residents in the Fukushima Prefecture was very poor [13]. Thus, the mental health of the residents was greatly affected by the disaster, and a similar impact could be expected from the PHNs who work in the Fukushima Prefecture. Therefore, mental support is important for the PHNs, as well as for the residents of the Fukushima Prefecture. 

The present study has several limitations. For example, we could not obtain sufficient information on the anxiety-related factors, such as detailed consultation

contents and other information. However, we believe that this study regarding the PHNs' 229230situation in the Fukushima Prefecture four years after the FDNPS disaster will be very 231important in the provision of future support. In conclusion, we conducted a survey of the radiation anxiety and stress 232processing capacity of PHNs in the Fukushima Prefecture four years after the nuclear 233accident at the FDNPS, and determined that it is important for PHNs to obtain 234knowledge and teaching materials about radiation. In addition to Fukushima, radiation 235education programs for PHNs must be established in areas that have nuclear power 236237stations and other nuclear facilities. 238239Footnotes 240Contributorship statement 241• Koji Yoshida conceived and designed the experiments, analyzed the data, wrote the 242paper, prepared Tables. · Makiko Orita, Akira Ohtsuru, Aya Goto, Atsushi Kumagai and Kiyotaka Yasui 243244contributed materials, reviewed drafts of the paper. 245• Naomi Hayashida, Takashi Kudo, and Shunichi Yamashita designed the experiments, reviewed drafts of the paper. 246Noboru Takamura conceived and designed the experiments, wrote the paper, 247reviewed drafts of the paper. 248249

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#### *Competing interests*

There are no competing interests

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- Data sharing statement
- e available. No additional data are available.

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#### Radiation-related Anxiety among Public Health Nurses in the Fukushima Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station

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SCHOLARONE<sup>™</sup> Manuscripts

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1	Radiation-related Anxiety among Public Health Nurses in the Fukushima
2	Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station
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4	Koji Yoshida <sup>1,2*</sup> , Makiko Orita <sup>3</sup> , Aya Goto <sup>4</sup> , Atsushi Kumagai <sup>2</sup> , Kiyotaka Yasui <sup>2</sup> , Akira
5	Ohtsuru <sup>5</sup> , Naomi Hayashida <sup>6</sup> , Takashi Kudo <sup>7</sup> , Shunichi Yamashita <sup>8</sup> , Noboru Takamura <sup>3</sup>
6	
7	1 Department of Health Sciences, Nagasaki University Graduate School of Biomedica
8	Sciences, Nagasaki, Japan
9	2 Education Center for Disaster Medicine, Fukushima Medical University, Fukushima
10	Japan
11	3 Department of Global Health, Medicine and Welfare, Atomic Bomb Disease Institute
12	Nagasaki University, Nagasaki, Japan
13	4 Center for Integrated Science and Humanities, Fukushima Medical University
14	Fukushima, Japan
15	5 Department of Radiation Health Management, Fukushima Medical University School
16	of Medicine, Fukushima, Japan
17	6 Division of Promotion of Collaborative Research on Radiation and Environment
18	Health Effects, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan
19	7 Department of Radioisotope Medicine, Atomic Bomb Disease Institute, Nagasak
20	University, Nagasaki, Japan
21	8 Department of, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan

- \*Corresponding author
- Koji Yoshida, R.N, Ph.D.
- Department of Health Sciences, Nagasaki University Graduate School of Biomedical
- Sciences, Nagasaki, Japan
- 1-7-1 Sakamoto, Nagasaki 850-8520, Japan
- Email: <u>koujiy@nagasaki-u.ac.jp</u> (KY)
- TEL: +81-95-819-7195 '5

31	Abstract
01	1 10 Sti uct

Objective: In Japan, public health nurses (PHNs) play important roles in managing the health of local residents, especially after a disaster. In this study, we assessed radiation anxiety and the stress processing capacity of PHNs in the Fukushima Prefecture in Japan, after the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS).

Methods: We conducted a questionnaire survey among the PHNs (n=430) in July of 2015 via mail by post. The questions included demographic factors (sex, age, and employment position), knowledge about radiation, degree of anxiety about radiation at the time of the FDNPS accident (and at present), by asking them to answer questions about radiation, and the Sense of Coherence-13 (SOC-13). We classified the low and high levels of anxiety by asking them to answer questions about radiation, and compared the anxiety-negative (-) group with the anxiety-positive (+) group.

Results: Of the PHNs, 269 (62.6%) were classified in the anxiety (-) group and 161 (37.4%) were in the anxiety (+) group. When the multivariate logistic regression analysis was conducted, the PHNs at the time of the accident (OR: 2.37, p=0.007), current general anxieties about radiation (OR: 3.56, p<0.001), current possession of materials to obtain knowledge about radiation (OR: 2.11, p=0.006), and knowledge of the childhood thyroid cancer increase after the Chernobyl accident (OR: 1.69, p=0.035) were significantly associated with anxiety after the FDNPS accident. The mean SOC-13 was  $43.0\pm7.7$ , with no significant difference between anxiety (-) group and anxiety (+) group (p=0.47).

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52	Conclusions: Our study suggested that anxiety about radiation was associated with
53	materials and knowledge about radiation in the PHNs of Fukushima Prefecture four
54	years after the FDNPS accident. It is important for PHNs to obtain knowledge and
55	teaching materials about radiation, and radiation education programs for PHNs must be
56	established in areas that have nuclear facilities.
57	
58	Keywords: public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power
59	Station, Sense of Coherence-13
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61	Strengths and limitations of this study
62	• We could assess radiation anxiety and the stress processing capacity of PHNs in the
63	Fukushima Prefecture in Japan, after the accident at the FDNPS.
64	• We believe that this study regarding the PHNs' situation in the Fukushima Prefecture
65	four years after the FDNPS disaster will be very important in the provision of future
66	support.
67	• We could not obtain sufficient information on the anxiety-related factors, such as
68	detailed consultation contents and other information.
69	• We were not able to gather sufficient information on stress management factors, such
70	as family issues and marital status.
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#### 72 Introduction

On March 11, 2011, the Great East Japan Earthquake struck the east coast of Japan. This large earthquake and tsunami caused immense damage, including that to the Fukushima Daiichi Nuclear Power Station (FDNPS) [1-4]. After the accident at the FDNPS, the Fukushima prefectural government immediately issued instructions for the evacuation of those areas within a 20 km radius of the FDNPS, and they also instructed sheltering in the areas between 20 km and 30 km from the FDNPS. Beyond the 30 km radius, additional areas were designated "deliberate evacuation areas" if there was concern that the cumulative doses of radiation might reach 20 mSy per year in those areas [2]. Despite the low estimated and measured external and internal exposure doses just after the accident, many residents of the Fukushima Prefecture evacuated inside or outside the prefecture [5-8]. 

In the report by the World Health Organization (WHO) on the health impacts 20 years after the Chernobyl accident, mental health was described as the most serious public health problem resulting from that nuclear accident [9-11]. Based on the lessons learned from the Chernobyl accident, the Fukushima Health Management Survey (FHMS) was initiated to assess the health impacts, including mental health, of the residents by the Fukushima prefectural government and the Fukushima Medical University [12, 13]. According to the results of this survey, the residents of the Fukushima Prefecture were exposed to a higher risk of not only physical problems, such as diabetes and obesity, but also mental problems (including the risk perception of the

health effects of radiation) [14, 15].

In Japan, public health nurses (PHNs) hold a national license, and many PHNs work for prefectural and municipal bodies, enabling them to provide community health services such as health guidance, home visits, and health education to local residents. In other words, they play important roles in managing the health of local residents, including the time after this disaster. While they were themselves victims of the radiation disaster, they had to respond to the residents' anxieties about radiation exposure, despite their lack of professional knowledge on this topic.

In this study, we conducted a survey to clarify the radiation anxiety and stress
 processing capacity of the PHNs in the Fukushima Prefecture, after the nuclear accident
 at the FDNPS.

#### 105 Materials and Methods

#### 106 Study population and data collection

We conducted a questionnaire survey among the PHNs in the Fukushima Prefecture located in Northeastern Japan, which was severely affected by the earthquake, tsunami, and FDNPS accident following the Great East Japan Earthquake in 2011. The survey was conducted in July of 2015 via mail by post, and contained questions about the demographic factors (sex, age, activity area, and employment position) and knowledge of the PHNs about radiation before and after the accident at the FDNPS, and their mental health status. In addition, we examined their degree of anxiety about

radiation at the time of the FDNPS accident, and at present, by asking them to answer questions about radiation at present. The degree of anxiety was rated on a 10-point Likert scale ranging from no anxiety to having a lot of anxiety; we defined 1-5 as "anxiety (-)" and 6-10 as "anxiety (+)."

To measure the PHNs' stress management capability, we used the Japanese version of the Sense of Coherence-13 (SOC-13). The SOC-13 consists of three dimensions (comprehensibility, manageability, and meaningfulness) that are equally weighted to create an overall (total) score. The score ranges from 7-91, with a higher score representing a stronger sense of coherence [16].

#### 124 Statistical analysis

We classified the low and high levels of anxiety by asking them to answer questions about radiation, and compared the anxiety (-) group and anxiety (+) group by using the chi-square test and t-test as univariate analyses. A multiple logistic regression analysis was then used to calculate the odds ratio (OR), and its 95% confidence interval (95% CI) was used to identify the factors independently associated with the anxiety level. A p-value of less than 0.05 was considered to be significant, and the statistical analysis was performed using SPSS Statistics 22.0 (IBM Japan, Tokyo, Japan). BMJ Open: first published as 10.1136/bmjopen-2016-013564 on 24 October 2016. Downloaded from http://bmjopen.bmj.com/ on June 13, 2025 at Agence Bibliographique de l Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

#### 133 Ethics statement

This study was approved by the ethics committee of the Fukushima Medical

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135 University (No. 2251), and conducted in accordance with the guidelines specified in the

138	Results
139	A total of 458 PHNs responded to the survey, and 430 of those PHNs (93.9%)
140	completed all of the questions. The number of women was 416 (96.7%), and 153
141	(35.6%) were 50 years old or older. The number of PHNs with less than 10 years of
142	working experience was 124 (22.8%), and 306 (71.2%) had ten years or more. There
143	were 119 participants (27.7%) with managerial positions. At the time of the accident,
144	330 (76.8%) worked as PHNs and 62 (14.4%) were still in training. The number of
145	those in Hamadori, which became the evacuation area of the FDNPS accident, was 83
146	(19.3%) (Table 1).

#### Table 1. Basic characteristics of the study participants.

Variable		Number (%)
Gender	Women	416(96.7)
	Men	14(3.3)
Age	20-29 years old	92(21.4)
	30-39 years old	72(16.7)
	40-49 years old	113(26.3)
	$\geq$ 50 years old	153(35.6)
Tenure as a public health nurse	<10 years	124(28.8)
	$\geq 10$ years	306(71.2)
Nursing experience in a hospital	Yes	149(34.7)
	No	281(65.3)
Activity area	Hamadori	83(19.3)
	Other area (Nakadori, Aizu et al.)	347(80.7)
Position in the workplace	Manager (director, chief)	119(27.7)
_	Staff	311(72.3)
Occupation at the time of the	Public health nurse	330(76.8)
accident	Other occupations (mostly nurses)	38(8.8)
	Students	62(14.4)

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150	Of the PHNs, 269 were classified in the anxiety (-) group and 161 were in the
151	anxiety (+) group (Table 2). A significantly higher ratio of PHNs younger than 40 years
152	old was observed in the anxiety (+) group (p<0.001, Table 2). Likewise, higher ratios of
153	PHNs with less than 10 years of working experience, staff positions, and nursing
154	licenses were observed in the anxiety (+) group (p<0.001, respectively, Table 2). On the
155	other hand, no significant differences were observed between the two groups in the
156	activity area, education curriculum, and seminars before or after the accident (p=0.62,
157	p=0.16, p=0.60, and p=0.13, respectively, Table 2). In addition, there was no significant
158	difference in the mean points in the SOC-13 observed between the two groups (p=0.47,
159	Table 2).

#### 161 Table 2. Participant's demographic factors, educational history, and mental health

		Anxiety (-)	Anxiety (+)	
Variable	Unit			p-values
		(n=269) (%)	(n=161) (%)	
Gender	Women/	262(97.4)/	154(95.7)/	0.32
	Men	7(2.6)	7(4.3)	0.52
Age	<40 years old/	77(28.6)/	87(54.0)/	<0.001
	$\geq$ 40 years old	192(71.4)	74(46.0)	<0.001
Working experience as a public	<10 years/	53(19.7)/	71(44.1)/	<0.001
health nurse	$\geq 10$ years	216(80.3)	90(55.9)	<0.001
Activity area	Hamadori/	54(20.1)/	29(18.0)/	0.62
	Other area	215(79.9)	132(72.0)	0.02
Position in the workplace	Manager/	88(32.7)/	31(19.3)/	0.003
	Staff	181(67.3)	130(80.7)	0.005
Occupation at the time of the	PHNs/	220(85 5)/	100(62 1)/	
accident	Others (nurses,	230(83.3)/	100(02.1)/	< 0.001
	students)	39(14.3)	61(37.9)	

#### 162 via anxiety with regard to questions about radiation after the FNPS accident.

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Did vou have children <15				
years old at the time of the accident?	Yes	110(40.9)	59(36.6)	0
Education history in curriculum	Yes	114(42.4)	80(49.7)	0
Education history in seminar before the accident	Yes	25(9.3)	12(7.5)	0
Education history in seminar after the accident	Yes	247(91.8)	140(87.0)	0
Frequency of participation in	Once/	47(19.0)/	42(29.6)/	0
seminars	Plural	200(81.0)	98(70.4)	0
SOC-13 total points	Mean	44.0	41.4	0

In the anxiety (+) group, the ratio of those having current anxiety about radiation was significantly higher than that in the anxiety (-) group (p < 0.001, Table 3). On the other hand, in the anxiety (-) group, the ratios with difficulty answering the questions about radiation, currently having the materials to obtain knowledge about radiation, and having knowledge about childhood thyroid cancer increases after the Chernobyl accident were significantly higher than in the anxiety (+) group (p < 0.05, p < 0.01, and p < 0.05, respectively, Table 3). However, there were no significant changes between the two groups in the anxiety about radiation at the time of the accident and the recognition of health effects (such as late effects and genetic effects) due to radiation exposure (p=0.68, p=0.79, and p=0.20, respectively, Table 3).

Table 3. Participants' anxiety, recognition, and knowledge about radiation via
anxiety with regard to answering the questions about radiation after the FDNPS
accident.

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	<b>T</b> T <b>1</b>	Anxiety (-)	Anxiety (+)		
Question	Unit	(n=269) (%)	(n=161) (%)	p-values	
Degree of anxiety about radiation at the time of the EDNIPS accident	anxiety (-)/	99(36.8)/ 170(63.2)	56(34.8)/	0.68	
Degree of anxiety about radiation currently	anxiety (+) anxiety (-)/ anxiety (+)	170(03.2) 251(93.3)/ 18(6.7)	130(80.7)/ 31(19.3)	< 0.001	
Do you think that delayed effects such as malignancies occur due to radiation exposure following the Fukushima accident?	Yes	37(13.8)	33(20.5)	0.79	
Do you think that genetic effects in offspring occur due to radiation exposure following the Fukushima accident?	Yes	33(12.3)	27(16.8)	0.20	
Did you have a difficult time answering the questions about radiation?	Yes	216(80.3)	115(71.4)	0.04	
Did you have the materials to obtain knowledge about radiation at the time of the accident?	Yes	87(32.3)	40(24.8)	0.10	
Do you currently have the materials to obtain knowledge about radiation?	Yes	233(86.6)	118(73.3)	0.01	
Did you know about the three principles of radiation protection?	Yes	64(23.8)	42(26.1)	0.64	
Did you know about the annual dose limit for the general public?	Yes	20(12.4)	11(6.8)	0.99	
Did you know about the half-life of radioactive substances?	Yes	129(48.0)	77(47.8)	0.99	
Did you know about childhood thyroid cancer increases after the Chernobyl accident?	Yes	213(79.2)	109(67.7)	0.01	

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When the logistic regression analysis was conducted, following the adjustment for confounding factors, being a PHN at the time of the accident (OR: 2.37, p<0.01), current general anxieties about radiation (OR: 3.56, p<0.001), currently having the materials to obtain knowledge about radiation (OR: 2.11, p<0.01), and having

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183 knowledge about childhood thyroid cancer increases after the Chernobyl accident (OR:
1.69, p=0.04) were all significantly associated with anxiety after the FDNPS accident
185 (Table 4).

# Table 4. Odds ratios and 95% confidence intervals of the study variables for anxiety (+) by asking them to answer questions about radiation, as assessed by the

189 logistic regression analysis.

Variable	Unit	Odds ratio	95% confidence interval	p-value
Age	$\geq 40$ years old	0.64	0.36-1.15	0.13
Manager in the workplace	No	1.14	0.65-2.00	0.66
Public health nurse at the time of the accident	No	2.37	1.27-4.42	< 0.01
Current degree of anxiety about radiation	anxiety (+)	3.56	1.82-6.96	< 0.001
Difficulty answering radiation questions in the past	No	1.27	0.76-2.12	0.37
Currently have materials to obtain knowledge about radiation	No	2.11	1.248-3.60	<0.01
Knowledgeaboutchildhoodthyroidcancer increase after theChernobyl accident	No	1.69	1.04-2.75	0.04
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#### 191 Discussion

This study was conducted four years after the FDNPS disaster to provide educational support for PHNs who receive many consultations from residents. In univariate analysis, younger and inexperienced PHNs had higher anxiety with regard to communicating with residents about radiation. When adjusting for other variables, those PHNs who were students at the time of the accident had higher anxiety when communicating with residents about radiation. Our results suggested that experience as a professional during the FDNPS accident is important. Although many of the PHNs had knowledge about the Chernobyl accident, they could not properly communicate the health effects of radiation with the residents, which caused anxiety in the residents after the accident at the FDNPS. In addition, our results showed that having the materials to obtain knowledge about radiation was independently associated with anxiety about the FDNPS accident. 

These results suggest that continuous effort is necessary to provided education and materials among the PHNs in the Fukushima Prefecture for them to gain knowledge about radiation, including the health effects caused by radiation exposure [17]. Some education initiatives have been undertaken in the prefecture after the nuclear accident, which includes Fukushima Medical University's disaster education for undergraduates and health literacy training for public health nurses for field practitioners [18, 19]. Appropriate and sustainable allocation of financial and human resources is needed to continue and expand such activities.

The SOC-13 was employed to estimate the stress management capability of the

PHNs in this study. There was no significant difference in the mean points in the SOC-13 observed between the anxiety (-) group and anxiety (+) group. This result, as well as other study, may suggest that factor of lifestyle related [20]. On the other hand, Eriksson et al. showed that individuals with high scores in the SOC-13 are better able to cope with chronic stress than those with low scores [21]. In other studies, the average points of the nursing students at two Japanese universities were  $50.2\pm7.7$  and  $53.8\pm10.7$ , respectively [22, 23], and the average score of elderly individuals in the Nagasaki Prefecture in Japan was 45.0 [24]. In this study, the average score ( $43.0\pm7.7$ ) was lower than those in other studies, and it was substantially lower when compared to those of nursing students. Accordingly, there is a need for planning of stress management capacity improvement for the PHNs in Fukushima Prefecture with low SOC score.

The correspondence of the disaster affected the stress management capability, and might cause a worsening of chronic stress. According to the FHMS, which includes monitoring the mental health and daily lives of Fukushima residents and providing proper care for them, the mental health status of the residents in the Fukushima Prefecture was very poor [13]. Thus, the mental health of the residents was greatly affected by the disaster, and a similar impact could be expected from the PHNs who work in the Fukushima Prefecture. Therefore, mental support is important for the PHNs, as well as for the residents of the Fukushima Prefecture. 

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The present study has several limitations. First, we could not obtain sufficient information on the anxiety-related factors, such as detailed consultation contents and

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> other information. Second, we were not able to gather sufficient information on stress management factors, such as family issues and marital status. However, we believe that this study regarding the PHNs' situation in the Fukushima Prefecture four years after the FDNPS disaster will be very important in the provision of future support.

> In conclusion, we conducted a survey of the radiation anxiety and stress processing capacity of PHNs in the Fukushima Prefecture four years after the nuclear accident at the FDNPS, and determined that it is important for PHNs to obtain knowledge and teaching materials about radiation. In order to develop workers' capabilities that can correspond to the timing of radiation disasters in the future, radiation education programs for PHNs and nursing students must be established in areas that have nuclear power stations and other nuclear facilities.

#### 246 Footnotes

- 247 Contributorship statement
- Koji Yoshida conceived and designed the experiments, analyzed the data, wrote the
  paper, prepared Tables.
- Makiko Orita, Akira Ohtsuru, Aya Goto, Atsushi Kumagai and Kiyotaka Yasui
   contributed materials, reviewed drafts of the paper.
- Naomi Hayashida, Takashi Kudo, and Shunichi Yamashita designed the experiments,
  reviewed drafts of the paper.
- 254 · Noboru Takamura conceived and designed the experiments, wrote the paper,

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5 6 7	255	reviewed drafts of the paper.
8 9	256	
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27 28 29	264	No additional data are available.
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## **BMJ Open**

#### Radiation-related Anxiety among Public Health Nurses in the Fukushima Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station : a cross-sectional study.

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Manuscript ID	bmjopen-2016-013564.R2
Article Type:	Research
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<b>Primary Subject Heading</b> :	Nursing
Secondary Subject Heading:	Public health
Keywords:	public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power Station, Sense of Coherence-13





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1	Radiation-related Anxiety among Public Health Nurses in the Fukushima
2	Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station: a
3	cross-sectional study.
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5	Koji Yoshida <sup>1,2*</sup> , Makiko Orita <sup>3</sup> , Aya Goto <sup>4</sup> , Atsushi Kumagai <sup>2</sup> , Kiyotaka Yasui <sup>2</sup> , Akira
6	Ohtsuru <sup>5</sup> , Naomi Hayashida <sup>6</sup> , Takashi Kudo <sup>7</sup> , Shunichi Yamashita <sup>8</sup> , Noboru Takamura <sup>3</sup>
7	
8	1 Department of Health Sciences, Nagasaki University Graduate School of Biomedical
9	Sciences, Nagasaki, Japan
10	2 Education Center for Disaster Medicine, Fukushima Medical University, Fukushima,
11	Japan
12	3 Department of Global Health, Medicine and Welfare, Atomic Bomb Disease Institute,
13	Nagasaki University, Nagasaki, Japan
14	4 Center for Integrated Science and Humanities, Fukushima Medical University,
15	Fukushima, Japan
16	5 Department of Radiation Health Management, Fukushima Medical University School
17	of Medicine, Fukushima, Japan
18	6 Division of Promotion of Collaborative Research on Radiation and Environment
19	Health Effects, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan
20	7 Department of Radioisotope Medicine, Atomic Bomb Disease Institute, Nagasaki
21	University, Nagasaki, Japan

8 Department of, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan \*Corresponding author Koji Yoshida, R.N, Ph.D. Department of Health Sciences, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan 1-7-1 Sakamoto, Nagasaki 850-8520, Japan Email: <u>koujiy@nagasaki-u.ac.jp</u> (KY) TEL: +81-95-819-7195 

39	Abstract
34	Abstract

Objective: In Japan, public health nurses (PHNs) play important roles in managing the health of local residents, especially after a disaster. In this study, we assessed radiation anxiety and the stress processing capacity of PHNs in the Fukushima Prefecture in Japan, after the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS). 

Methods: We conducted a questionnaire survey among the PHNs (n=430) in July of 2015 via mail by post. The questions included demographic factors (sex, age, and employment position), knowledge about radiation, degree of anxiety about radiation at the time of the FDNPS accident (and at present), by asking them to answer questions about radiation, and the Sense of Coherence-13 (SOC-13). We classified the low and high levels of anxiety by asking them to answer questions about radiation, and compared the anxiety-negative (-) group with the anxiety-positive (+) group. 

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Results: Of the PHNs, 269 (62.6%) were classified in the anxiety (-) group and 161 (37.4%) were in the anxiety (+) group. When the multivariate logistic regression analysis was conducted, the PHNs at the time of the accident (OR: 2.37, p=0.007), current general anxieties about radiation (OR: 3.56, p<0.001), current possession of materials to obtain knowledge about radiation (OR: 2.11, p=0.006), and knowledge of the childhood thyroid cancer increase after the Chernobyl accident (OR: 1.69, p=0.035) were significantly associated with anxiety after the FDNPS accident. The mean SOC-13 was  $43.0\pm7.7$ , with no significant difference between anxiety (-) group and anxiety (+) group (p=0.47).

53	Conclusions: Our study suggested that anxiety about radiation was associated with
54	materials and knowledge about radiation in the PHNs of Fukushima Prefecture four
55	years after the FDNPS accident. It is important for PHNs to obtain knowledge and
56	teaching materials about radiation, and radiation education programs for PHNs must be
57	established in areas that have nuclear facilities.
58	
59	Keywords: public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power
60	Station, Sense of Coherence-13
61	
62	Strengths and limitations of this study
63	• We could assess radiation anxiety and the stress processing capacity of PHNs in the
64	Fukushima Prefecture in Japan, after the accident at the FDNPS.
65	• We believe that this study regarding the PHNs' situation in the Fukushima Prefecture
66	four years after the FDNPS disaster will be very important in the provision of future
67	support.
68	• We could not obtain sufficient information on the anxiety-related factors, such as
69	detailed consultation contents and other information.
70	• We were not able to gather sufficient information on stress management factors, such
71	as family issues and marital status.
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#### 73 Introduction

On March 11, 2011, the Great East Japan Earthquake struck the east coast of Japan. This large earthquake and tsunami caused immense damage, including that to the Fukushima Daiichi Nuclear Power Station (FDNPS) [1-4]. After the accident at the FDNPS, the Fukushima prefectural government immediately issued instructions for the evacuation of those areas within a 20 km radius of the FDNPS, and they also instructed sheltering in the areas between 20 km and 30 km from the FDNPS. Beyond the 30 km radius, additional areas were designated "deliberate evacuation areas" if there was concern that the cumulative doses of radiation might reach 20 mSy per year in those areas [2]. Despite the low estimated and measured external and internal exposure doses just after the accident, many residents of the Fukushima Prefecture evacuated inside or outside the prefecture [5-8]. 

In the report by the World Health Organization (WHO) on the health impacts 20 years after the Chernobyl accident, mental health was described as the most serious public health problem resulting from that nuclear accident [9-11]. Based on the lessons learned from the Chernobyl accident, the Fukushima Health Management Survey (FHMS) was initiated to assess the health impacts, including mental health, of the residents by the Fukushima prefectural government and the Fukushima Medical University [12, 13]. According to the results of this survey, the residents of the Fukushima Prefecture were exposed to a higher risk of not only physical problems, such as diabetes and obesity, but also mental problems (including the risk perception of the

health effects of radiation) [14, 15].

95	In Japan, public health nurses (PHNs) hold a national license, and many PHNs
96	work for prefectural and municipal bodies, enabling them to provide community health
97	services such as health guidance, home visits, and health education to local residents. In
98	other words, they play important roles in managing the health of local residents,
99	including the time after this disaster. While they were themselves victims of the
100	radiation disaster, they had to respond to the residents' anxieties about radiation
101	exposure, despite their lack of professional knowledge on this topic.

In this study, we conducted a survey to clarify the radiation anxiety and stress
processing capacity of the PHNs in the Fukushima Prefecture, after the nuclear accident
at the FDNPS.

#### 106 Materials and Methods

#### 107 Study population and data collection

We conducted a questionnaire survey among the PHNs in the Fukushima Prefecture located in Northeastern Japan, which was severely affected by the earthquake, tsunami, and FDNPS accident following the Great East Japan Earthquake in 2011. We initially distributed questionnaires to 509 PHNs, and we obtained responses from 458 PHNs (90.0%), after excluding 28 PHNs with insufficient responses. The survey was conducted in July of 2015 via mail by post, and contained questions about the demographic factors (sex, age, activity area, and employment position) and knowledge

of the PHNs about radiation before and after the accident at the FDNPS, and their mental health status. In addition, we examined their degree of anxiety about radiation at the time of the FDNPS accident, and at present, by asking them to answer questions about radiation at present. The degree of anxiety was rated on a 10-point Likert scale ranging from no anxiety to having a lot of anxiety; we defined 1-5 as "anxiety (-)" and 6-10 as "anxiety (+)."

To measure the PHNs' stress management capability, we used the Japanese version of the Sense of Coherence-13 (SOC-13). The SOC-13 consists of three dimensions (comprehensibility, manageability, and meaningfulness) that are equally weighted to create an overall (total) score. The score ranges from 7-91, with a higher score representing a stronger sense of coherence [16].

#### 127 Statistical analysis

We classified the low and high levels of anxiety by asking them to answer questions about radiation, and compared the anxiety (-) group and anxiety (+) group by using the chi-square test and t-test as univariate analyses. A multiple logistic regression analysis was then used to calculate the odds ratio (OR), and its 95% confidence interval (95% CI) was used to identify the factors independently associated with the anxiety level. A p-value of less than 0.05 was considered to be significant, and the statistical analysis was performed using SPSS Statistics 22.0 (IBM Japan, Tokyo, Japan).

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#### *Ethics statement*

This study was approved by the ethics committee of the Fukushima Medical
University (No. 2251), and conducted in accordance with the guidelines specified in the
Declaration of Helsinki.

141	Results
142	A total of 458 PHNs responded to the survey, and 430 of those PHNs (93.9%)
143	completed all of the questions. The number of women was 416 (96.7%), and 153
144	(35.6%) were 50 years old or older. The number of PHNs with less than 10 years of
145	working experience was 124 (22.8%), and 306 (71.2%) had ten years or more. There

were 119 participants (27.7%) with managerial positions. At the time of the accident, 330 (76.8%) worked as PHNs and 62 (14.4%) were still in training. The number of those in Hamadori, which became the evacuation area of the FDNPS accident, was 83 

(19.3%) (Table 1).

#### Table 1. Basic characteristics of the study participants.

Variable		Number (%)
Gender	Women	416(96.7)
	Men	14(3.3)
Age	20-29 years old	92(21.4)
	30-39 years old	72(16.7)
	40-49 years old	113(26.3)
	≥50 years old	153(35.6)
Tenure as a public health nurse	<10 years	124(28.8)
-	$\geq 10$ years	306(71.2)
Nursing experience in a hospital	Yes	149(34.7)
	No	281(65.3)
Activity area	Hamadori	83(19.3)
-	Other area (Nakadori, Aizu et al.)	347(80.7)
Position in the workplace	Manager (director, chief)	119(27.7)
*	Staff	311(72.3)
Occupation at the time of the	Public health nurse	330(76.8)
accident	Other occupations (mostly nurses)	38(8.8)
	Students	62(14.4)

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153	Of the PHNs, 269 were classified in the anxiety (-) group and 161 were in the
154	anxiety (+) group (Table 2). A significantly higher ratio of PHNs younger than 40 years
155	old was observed in the anxiety (+) group (p<0.001, Table 2). Likewise, higher ratios of
156	PHNs with less than 10 years of working experience, staff positions, and nursing
157	licenses were observed in the anxiety (+) group (p<0.001, respectively, Table 2). On the
158	other hand, no significant differences were observed between the two groups in the
159	activity area, education curriculum, and seminars before or after the accident (p=0.62,
160	p=0.16, p=0.60, and p=0.13, respectively, Table 2). In addition, there was no significant
161	difference in the mean points in the SOC-13 observed between the two groups (p=0.47,
162	Table 2).

#### 164 Table 2. Participant's demographic factors, educational history, and mental health

		Anxiety (-)	Anxiety (+)		
Variable	Unit			p-values	
		(n=269) (%)	(n=161) (%)		
Gender	Women/	262(97.4)/	154(95.7)/	0.32	
	Men	7(2.6)	7(4.3)	0.32	
Age	<40 years old/	77(28.6)/	87(54.0)/	<0.001	
	$\geq$ 40 years old	192(71.4)	74(46.0)	<u>\0.001</u>	
Working experience as a public	<10 years/	53(19.7)/	71(44.1)/	<0.001	
health nurse	$\geq 10$ years	216(80.3)	90(55.9)	<0.001	
Activity area	Hamadori/	54(20.1)/	29(18.0)/	0.62	
	Other area	215(79.9)	132(72.0)	0.02	
Position in the workplace	Manager/	88(32.7)/	31(19.3)/	0.002	
	Staff	181(67.3)	130(80.7)	0.005	
Occupation at the time of the	PHNs/	220(95 5)/	100(62 1)/		
accident	Others (nurses,	230(83.3)/	100(62.1)/	< 0.001	
	students)	39(14.3)	01(37.9)		

#### 165 via anxiety with regard to questions about radiation after the FNPS accident.

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Did vou have children <15				
years old at the time of the accident?	Yes	110(40.9)	59(36.6)	0
Education history in curriculum	Yes	114(42.4)	80(49.7)	0
Education history in seminar before the accident	Yes	25(9.3)	12(7.5)	0
Education history in seminar after the accident	Yes	247(91.8)	140(87.0)	0
Frequency of participation in	Once/	47(19.0)/	42(29.6)/	0
seminars	Plural	200(81.0)	98(70.4)	0
SOC-13 total points	Mean	44.0	41.4	0

In the anxiety (+) group, the ratio of those having current anxiety about radiation was significantly higher than that in the anxiety (-) group (p < 0.001, Table 3). On the other hand, in the anxiety (-) group, the ratios with difficulty answering the questions about radiation, currently having the materials to obtain knowledge about radiation, and having knowledge about childhood thyroid cancer increases after the Chernobyl accident were significantly higher than in the anxiety (+) group (p < 0.05, p < 0.01, and p < 0.05, respectively, Table 3). However, there were no significant changes between the two groups in the anxiety about radiation at the time of the accident and the recognition of health effects (such as late effects and genetic effects) due to radiation exposure (p=0.68, p=0.79, and p=0.20, respectively, Table 3).

Table 3. Participants' anxiety, recognition, and knowledge about radiation via
anxiety with regard to answering the questions about radiation after the FDNPS
accident.

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	TT. '4	Anxiety (-)	Anxiety (+)	p-values	
Question	Unit	(n=269) (%)	(n=161) (%)		
Degree of anxiety about radiation at the time of the FDNPS accident	anxiety (-)/ anxiety (+)	99(36.8)/ 170(63.2)	56(34.8)/ 105(65.2)	0.68	
Degree of anxiety about radiation currently	anxiety (-)/ anxiety (+)	251(93.3)/ 18(6.7)	130(80.7)/ 31(19.3)	< 0.001	
Do you think that delayed effects such as malignancies occur due to radiation exposure following the Fukushima accident?	Yes	37(13.8)	33(20.5)	0.79	
Do you think that genetic effects in offspring occur due to radiation exposure following the Fukushima accident?	Yes	33(12.3)	27(16.8)	0.20	
Did you have a difficult time answering the questions about radiation?	Yes	216(80.3)	115(71.4)	0.04	
Did you have the materials to obtain knowledge about radiation at the time of the accident?	Yes	87(32.3)	40(24.8)	0.10	
Do you currently have the materials to obtain knowledge about radiation?	Yes	233(86.6)	118(73.3)	0.01	
Did you know about the three principles of radiation protection?	Yes	64(23.8)	42(26.1)	0.64	
Did you know about the annual dose limit for the general public?	Yes	20(12.4)	11(6.8)	0.99	
Did you know about the half-life of radioactive substances?	Yes	129(48.0)	77(47.8)	0.99	
Did you know about childhood thyroid cancer increases after the Chernobyl accident?	Yes	213(79.2)	109(67.7)	0.01	

- 181

When the logistic regression analysis was conducted, following the adjustment 182for confounding factors, being a PHN at the time of the accident (OR: 2.37, p<0.01), 183 current general anxieties about radiation (OR: 3.56, p<0.001), currently having the 184materials to obtain knowledge about radiation (OR: 2.11, p<0.01), and having 185

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186	knowledge about childhood thyroid cancer increases after the Chernobyl accident (OR:
187	1.69, p=0.04) were all significantly associated with anxiety after the FDNPS accident
188	(Table 4).

### 190 Table 4. Odds ratios and 95% confidence intervals of the study variables for 191 anxiety (+) by asking them to answer questions about radiation, as assessed by the

192 logistic regression analysis.

Variable	Unit	Odds ratio	95% confidence interval	p-value
Age	$\geq 40$ years old	0.64	0.36-1.15	0.13
Manager in the workplace	No	1.14	0.65-2.00	0.66
Public health nurse at the time of the accident	No	2.37	1.27-4.42	< 0.01
Current degree of anxiety about radiation	anxiety (+)	3.56	1.82-6.96	< 0.001
Difficulty answering radiation questions in the past	No	1.27	0.76-2.12	0.37
Currently have materials to obtain knowledge about radiation	No	2.11	1.248-3.60	<0.01
Knowledgeaboutchildhoodthyroidcancer increase after theChernobyl accident	No	1.69	1.04-2.75	0.04

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#### 194 Discussion

This study was conducted four years after the FDNPS disaster to provide educational support for PHNs who receive many consultations from residents. In univariate analysis, younger and inexperienced PHNs had higher anxiety with regard to communicating with residents about radiation. When adjusting for other variables, those PHNs who were students at the time of the accident had higher anxiety when communicating with residents about radiation. Our results suggested that experience as a professional during the FDNPS accident is important. Although many of the PHNs had knowledge about the Chernobyl accident, they could not properly communicate the health effects of radiation with the residents, which caused anxiety in the residents after the accident at the FDNPS. In addition, our results showed that having the materials to obtain knowledge about radiation was independently associated with anxiety about the FDNPS accident. 

These results suggest that continuous effort is necessary to provided education and materials among the PHNs in the Fukushima Prefecture for them to gain knowledge about radiation, including the health effects caused by radiation exposure [17]. Some education initiatives have been undertaken in the prefecture after the nuclear accident, which includes Fukushima Medical University's disaster education for undergraduates and health literacy training for public health nurses for field practitioners [18, 19]. Appropriate and sustainable allocation of financial and human resources is needed to continue and expand such activities.

The SOC-13 was employed to estimate the stress management capability of the

PHNs in this study. There was no significant difference in the mean points in the SOC-13 observed between the anxiety (-) group and anxiety (+) group. This result, as well as other study, may suggest that factor of lifestyle related [20]. On the other hand, Eriksson et al. showed that individuals with high scores in the SOC-13 are better able to cope with chronic stress than those with low scores [21]. In other studies, the average points of the nursing students at two Japanese universities were  $50.2\pm7.7$  and  $53.8\pm10.7$ , respectively [22, 23], and the average score of elderly individuals in the Nagasaki Prefecture in Japan was 45.0 [24]. In this study, the average score ( $43.0\pm7.7$ ) was lower than those in other studies, and it was substantially lower when compared to those of nursing students. Accordingly, there is a need for planning of stress management capacity improvement for the PHNs in Fukushima Prefecture with low SOC score.

The correspondence of the disaster affected the stress management capability, and might cause a worsening of chronic stress. According to the FHMS, which includes monitoring the mental health and daily lives of Fukushima residents and providing proper care for them, the mental health status of the residents in the Fukushima Prefecture was very poor [13]. Thus, the mental health of the residents was greatly affected by the disaster, and a similar impact could be expected from the PHNs who work in the Fukushima Prefecture. Therefore, mental support is important for the PHNs, as well as for the residents of the Fukushima Prefecture. 

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The present study has several limitations. First, we could not obtain sufficient information on the anxiety-related factors, such as detailed consultation contents and

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> other information. Second, we were not able to gather sufficient information on stress management factors, such as family issues and marital status. Third, this study might have caused a recall bias on the study participants. However, we believe that this study regarding the PHNs' situation in the Fukushima Prefecture four years after the FDNPS disaster will be very important in the provision of future support.

> In conclusion, we conducted a survey of the radiation anxiety and stress processing capacity of PHNs in the Fukushima Prefecture four years after the nuclear accident at the FDNPS, and determined that it is important for PHNs to obtain knowledge and teaching materials about radiation. In order to develop workers' capabilities that can correspond to the timing of radiation disasters in the future, radiation education programs for PHNs and nursing students must be established in areas that have nuclear power stations and other nuclear facilities.

250 Footnotes

251 Contributorship statement

• Koji Yoshida conceived and designed the experiments, analyzed the data, wrote the
paper, prepared Tables.

• Makiko Orita, Akira Ohtsuru, Aya Goto, Atsushi Kumagai and Kiyotaka Yasui
 contributed materials, reviewed drafts of the paper.

- Naomi Hayashida, Takashi Kudo, and Shunichi Yamashita designed the experiments,
- 257 reviewed drafts of the paper.

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258	· Noboru lakamura conceived and designed the experiments, wrote the paper,
259	reviewed drafts of the paper.
260	
261	Competing interests
262	There are no competing interests
263	
264	Funding
265	This study was partly supported by Japan Society for Promotion of Science
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267	Data sharing statement
268	No additional data are available.
269	
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	Item No	Recommendation
Title and abstract	<u>1</u>	(a) Indicate the study's design with a commonly used term in the title or the
The and abstract	V I	abstract Pages 1 and 3
		(b) Provide in the abstract an informative and balanced summary of what was done
		and what was found Page 3
		and what was found 1 age 5
Introduction	<u> </u>	
Background/rationale	✓ 2	Explain the scientific background and rationale for the investigation being reported Pages 5-6
Objectives	✓ 3	State specific objectives, including any prespecified hypotheses Page 6
Methods		
Study design	✓4	Present key elements of study design early in the paper Page 6
Setting	15	Describe the setting, locations, and relevant dates, including periods of recruitment
8		exposure, follow-up, and data collection Page 6
Participants	16	(a) Give the eligibility criteria and the sources and methods of selection of
- u. u. pullo		participants Page 6
Variables	<b>√</b> 7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect
	- ,	modifiers. Give diagnostic criteria, if applicable Pages 7-8
Data sources/	✓ 8*	For each variable of interest, give sources of data and details of methods of
measurement	• •	assessment (measurement) Describe comparability of assessment methods if there
		is more than one group Pages 6-7
Bias	19	Describe any efforts to address potential sources of bias Page 16
Study size	<b>1</b> 0	Explain how the study size was arrived at Page 6
Ouantitative variables	<b>1</b> 11	Explain how due study size was arrived at Fuge 0
Quantitative variables	• 11	describe which groupings were chosen and why Pages 7-8
Statistical methods	<b>√</b> 12	(a) Describe all statistical methods, including those used to control for confounding
Pages 7-8	• • • •	(b) Describe any methods used to examine subgroups and interactions
		(c) Evaluin how missing data were addressed
		(d) If applicable, describe analytical methods taking account of sampling strategy
		(a) Describe any sensitivity analyses
<b>D</b>		(E) Describe any sensitivity analyses
Results	(10)	
Participants	✓ 13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially
Pages 6 and 9		eligible, examined for eligibility, confirmed eligible, included in the study,
		completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	✓ 14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and
Pages 6 and 9		information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
Outcome data	✓ 15*	Report numbers of outcome events or summary measures Pages 9-13
Main results	<b>√</b> 16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and
Table 4		their precision (eg, 95% confidence interval). Make clear which confounders were
		adjusted for and why they were included
		(b) Report category boundaries when continuous variables were categorized
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a
		meaningful time period

Other analyses	<b>√</b> 17	Report other analyses done-eg analyses of subgroups and interactions, and
		sensitivity analyses Not applicable
Discussion		
Key results	✓18	Summarise key results with reference to study objectives Page 14
Limitations	<b>√</b> 19	Discuss limitations of the study, taking into account sources of potential bias or
		imprecision. Discuss both direction and magnitude of any potential bias Pages 16-
		17
Interpretation	✓20	Give a cautious overall interpretation of results considering objectives, limitations,
		multiplicity of analyses, results from similar studies, and other relevant evidence
		Pages 16-17
Generalisability	✓21	Discuss the generalisability (external validity) of the study results Page 17
Other information		
Funding	✓ 22	Give the source of funding and the role of the funders for the present study and, if
		applicable, for the original study on which the present article is based Page 17

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

## **BMJ Open**

#### Radiation-related Anxiety among Public Health Nurses in the Fukushima Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station : a cross-sectional study.

Journal:	BMJ Open
Manuscript ID	bmjopen-2016-013564.R3
Article Type:	Research
Date Submitted by the Author:	29-Sep-2016
Complete List of Authors:	Yoshida, Koji; Nagasaki University Graduate School of Biomedical Sciences, Health Sciences; Fukushima Medical University, Education Center for Disaster Medicine Orita, Makiko; Atomic Bomb Disease Institute, Nagasaki University, , Global Health, Medicine and Welfare Goto, Aya; Fukushima Medical University, Integrated Science and Humanities Kumagai, Atsushi; Fukushima Medical University, Education Center for Disaster Medicine Yasui, Kiyotaka; Fukushima Medical University, Education Center for Disaster Medicine Ohtsuru, Akira; Fukushima Medical University, Radiation Health Management Hayashida, Naomi ; Atomic Bomb Disease Institute, Nagasaki University, Promotion of Collaborative Research on Radiation and Environment Health Effects Kudo, Takashi; Atomic Bomb Disease Institute, Nagasaki University, Radioisotope Medicine Yamashita, Shunichi ; Atomic Bomb Disease Institute, Nagasaki University, Radiation Medical Sciences Takamura, Noboru; Atomic Bomb Disease Institute, Nagasaki University, Radiation Medical Sciences
<b>Primary Subject Heading</b> :	Nursing
Secondary Subject Heading:	Public health
Keywords:	public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power Station, Sense of Coherence-13





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1 Radiation-related Anxiety among Public Health Nurses in the Fukushima 2 Prefecture after the Accident at the Fukushima Daiichi Nuclear Power Station: a 3 cross-sectional study. 4 Koji Yoshida<sup>1,2\*</sup>, Makiko Orita<sup>3</sup>, Aya Goto<sup>4</sup>, Atsushi Kumagai<sup>2</sup>, Kiyotaka Yasui<sup>2</sup>, Akira 5 Ohtsuru<sup>5</sup>, Naomi Hayashida<sup>6</sup>, Takashi Kudo<sup>7</sup>, Shunichi Yamashita<sup>8</sup>, Noboru Takamura<sup>3</sup> 6  $\overline{7}$ 1 Department of Health Sciences, Nagasaki University Graduate School of Biomedical 8 9 Sciences, Nagasaki, Japan 2 Education Center for Disaster Medicine, Fukushima Medical University, Fukushima, 10 11 Japan 3 Department of Global Health, Medicine and Welfare, Atomic Bomb Disease Institute, 1213Nagasaki University, Nagasaki, Japan 4 Center for Integrated Science and Humanities, Fukushima Medical University, 14 Fukushima, Japan 155 Department of Radiation Health Management, Fukushima Medical University School 16of Medicine, Fukushima, Japan 176 Division of Promotion of Collaborative Research on Radiation and Environment 18 Health Effects, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan 19207 Department of Radioisotope Medicine, Atomic Bomb Disease Institute, Nagasaki 21University, Nagasaki, Japan
8 Department of, Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan \*Corresponding author Koji Yoshida, R.N, Ph.D. Department of Health Sciences, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan 1-7-1 Sakamoto, Nagasaki 850-8520, Japan Email: <u>koujiy@nagasaki-u.ac.jp</u> (KY) TEL: +81-95-819-7195 

Abstract

33	Objective: In Japan, public health nurses (PHNs) play important roles in managing the
34	health of local residents, especially after a disaster. In this study, we assessed radiation
35	anxiety and the stress processing capacity of PHNs in the Fukushima Prefecture in
36	Japan, after the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS).
37	Methods: We conducted a questionnaire survey among the PHNs (n=430) in July of
38	2015 via mail by post. The questions included demographic factors (sex, age, and
39	employment position), knowledge about radiation, degree of anxiety about radiation at
40	the time of the FDNPS accident (and at present), by asking them to answer questions
41	about radiation, and the Sense of Coherence-13 (SOC-13). We classified the low and
42	high levels of anxiety by asking them to answer questions about radiation, and
43	compared the anxiety-negative (-) group with the anxiety-positive (+) group.
44	Results: Of the PHNs, 269 (62.6%) were classified in the anxiety (-) group and 161
45	(37.4%) were in the anxiety (+) group. When the multivariate logistic regression
46	analysis was conducted, the PHNs at the time of the accident (OR: 2.37, p=0.007),
47	current general anxieties about radiation (OR: 3.56, p<0.001), current possession of
48	materials to obtain knowledge about radiation (OR: 2.11, p=0.006), and knowledge of
49	the childhood thyroid cancer increase after the Chernobyl accident (OR: 1.69, p=0.035)
50	were significantly associated with anxiety after the FDNPS accident. The mean SOC-13
51	was 43.0 $\pm$ 7.7, with no significant difference between anxiety (-) group and anxiety (+)

52 group (p=0.47).

Conclusions: Our study suggested that anxiety about radiation was associated with materials and knowledge about radiation in the PHNs of Fukushima Prefecture four years after the FDNPS accident. It is important for PHNs to obtain knowledge and teaching materials about radiation, and radiation education programs for PHNs must be established in areas that have nuclear facilities. Keywords: public health nurse, anxiety, radiation, Fukushima Daiichi Nuclear Power Station, Sense of Coherence-13 Strengths and limitations of this study • We could assess radiation anxiety and the stress processing capacity of PHNs in the Fukushima Prefecture in Japan, after the accident at the FDNPS. • We believe that this study regarding the PHNs' situation in the Fukushima Prefecture four years after the FDNPS disaster will be very important in the provision of future support. • We could not obtain sufficient information on the anxiety-related factors, such as detailed consultation contents and other information. • We were not able to gather sufficient information on stress management factors, such as family issues and marital status. 

## 73 Introduction

On March 11, 2011, the Great East Japan Earthquake struck the east coast of Japan. This large earthquake and tsunami caused immense damage, including that to the Fukushima Daiichi Nuclear Power Station (FDNPS) [1-4]. After the accident at the FDNPS, the Fukushima prefectural government immediately issued instructions for the evacuation of those areas within a 20 km radius of the FDNPS, and they also instructed sheltering in the areas between 20 km and 30 km from the FDNPS. Beyond the 30 km radius, additional areas were designated "deliberate evacuation areas" if there was concern that the cumulative doses of radiation might reach 20 mSy per year in those areas [2]. Despite the low estimated and measured external and internal exposure doses just after the accident, many residents of the Fukushima Prefecture evacuated inside or outside the prefecture [5-8]. 

In the report by the World Health Organization (WHO) on the health impacts 20 years after the Chernobyl accident, mental health was described as the most serious public health problem resulting from that nuclear accident [9-11]. Based on the lessons learned from the Chernobyl accident, the Fukushima Health Management Survey (FHMS) was initiated to assess the health impacts, including mental health, of the residents by the Fukushima prefectural government and the Fukushima Medical University [12, 13]. According to the results of this survey, the residents of the Fukushima Prefecture were exposed to a higher risk of not only physical problems, such as diabetes and obesity, but also mental problems (including the risk perception of the

health effects of radiation) [14, 15].

95	In Japan, public health nurses (PHNs) hold a national license, and many PHNs
96	work for prefectural and municipal bodies, enabling them to provide community health
97	services such as health guidance, home visits, and health education to local residents. In
98	other words, they play important roles in managing the health of local residents,
99	including the time after this disaster. While they were themselves victims of the
100	radiation disaster, they had to respond to the residents' anxieties about radiation
101	exposure, despite their lack of professional knowledge on this topic.

In this study, we conducted a survey to clarify the radiation anxiety and stress processing capacity of the PHNs in the Fukushima Prefecture, after the nuclear accident at the FDNPS.

#### 106 Materials and Methods

#### 107 Study population and data collection

We conducted a questionnaire survey among the PHNs in the Fukushima Prefecture located in Northeastern Japan, which was severely affected by the earthquake, tsunami, and FDNPS accident following the Great East Japan Earthquake in 2011. We initially distributed questionnaires to 509 PHNs, and we obtained responses from 458 PHNs (90.0%), after excluding 28 PHNs with insufficient responses. The survey was conducted in July of 2015 via mail by post, and contained questions about the demographic factors (sex, age, activity area, and employment position) and knowledge

of the PHNs about radiation before and after the accident at the FDNPS, and their mental health status. In addition, we examined their degree of anxiety about radiation at the time of the FDNPS accident, and at present, by asking them to answer questions about radiation at present. The degree of anxiety was rated on a 10-point Likert scale ranging from no anxiety to having a lot of anxiety; we defined 1-5 as "anxiety (-)" and 6-10 as "anxiety (+)."

To measure the PHNs' stress management capability, we used the Japanese version of the Sense of Coherence-13 (SOC-13). The SOC-13 consists of three dimensions (comprehensibility, manageability, and meaningfulness) that are equally weighted to create an overall (total) score. Each question was rates on a 5-point Likert scale from one to five, with a higher score representing a stronger sense of coherence (range:13-65) [16]. BMJ Open: first published as 10.1136/bmjopen-2016-013564 on 24 October 2016. Downloaded from http://bmjopen.bmj.com/ on June 13, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

#### 128 Statistical analysis

We classified the low and high levels of anxiety by asking them to answer questions about radiation, and compared the anxiety (-) group and anxiety (+) group by using the chi-square test and t-test as univariate analyses. A multiple logistic regression analysis was performed to assess the effects of each variable on the anxiety level adjusted for confounding variables. In this study, the dependent variable was "the anxiety (+) by asking them to answer questions about radiation," the exposure variables were "Manager in the workplace," "Public health nurse at the time of the accident,"

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"Current degree of anxiety about radiation," "Difficulty answering radiation questions
in the past," "Currently have materials to obtain knowledge about radiation," and
"Knowledge about childhood thyroid cancer increase after the Chernobyl accident" and
the confounding variables was "age." Odds ratio (ORs), and their 95% confidence
interval (95% CI) were also calculated. A p-value of less than 0.05 was considered to be
significant, and the statistical analysis was performed using SPSS Statistics 22.0 (IBM
Japan, Tokyo, Japan).

#### *Ethics statement*

This study was approved by the ethics committee of the Fukushima Medical
University (No. 2251), and conducted in accordance with the guidelines specified in the
Declaration of Helsinki.

149	Results
150	A total of 458 PHNs responded to the survey, and 430 of those PHNs (93.9%)
151	completed all of the questions. The number of women was 416 (96.7%), and 153
152	(35.6%) were 50 years old or older. The number of PHNs with less than 10 years of
153	working experience was 124 (22.8%), and 306 (71.2%) had ten years or more. There
154	were 119 participants (27.7%) with managerial positions. At the time of the accident,

330 (76.8%) worked as PHNs and 62 (14.4%) were still in training. The number of those in Hamadori, which became the evacuation area of the FDNPS accident, was 83 

(19.3%) (Table 1).

#### Table 1. Basic characteristics of the study participants.

Variable		Number (%)
Gender	Women	416(96.7)
	Men	14(3.3)
Age	20-29 years old	92(21.4)
	30-39 years old	72(16.7)
	40-49 years old	113(26.3)
	≥50 years old	153(35.6)
Tenure as a public health nurse	<10 years	124(28.8)
-	$\geq 10$ years	306(71.2)
Nursing experience in a hospital	Yes	149(34.7)
	No	281(65.3)
Activity area	Hamadori	83(19.3)
-	Other area (Nakadori, Aizu et al.)	347(80.7)
Position in the workplace	Manager (director, chief)	119(27.7)
-	Staff	311(72.3)
Occupation at the time of the	Public health nurse	330(76.8)
accident	Other occupations (mostly nurses)	38(8.8)
	Students	62(14.4)

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161	Of the PHNs, 269 were classified in the anxiety (-) group and 161 were in the
162	anxiety (+) group (Table 2). A significantly higher ratio of PHNs younger than 40 years
163	old was observed in the anxiety (+) group (p<0.001, Table 2). Likewise, higher ratios of
164	PHNs with less than 10 years of working experience, staff positions, and nursing
165	licenses were observed in the anxiety (+) group (p<0.001, respectively, Table 2). On the
166	other hand, no significant differences were observed between the two groups in the
167	activity area, education curriculum, and seminars before or after the accident (p=0.62,
168	p=0.16, p=0.60, and p=0.13, respectively, Table 2). In addition, there was no significant
169	difference in the mean points in the SOC-13 observed between the two groups (p=0.47,
170	Table 2).

# 172 Table 2. Participant's demographic factors, educational history, and mental health

Variable	Unit	Anxiety (-) (n=269) (%)	Anxiety (+) (n=161) (%)	p-values	
Gender	Women/	262(97.4)/	154(95.7)/	0.32	
	Men	7(2.6)	7(4.3)	0.32	
Age	<40 years old/	77(28.6)/	87(54.0)/	<0.001	
	$\geq$ 40 years old	192(71.4)	74(46.0)	<u>\0.001</u>	
Working experience as a public	<10 years/	53(19.7)/	71(44.1)/	<0.001	
health nurse	$\geq 10$ years	216(80.3)	90(55.9)	<0.001	
Activity area	Hamadori/	54(20.1)/	29(18.0)/	0.62	
	Other area	215(79.9)	132(72.0)	0.02	
Position in the workplace	Manager/	88(32.7)/	31(19.3)/	0.003	
	Staff	181(67.3)	130(80.7)	0.005	
Occupation at the time of the accident	PHNs/ Others (nurses, students)	230(85.5)/ 39(14.5)	100(62.1)/ 61(37.9)	< 0.001	

# 173 via anxiety with regard to questions about radiation after the FNPS accident.

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Did you have children ≤15				
years old at the time of the accident?	Yes	110(40.9)	59(36.6)	0
Education history in curriculum	Yes	114(42.4)	80(49.7)	0
Education history in seminar before the accident	Yes	25(9.3)	12(7.5)	0
Education history in seminar after the accident	Yes	247(91.8)	140(87.0)	0
Frequency of participation in	Once/	47(19.0)/	42(29.6)/	0
seminars	Plural	200(81.0)	98(70.4)	0
SOC-13 total points	Mean	44.0	41.4	0

In the anxiety (+) group, the ratio of those having current anxiety about radiation was significantly higher than that in the anxiety (-) group (p < 0.001, Table 3). On the other hand, in the anxiety (-) group, the ratios with difficulty answering the questions about radiation, currently having the materials to obtain knowledge about radiation, and having knowledge about childhood thyroid cancer increases after the Chernobyl accident were significantly higher than in the anxiety (+) group (p < 0.05, p < 0.01, and p < 0.05, respectively, Table 3). However, there were no significant changes between the two groups in the anxiety about radiation at the time of the accident and the recognition of health effects (such as late effects and genetic effects) due to radiation exposure (p=0.68, p=0.79, and p=0.20, respectively, Table 3).

Table 3. Participants' anxiety, recognition, and knowledge about radiation via
anxiety with regard to answering the questions about radiation after the FDNPS
accident.

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Question	Unit	Anxiety (-)	Anxiety (+)	n valuos
Question	Ullit	(n=269) (%)	(n=161) (%)	p-values
Degree of anxiety about radiation at the time of the FDNPS accident	anxiety (-)/ anxiety (+)	99(36.8)/ 170(63.2)	56(34.8)/ 105(65.2)	0.68
Degree of anxiety about radiation currently	anxiety (-)/ anxiety (+)	251(93.3)/ 18(6.7)	130(80.7)/ 31(19.3)	< 0.001
Do you think that delayed effects such as malignancies occur due to radiation exposure following the Fukushima accident?	Yes	37(13.8)	33(20.5)	0.79
Do you think that genetic effects in offspring occur due to radiation exposure following the Fukushima accident?	Yes	33(12.3)	27(16.8)	0.20
Did you have a difficult time answering the questions about radiation?	Yes	216(80.3)	115(71.4)	0.04
Did you have the materials to obtain knowledge about radiation at the time of the accident?	Yes	87(32.3)	40(24.8)	0.10
Do you currently have the materials to obtain knowledge about radiation?	Yes	233(86.6)	118(73.3)	0.01
Did you know about the three principles of radiation protection?	Yes	64(23.8)	42(26.1)	0.64
Did you know about the annual dose limit for the general public?	Yes	20(12.4)	11(6.8)	0.99
Did you know about the half-life of radioactive substances?	Yes	129(48.0)	77(47.8)	0.99
Did you know about childhood thyroid cancer increases after the Chernobyl accident?	Yes	213(79.2)	109(67.7)	0.01

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When the logistic regression analysis was conducted, following the adjustment for confounding factors, being a PHN at the time of the accident (OR: 2.37, p<0.01), current general anxieties about radiation (OR: 3.56, p<0.001), currently having the materials to obtain knowledge about radiation (OR: 2.11, p<0.01), and having

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194 knowledge about childhood thyroid cancer increases after the Chernobyl accident (OR:
195 1.69, p=0.04) were all significantly associated with anxiety after the FDNPS accident
196 (Table 4).

198 Table 4. Odds ratios and 95% confidence intervals of the study variables for 199 anxiety (+) by asking them to answer questions about radiation, as assessed by the

# 200 logistic regression analysis.

Variable	Unit	Odds ratio	95% confidence interval	p-value
Adjusted				
Age	$\geq$ 40 years old	0.64	0.36-1.15	0.13
Manager in the workplace	No	1.14	0.65-2.00	0.66
Public health nurse at the time of the accident	No	2.37	1.27-4.42	0.007
Current degree of anxiety about radiation	anxiety (+)	3.56	1.82-6.96	< 0.001
Difficulty answering radiation questions in the past	No	1.27	0.76-2.12	0.37
Currently have materials to obtain knowledge about radiation	No	2.11	1.25-3.60	0.006
Knowledgeaboutchildhoodthyroidcancer increase after theChernobyl accident	No	1.69	1.04-2.75	0.04
Unadjusted				
Age	$\geq$ 40 years old	0.34	0.23-0.51	< 0.001
Manager in the workplace	No	2.04	1.28-3.25	0.003
Public health nurse at the time of the accident	No	3.60	2.26-5.73	< 0.001
Current degree of	anxiety (+)	3.33	1.79-6.17	< 0.001

anxiety about radiation				
radiation questions in the past	No	1.63	1.03-2.57	0.0
Currently have materials to obtain knowledge about radiation	No	2.36	1.44-3.87	<0
Knowledge about childhood thyroid cancer increase after the Chernobyl accident	No	1.82	1.17-2.82	0.0

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# 202 Discussion

This study was conducted four years after the FDNPS disaster to provide educational support for PHNs who receive many consultations from residents. In univariate analysis, younger and inexperienced PHNs had higher anxiety with regard to communicating with residents about radiation. When adjusting for other variables, those PHNs who were students at the time of the accident had higher anxiety when communicating with residents about radiation. Our results suggested that experience as a professional during the FDNPS accident is important. Although many of the PHNs had knowledge about the Chernobyl accident, they could not properly communicate the health effects of radiation with the residents, which caused anxiety in the residents after the accident at the FDNPS. In addition, our results showed that having the materials to obtain knowledge about radiation was independently associated with anxiety about the FDNPS accident. 

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These results suggest that continuous effort is necessary to provided education and materials among the PHNs in the Fukushima Prefecture for them to gain knowledge about radiation, including the health effects caused by radiation exposure [17]. Some education initiatives have been undertaken in the prefecture after the nuclear accident, which includes Fukushima Medical University's disaster education for undergraduates and health literacy training for public health nurses for field practitioners [18, 19]. Appropriate and sustainable allocation of financial and human resources is needed to continue and expand such activities.

The SOC was employed to estimate the stress management capability of the

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224	PHNs in this study. There was no significant difference in the mean points in the SOC
225	observed between the anxiety (-) group and anxiety (+) group. This result, as well as
226	other study, may suggest that factor of lifestyle related [20]. On the other hand, Eriksson
227	et al. showed that individuals with high scores in the SOC are better able to cope with
228	chronic stress than those with low scores [21]. In other studies, the average points of the
229	nurse at two Japanese hospitals were 38.5±6.4 and 39.3±6.3, respectively [22, 23], and
230	the average score of mothers of children with intellectual disabilities in Japan was
231	$40.0\pm8.0$ [24]. In this study, the average score ( $43.0\pm7.7$ ) was higher than those in other
232	studies, and it was substantially higher when compared to those of nurses. We believe
233	that expertise as a public health nurse is one of the factors that increase the SOC.
234	Accordingly, in order to maintain the high scores of in the SOC, there is a need for
235	planning of stress management capacity improvement for the PHNs in Fukushima
236	Prefecture.

The correspondence of the disaster affected the stress management capability, and might cause a worsening of chronic stress. According to the FHMS, which includes monitoring the mental health and daily lives of Fukushima residents and providing proper care for them, the mental health status of the residents in the Fukushima Prefecture was very poor [13]. Thus, the mental health of the residents was greatly affected by the disaster, and a similar impact could be expected from the PHNs who work in the Fukushima Prefecture. Therefore, mental support is important for the PHNs, as well as for the residents of the Fukushima Prefecture. 

The present study has several limitations. First, we could not obtain sufficient information on the anxiety-related factors, such as detailed consultation contents and other information. Second, we were not able to gather sufficient information on stress management factors, such as family issues and marital status. Third, this study might have caused a recall bias on the study participants. Finally, since this study targeted to PHNs only in Fukushima, Japan, there might be a problem about generalizability. However, we believe that this study regarding the PHNs' situation in the Fukushima Prefecture four years after the FDNPS disaster will be very important in the provision of future support.

In conclusion, we conducted a survey of the radiation anxiety and stress processing capacity of PHNs in the Fukushima Prefecture four years after the nuclear accident at the FDNPS, and determined that it is important for PHNs to obtain knowledge and teaching materials about radiation. In order to develop workers' capabilities that can correspond to the timing of radiation disasters in the future, radiation education programs for PHNs and nursing students must be established in areas that have nuclear power stations and other nuclear facilities. BMJ Open: first published as 10.1136/bmjopen-2016-013564 on 24 October 2016. Downloaded from http://bmjopen.bmj.com/ on June 13, 2025 at Agence Bibliographique de Enseignement Superieur (ABES)

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262 Footnotes

263 Contributorship statement

• Koji Yoshida conceived and designed the experiments, analyzed the data, wrote the paper, prepared Tables.

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6	266	• Makiko Orita, Akira Ohtsuru, Aya Goto, Atsushi Kumagai and Kiyotaka Yasui
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8	267	contributed materials, reviewed drafts of the paper.
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10	0.00	
11	268	• Naomi Hayashida, Takashi Kudo, and Shunichi Yamashita designed the experiments,
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13	269	reviewed drafts of the paper.
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15	970	. Nohary Takamura conceived and designed the experiments wrote the paper
16	270	Nobolu lakamula concerved and designed the experiments, while the paper,
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18	271	reviewed drafts of the paper.
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20	272	
21	212	
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23	273	Competing interests
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25	274	There are no competing interests
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	Item No	Recommendation
Title and abstract	✓1	(a) Indicate the study's design with a commonly used term in the title or the
		abstract Pages 1 and 3-4
		(b) Provide in the abstract an informative and balanced summary of what was done
		and what was found Pages 3-4
Introduction		
Background/rationale	✓2	Explain the scientific background and rationale for the investigation being reported
0		Pages 5-6
Objectives	✓ 3	State specific objectives, including any prespecified hypotheses Page 6
Methods		
Study design	✓ 4	Present key elements of study design early in the paper Page 6
Setting	√5	Describe the setting, locations, and relevant dates, including periods of recruitment,
C		exposure, follow-up, and data collection Page 6
Participants	√6	(a) Give the eligibility criteria, and the sources and methods of selection of
		participants Page 6
Variables	√7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect
		modifiers. Give diagnostic criteria, if applicable Pages 7-8
Data sources/	<b>√</b> 8*	For each variable of interest, give sources of data and details of methods of
measurement		assessment (measurement). Describe comparability of assessment methods if there
		is more than one group Pages 6-7
Bias	√9	Describe any efforts to address potential sources of bias Page 17
Study size	<b>√</b> 10	Explain how the study size was arrived at Page 6
Quantitative variables	<b>√</b> 11	Explain how quantitative variables were handled in the analyses. If applicable,
		describe which groupings were chosen and why Pages 7-8
Statistical methods	<b>√</b> 12	(a) Describe all statistical methods, including those used to control for confounding
Pages 7-8		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed
		(d) If applicable, describe analytical methods taking account of sampling strategy
		( <u>e</u> ) Describe any sensitivity analyses
Results		
Participants	<b>√</b> 13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially
Pages 6 and 9		eligible, examined for eligibility, confirmed eligible, included in the study,
		completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	<b>√</b> 14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and
Pages 6 and 9		information on exposures and potential confounders
	<i>.</i>	(b) Indicate number of participants with missing data for each variable of interest
Outcome data	✓ 15*	Report numbers of outcome events or summary measures Pages 9-14
Main results	✓ 16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and
Table 4		their precision (eg, 95% confidence interval). Make clear which confounders were
		adjusted for and why they were included
		( <i>b</i> ) Report category boundaries when continuous variables were categorized
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a
		meaningrui ume period

Other analyses	<b>√</b> 17	Report other analyses done-eg analyses of subgroups and interactions, and
		sensitivity analyses Not applicable
Discussion		
Key results	<b>√</b> 18	Summarise key results with reference to study objectives Page 15
Limitations	<b>√</b> 19	Discuss limitations of the study, taking into account sources of potential bias or
		imprecision. Discuss both direction and magnitude of any potential bias Page 17
Interpretation	<b>√</b> 20	Give a cautious overall interpretation of results considering objectives, limitations,
		multiplicity of analyses, results from similar studies, and other relevant evidence
		Pages 15-17
Generalisability	✓21	Discuss the generalisability (external validity) of the study results Page 17
Other information		
Funding	✓ 22	Give the source of funding and the role of the funders for the present study and, if
		applicable, for the original study on which the present article is based Page 18

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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