Association between psychological distress and dietary intake among evacuees after the Great East Japan Earthquake in a cross-sectional study: the Fukushima Health Management Survey

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ABSTRACT

Objective: Psychological distress is generally associated with poor dietary intake, but this has never been investigated among residents after a major disaster. We attempted to reveal the associations between dietary intake and non-specific mental health distress as well as traumatic symptoms among evacuees after the Great East Japan Earthquake of 2011.

Methods: In this cross-sectional analysis of 63 047 evacuees (27 901 men, 35 146 women) who responded to The Fukushima Health Management Survey in 2012, non-specific mental health distress was assessed using the Kessler-6 (K6) scale, while traumatic symptoms were evaluated using the Posttraumatic Stress Disorder (PTSD) Checklist—Stressor-Specific Version (PCL-S). The outcome was ‘low frequency’—meaning a daily consumption in the 25th centile or less according to the food frequency questionnaire (FFQ)—of 19 targeted food items. Logistic regression analysis was used to estimate ORs and 95% CIs adjusted for demographic, lifestyle-related and disaster-related factors.

Results: Of the participants, 14.7% suffered non-specific mental health distress, and 21.2% exhibited traumatic symptoms. Multivariable adjusted logistic regression analysis showed that the former were likely to have a low intake frequency of certain foods, such as rice and bread, fish, meat, vegetables or fruit (non-juice), soya bean products, milk, and yogurt or lactobacillus drinks; the latter were also likely to have a low intake frequency of certain foods, including rice and bread, fish, meat, vegetables (non-juice), milk and yogurt or lactobacillus drinks, but conversely consumed vegetable and fruit juices more often. These associations between dietary intake and non-specific mental health distress, as well as traumatic symptoms, were predominantly observed in women.

Strengthen and limitations of this study

We examined the association between psychological distress and dietary intake among evacuees of the number of more than 60 000 after the Great East Japan Earthquake in a situation where the associations between psychological distress and food intake have never been investigated after major disasters, although major disasters could lead to psychological distress.

A limitation of this study was an overall low response rate (40.7%), and a relatively high percentage of missing observations under the category of psychological distress (10.3%). It should be noted that participants in the present study were not always representative of all the residents in Fukushima, and this could have enhanced or weakened the association between psychological distress and dietary intake.

We could not assess the associations between psychological distress and modern Japanese food, such as processed food, fast food, ready-to-eat foods or recently introduced Western food, as we used a food frequency questionnaire (FFQ) of 19 items, in which some food items that might have been consumed by evacuees with higher probability were not included.

In addition, information on portion size was not included on the FFQ, which prevented us from calculating the quantity of each food consumed and the participants’ dietary nutrient intake.

Conclusions: Psychological distress after the Great East Japan Earthquake among evacuees was associated with a low intake frequency of certain foods, and the association was predominantly observed in women.
INTRODUCTION
The Great East Japan Earthquake on 11 March 2011 and the subsequent gigantic tsunami and nuclear incident at Fukushima Daiichi Nuclear Power Plant triggered physical1–3 and mental health disorders4 in evacuees formerly residing in Fukushima Prefecture. In response to the evacuees’ concerns surrounding the disaster and ensuing accidents, the Fukushima Health Management Survey was conducted to investigate long-term effects of low-dose radiation exposure, the evacuees’ experiences of disaster-related events and their dramatically altered lifestyle.5

These experiences and prolonged unsettled lifestyle have caused a great deal of mental health problems among evacuees, such as anxiety, stress and traumatic symptoms. Prevalences of these have been of serious concern; for example, the prevalence of non-specific mental health distress among evacuees was above average for Japan.4 6 Furthermore, the prevalence of non-specific mental health distress and traumatic symptoms was higher among evacuees in Fukushima Prefecture than among evacuees in other disaster areas like Miyagi and Iwate Prefectures.7 8

In addition, disaster-related factors like poor living arrangements and decreased income most likely made the lives of evacuees even more difficult. Poor diet in particular has been found to be associated with the incidence of physical diseases and conditions. Psychological distress and poor dietary intake are known to be associated: for example, people with depression tend not to consume fresh foods.9 It is thus easy to imagine how mental health problems might be aggravated by poor dietary and nutritional intake.9 10

Given the close link between mental health and food intake alluded to above, we believe that support from a healthy diet is a truly essential aspect of alleviating the physical and mental health problems of evacuees. However, these associations between mental health problems and dietary intake have never been investigated in the context of evacuees of major disasters.

The dietary problems of evacuees with mental health problems must be clarified in order to provide them with appropriate healthcare. We therefore examined the association of psychological distress—that is, non-specific mental health distress and traumatic symptoms—with dietary intake among evacuees after the Great East Japan Earthquake.

METHODS
Participants
The data used in this cross-sectional study were obtained from the Fukushima Health Management Survey. The target population was 210 189 evacuees aged ≥0 years at the time of the earthquake, who were registered officially in fiscal year 2011 from evacuation zones including Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village, Minamisoma City, Tamura City, Yamakiya district of Kawamata Town and Iitate Village. Of these, 180 604 evacuees were over 15 years old. In total, 73 433 people aged 15 years and older responded to and were included in the Fukushima Health Management Survey of survivors of the Great East Japan Earthquake from the evacuation zones (response rate: 40.7%).1

We excluded participants with missing information for variables related to psychological distress (n=7567) or with more than three missing pieces of information for questions about dietary intake (n=2819), leaving 63 047 participants (27 901 men, 35 146 women) for inclusion in the present analysis.

The study protocol was approved by the Ethics Review Committee of Fukushima Medical University (number 1316).5

Assessment of mental health status
To assess the mental health status of participants, we used the Kessler 6 (K6) scale11 and the Post-traumatic Stress Disorder (PTSD) Checklist—Stressor-Specific Version (PCL-S).12 Of the respondents to the questionnaire, 88.6% responded directly, while 9.3% responded by proxy and 2.1% of questionnaires were missing this information.

The K6 scale was used to measure non-specific mental health distress. This scale asks participants if they have experienced any of the following six symptoms during the past 30 days: ‘feeling so sad that nothing could cheer you up’, ‘feeling nervous’, ‘hopeless’, ‘restless or fidgety’, ‘feeling everything was an effort’ and ‘feeling worthless’. Each question was scored on a five-point Likert-type scale from 0 to 4, with higher scores meaning worse mental health status. Scores thus ranged from 0 to 24. The Japanese version of the K6 has been validated.13 14 We defined non-specific mental health distress as corresponding to a K6 score of ≥13.11

The PCL-S was used to measure traumatic symptoms caused by the experience of the Great East Japan Earthquake and the following accidents. The PCL-S is a 17-item self-report measure designed to detect PTSD, where each item is scored from 1 to 5, corresponding to ‘not at all’, ‘a little bit’, ‘moderately’, ‘quite a bit’ or ‘extremely’, respectively. We classified participants as having probable PTSD if their total PCL-S score was ≥44.15

Assessment of dietary intake
Participants’ food intake was assessed by using a food frequency questionnaire (FFQ). We modified a reference FFQ used in studies conducted by the Radiation Effects Research Foundation16 and selected 19 items. The current frequency of consumption for these items was then assessed.

The 19 items were divided into 10 groups: rice and bread, fish (sashimi, cooked/boiled/fried fish), meat (chicken, beef, pork, ham, sausages), vegetables (green and
vegetables, red and orange vegetables, light-coloured vegetables), vegetable juice, fruits, fruit juice, soya bean products (natto fermented soya beans, miso soup, tofu dishes, boiled bean dishes, soya milk), milk and yogurt, and lactobacillus drinks. Food intake frequency was assessed in terms of the following six categories: everyday, 5–6 times/week, 3–4 times/week, 1–2 times/week, less than once/week and never.

To calculate daily food intake, the daily midpoint for each frequency category was used. For instance, ‘3–4 times/week’ was evaluated as 0.5 times/day. The frequency of consumption of each food was categorised by quartile, and the frequencies in the 25th centile (Q1) were lowest. Daily food consumption in the 25th centile or lower was defined as ‘low frequency’ for the corresponding food group.

Disaster-related and other variables
Participants’ basic characteristics and disaster-related factors were obtained through the self-report questionnaire. Smoking status was classified into three categories: current, former and never. Drinking status was similarly classified: once or more/month, previous drinker or less than once/month. Perceived health condition was self-reported as one of five categories: very good, good, normal, poor and very poor. History of mental illness and history of other illness were both answered by a dichotomised variable (yes, no). Leisure-time physical activity was classified into four categories: almost every day, 2–4 times/week, once/week and almost never. Sleep habits were classified into four categories: satisfied, slightly dissatisfied, quite dissatisfied and very dissatisfied/have not slept at all. Educational attainment was classified into four groups: elementary or junior high school, high school, vocational or junior college and university or graduate school. Age was categorised into five groups: 15–44, 45–54, 55–64, 65–74 and 75 years and older. Having experienced the Great East Japan Earthquake was answered with a ‘yes’ or ‘no’. There were six options for living arrangements at the time of the survey, which were classified into two groups for analysis: ‘evacuation shelter or temporary housing’ and ‘rental housing or relative’s home, own home, or other’. Changes in work situation since the disaster, loss of employment, decrease in income and death of someone close were answered with a ‘yes’ or ‘no’.

Statistical analysis
Participants’ characteristics were compared using χ² tests between participants with habitual intake of a given food group and participants without it, for each food group. Logistic regression analysis was used to investigate the association between psychological distress and low frequency of consumption of certain foods, in terms of estimated ORs and 95% CIs. Model 1 was adjusted for age and sex. Model 2 consisted of the parameters of model 1 plus the variables of smoking and drinking statuses, perceived health condition, history of mental illness, history of other illness, leisure-time physical activity, sleeping habits, educational attainment, experiences of specific events during the disaster, living arrangements, changes in working situation, loss of employment, decreased income and death of someone close.

All statistical analyses were conducted with SPSS Statistics for Windows, V.23.0 software (IBM, Armonk, New York, New York, USA). All tests were two-sided; p<0.05 was considered statistically significant.

RESULTS
Of the 63,047 participants included in our analysis, 14.7% had a K6 score of ≥13 and 21.2% had a PCL-S score of ≥44. Above-threshold scores were more common in women than in men (12.1% vs 16.7%, and 17.5% vs 23.6%, respectively).

Table 1 shows the demographic, lifestyle-related and disaster-related characteristics of participants stratified according to the frequency of food consumption status for different food groups. Compared with older participants, younger participants tended to have a low frequency of consumption of rice and bread, fish, vegetables (non-juice), fruit (non-juice), soya bean products and milk. Assuming the high-consumption versus low-consumption cut-offs described in the column headings in table 1, for most food groups participants with the lower frequency of the pair were more likely to: drink once or more per month, be a current smoker, not perform any physical activities in their leisure time and have suffered decreased income.

The frequency of food consumption and percentage of participants with a low frequency of food consumption are shown in table 2. In both sexes, a low frequency of consumption was more common in participants with K6≥13 than in participants with K6<13 for rice and bread, fish, meat, vegetables (non-juice), fruits (non-juice), soya bean products, milk and yogurt or lactobacillus drinks. Moreover, a low frequency of food consumption was more common in participants with PCL≥44 than in participants with PCL<44 for rice and bread, meat and milk. Conversely, a low frequency of food consumption was more common in participants with PCL<44 than in participants with PCL≥44 for vegetable juice and fruit juice (all p<0.05).

In age-adjusted logistic models, non-specific mental health distress was positively associated with a low frequency of food consumption for rice and bread, fish, meat, vegetables (non-juice), fruits (non-juice), soya bean products, milk and yogurt or lactobacillus drinks (model 1) (table 3). In the multivariable adjusted model, these positive associations between non-specific mental health distress and low frequency of food consumption were also confirmed for rice and bread, fish, meat, vegetables (non-juice), fruits (non-juice), soya bean products, milk and yogurt and/or lactobacillus drinks; 1.16 (1.08 to 1.25), 1.22 (1.12 to 1.32), 1.09 (1.02 to 1.17), 1.12 (1.04 to 1.20), 1.13 (1.05 to 1.21), 1.08...
| Table 1 | Participant characteristics according to frequency of food consumption status (2011 data) |
|---------|-------------------------------------------------------------------------------------|
| **Number (%)** | **Rice and bread** | **Fish** | **Meat** | **Vegetables (non-juice)** | **Vegetable juice** |
| | Total | Daily | 5–6 times/week or less | p value | 3–4 times/week or more | 1–2 times/week or less | p value | Daily | 5–6 times/week or less | p value | Less than once/week or more | Never | p value |
| Sex (n=63,047) | | | | | | | | | | | | | | |
| Men | 27,901 | 26,375 | 1526 | 0.10 | 14,597 | 13,304 | 0.045 | 16,454 | 11,447 | <0.001 | 16,620 | 11,447 | <0.001 | 14,754 | 13,151 | 0.31 |
| Age (years) (n=63,047) | | | | | | | | | | | | | | |
| 15–44 | 20,384 | 18,699 | 1,685 | <0.001 | 7,087 | 13,297 | <0.001 | 15,367 | 5,017 | <0.001 | 11,560 | 8,824 | <0.001 | 10,795 | 9,589 | <0.001 |
| 45–54 | 8,923 | 8,410 | (14.1) | <0.001 | 5,585 | 3,338 | (12.4) | 9,819 | 4,685 | <0.001 | 7,564 | 6,890 | <0.001 | 4,401 | 4,522 | <0.001 |
| 55–64 | 14,504 | 13,871 | (23.2) | <0.001 | 7,704 | 5,723 | (20.0) | 11,616 | 8,196 | <0.001 | 8,201 | 7,177 | <0.001 | 5,602 | 6,589 | <0.001 |
| 65–74 | 10,378 | 10,076 | (16.9) | <0.001 | 7,246 | 3,132 | (12.8) | 5,947 | 1,877 | <0.001 | 5,302 | 1,782 | <0.001 | 3,154 | 1,680 | <0.001 |
| ≥75 | 8,858 | 8,626 | (14.5) | <0.001 | 5,980 | 2,878 | (11.9) | 4,396 | 2,462 | <0.001 | 3,827 | 1,763 | <0.001 | 2,081 | 1,457 | <0.001 |
| Drinking status (n=62,343) | | | | | | | | | | | | | | |
| Once or more per month | 27,734 | 25,906 | 18,280 | <0.001 | 14,744 | 12,990 | <0.001 | 16,915 | 10,819 | <0.001 | 15,046 | 10,230 | <0.001 | 13,402 | 13,402 | <0.001 |
| Smoking status (n=61,933) | | | | | | | | | | | | | | |
| Current | 13,402 | 12,333 | (21.0) | <0.001 | 5,985 | 7,507 | (25.5) | 8,430 | 4,972 | <0.001 | 7,106 | 6,296 | <0.001 | 6,428 | 6,974 | <0.001 |
| Health condition (n=62,009) | | | | | | | | | | | | | | |
| Poor/very poor | 11,547 | 10,716 | (18.2) | <0.001 | 5,634 | 5,223 | (18.7) | 6,544 | 5,143 | <0.001 | 6,714 | 3,933 | <0.001 | 6,223 | 5,324 | <0.001 |
| History of mental illness (n=61,239) | | | | | | | | | | | | | | |
| Yes | 3406 | 3129 | (5.4) | <0.001 | 1,767 | 1,639 | (5.7) | 1,929 | 1,477 | <0.001 | 2,034 | 1,355 | <0.001 | 1,852 | 1,554 | 0.02 |
| History of other illness (n=63,047) | | | | | | | | | | | | | | |
| Yes | 62,912 | 59,566 | (99.8) | <0.001 | 33,156 | 29,756 | (99.8) | 38,496 | 24,416 | 0.23 | 41,882 | 21,030 | 0.01 | 33,178 | 29,734 | 0.06 |
| Leisure-time physical activity (n=62,150) | | | | | | | | | | | | | | |
| Almost never | 33,060 | 31,082 | (52.8) | <0.001 | 15,152 | 17,908 | (60.6) | 20,875 | 12,185 | <0.001 | 19,812 | 13,248 | <0.001 | 16,010 | 17,050 | <0.001 |
| Sleeping habits (n=52,474) | | | | | | | | | | | | | | |
| Very dissatisfied or have | 22,540 | 20,000 | (4.0) | <0.001 | 11,166 | 11,383 | (4.5) | 12,551 | 9,999 | <0.001 | 13,701 | 8,844 | <0.001 | 12,222 | 10,322 | <0.001 |
| Educational attainment (n=60,998) | | | | | | | | | | | | | | |
| University/graduate school | 54,577 | 50,966 | (8.8) | <0.001 | 25,967 | 28,617 | (9.9) | 36,971 | 17,607 | <0.001 | 37,499 | 17,087 | <0.001 | 30,590 | 24,278 | <0.001 | 0.01 |

Continued
| Table 1 Continued |
|-------------------|
| **Number (%)**    |
|                   |
| **Rice and bread**|
| **Fish**          |
| **Meat**          |
| **Vegetables (non-juice)** |
| **Vegetable juice** |
| **Total** | **Daily** | **5–6 times/week or less** | **3–4 times/week or more** | **1–2 times/week or less** | **p value** | **5–6 times/week or less** | **3–4 times/week or more** | **1–2 times/week or less** | **p value** | **5–6 times/week or less** | **3–4 times/week or more** | **1–2 times/week or less** | **p value** |
| Rice and bread    |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Fish             |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Meat             |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Vegetables (non-juice) |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Vegetable juice  |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| **Experiences of the Great East Japan Earthquake** (n=63,047) |
| Earthquake       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Yes              | 61,014 | 57,769 | 32,45 | 0.14  | 32,055 | 28,959 | <0.001 | 37,421 | 23,593 | <0.001 | 40,596 | 20,418 | 0.68   | 32,143 | 28,871 | 0.03   |
| No               | 32,055 | 28,959 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Tsunami (n=63,047) |
| Yes              | 12,435 | 11,690 | 745   | <0.001| 6,767  | 5,566  | <0.001 | 7,350  | 5,085  | <0.001 | 8,074  | 4,361  | <0.001 | 6,688  | 5,567  | <0.001 |
| No               | 30,800 | 28,994 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Nuclear reactor accident (n=63,047) |
| Yes              | 32,846 | 30,880 | 1,966 | <0.001| 17,967 | 14,879 | <0.001 | 19,661 | 13,185 | <0.001 | 22,108 | 10,738 | <0.001 | 17,655 | 15,191 | <0.001 |
| No               | 30,199 | 28,843 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| None (n=63,047)   |
| Yes              | 696    | 663    | 33    | 0.27  | 378    | 318    | 0.21   | 402    | 294    | 0.03   | 480    | 216    | 0.18   | 396    | 300    | 0.02   |
| Living arrangements (n=63,047) |
| Evacuation shelter or temporary housing |
| Yes              | 6,599  | 6,206  | 393   | <0.01 | 3,598  | 3,001  | <0.001 | 3,659  | 2,940  | <0.001 | 4,175  | 2,424  | <0.001 | 3,662  | 2,937  | <0.001 |
| No               | 30,074 | 24,477 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Changes in work situation (n=60,077) |
| Yes              | 32,118 | 30,074 | 2,144 | <0.001| 16,160 | 15,958 | <0.001 | 19,970 | 12,148 | <0.001 | 20,634 | 11,484 | <0.001 | 16,981 | 15,137 | 0.08   |
| No               | 27,959 | 24,006 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Loss of employment (n=63,047) |
| Yes              | 12,702 | 11,812 | 890   | <0.001| 6,408  | 6,294  | <0.001 | 7,887  | 4,815  | <0.01  | 8,285  | 4,417  | <0.001 | 6,569  | 6,133  | 0.01   |
| No               | 30,345 | 26,133 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Decreased income (n=63,047) |
| Yes              | 11,513 | 10,829 | 684   | <0.001| 5,789  | 5,724  | <0.001 | 7,178  | 4,335  | <0.001 | 7,235  | 4,278  | <0.001 | 6,063  | 5,450  | 0.42   |
| No               | 21,534 | 18,218 |       |       |        |        |        |        |        |        |        |        |        |        |        |        |
| Death of someone close (n=62,081) |
| Yes              | 12,006 | 11,287 | 719   | <0.001| 6,602  | 5,404  | <0.001 | 7,264  | 4,742  | 0.04   | 8,092  | 3,914  | 0.03   | 6,574  | 5,432  | <0.001 |
| **Fruits (non-juice)** |
| **Fruit juice**  |
| **Soya bean products** |
| **Milk**         |
| **Yogurt and lactobacillus drinks** |
| **Sex (n=63,047)** |
| Men              | 17,332 | 10,569 | 0.01  | 16,397 | 11,504 | 0.48   | 21,517 | 6,834  | <0.001 | 19,356 | 8,545  | <0.001 | 21,089 | 6,812  | <0.001 |
| Age (years) (n=63,047) |
| 15–44            | 11,061 | 9,323  | 0.01  | 13,122 | 7,262  | <0.001 | 13,264 | 7,120  | <0.001 | 14,436 | 5,948  | <0.001 | 17,075 | 3,309  | <0.01  |

*Uemura M, et al. BMJ Open 2016;6:e011534. doi:10.1136/bmjopen-2016-011534"
| Table 1 Continued |
|-------------------|
| **Fruits (non-juice)** | **Soya bean products** | **Milk** | **Yogurt and lactobacillus drinks** |
| **1–2 times/week or more** | **Less than once/week or never** | **p value** | **5–6 times/week or less** | **Daily** | **p value** | **1–2 times/week or more** | **Less than once/week or never** | **p value** |
| 45–54 | 5754 (12.9) | 3169 (17.1) | 4907 (13.2) | 4016 (15.4) | 6577 (13.4) | 2346 (16.8) | 6188 (13.7) | 2735 (15.3) | 7363 (14.0) |
| 55–64 | 11 125 (25.0) | 3379 (18.2) | 7915 (21.4) | 6589 (25.3) | 12 007 (24.5) | 2497 (19.7) | 10 409 (23.0) | 4095 (22.9) | 12 056 (24.4) |
| 65–74 | 8930 (20.1) | 1448 (7.8) | 6015 (16.2) | 4363 (16.8) | 9296 (18.9) | 1082 (7.7) | 7799 (17.3) | 2579 (14.4) | 8755 (16.6) |
| ≥75 | 7647 (17.2) | 1211 (6.5) | 5084 (13.7) | 3774 (14.5) | 7937 (16.2) | 921 (6.6) | 6348 (14.1) | 2510 (14.0) | 7350 (15.0) |

**Drinking status (n=62 343)**

| **Once or more per month** | **p value** |
|---------------------------|------------|
| 17 711 (40.3) | 10 023 (54.4) | <0.001 |
| 15 582 (42.6) | 12 152 (47.2) | <0.001 |
| 21 409 (44.2) | 6325 (45.6) | <0.001 |
| 19 427 (43.5) | 8307 (47.0) | <0.001 |
| 21 910 (42.1) | 5824 (56.3) | <0.001 |

**Smoking status (n=61 933)**

| **Current** | **p value** |
|-------------|------------|
| 6661 (15.3) | 6741 (36.8) | <0.001 |
| 7447 (20.5) | 5955 (23.3) | <0.001 |
| 9247 (19.2) | 4155 (30.1) | <0.001 |
| 8435 (19.0) | 4967 (28.3) | <0.001 |
| 9660 (18.7) | 3742 (36.3) | <0.001 |

**Health condition (n=62 009)**

| **Poor/very poor** | **p value** |
|---------------------|------------|
| 8373 (19.1) | 3174 (17.3) | <0.001 |
| 6576 (18.1) | 4971 (19.4) | <0.001 |
| 8849 (18.4) | 2698 (19.6) | <0.001 |
| 8025 (18.1) | 3522 (20.0) | <0.001 |
| 9528 (18.5) | 2019 (19.6) | <0.001 |

**History of mental illness (n=61 239)**

| **Yes** | **p value** |
|---------|------------|
| 2370 (5.5) | 1036 (5.8) | 0.10 |
| 1959 (5.5) | 1447 (5.7) | 0.08 |
| 2542 (5.5) | 864 (6.4) | <0.001 |
| 2403 (5.5) | 1003 (5.8) | 0.07 |
| 2770 (5.4) | 636 (6.3) | <0.01 |

**History of other illness (n=63 047)**

| **Yes** | **p value** |
|---------|------------|
| 44 428 (99.8) | 18 484 (99.8) | 0.14 |
| 36 954 (99.8) | 25 958 (99.8) | 0.05 |
| 48 984 (99.8) | 13 928 (99.7) | 0.06 |
| 45 089 (99.8) | 17 823 (99.8) | 0.16 |
| 52 487 (99.8) | 10 425 (99.8) | 0.49 |

**Leisure-time physical activity**

| **Almost never** | **p value** |
|------------------|------------|
| 20 960 (47.9) | 12 100 (65.9) | <0.001 |
| 14 597 (56.8) | 18 463 (50.6) | <0.001 |
| 23 962 (49.6) | 9098 (65.6) | <0.001 |
| 22 488 (50.5) | 10 572 (59.9) | <0.001 |
| 26 734 (51.6) | 6326 (61.3) | <0.001 |

**Sleeping habits (n=52 474)**

| **Very dissatisfied or have not slept at all** | **p value** |
|-----------------------------------------------|------------|
| 1502 (4.1) | 752 (4.7) | <0.001 |
| 1282 (4.2) | 972 (4.5) | <0.01 |
| 1644 (4.1) | 610 (5.1) | <0.01 |
| 1512 (4.0) | 742 (5.0) | <0.01 |
| 1815 (4.1) | 439 (5.1) | <0.01 |

**Educational attainment (n=60 998)**

| **University/graduate school** | **p value** |
|--------------------------------|------------|
| 3809 (8.9) | 1648 (9.1) | <0.001 |
| 3310 (9.2) | 2147 (8.5) | <0.001 |
| 4076 (8.6) | 1381 (10.2) | <0.001 |
| 4197 (9.6) | 1260 (7.3) | <0.001 |
| 4643 (9.1) | 814 (8.1) | <0.001 |

**Experiences of the Great East Japan Earthquake**

| **Earthquake (n=63 047)** | **p value** |
|---------------------------|------------|
| Yes | 43 040 (96.7) | 17 974 (97.0) | 0.02 |
| 35 806 (96.7) | 25 208 (96.9) | 0.03 |
| 47 487 (96.8) | 13 527 (96.9) | 0.28 |
| 43 737 (96.8) | 17 277 (96.7) | 0.25 |
| 50 952 (96.9) | 10 062 (96.3) | <0.01 |

**Tsunami (n=63 047)**

| **Yes** | **p value** |
|---------|------------|
| 8762 (19.7) | 3673 (19.8) | 0.35 |
| 7523 (20.3) | 4912 (18.9) | <0.001 |
| 9737 (19.8) | 2698 (19.3) | 0.09 |
| 8985 (19.9) | 3450 (19.7) | 0.05 |
| 10 368 (19.7) | 2067 (19.8) | 0.44 |

Continued
|                          | Fruits (non-juice) | Fruit juice | Soya bean products | Milk | Yogurt and lactobacillus drinks |
|--------------------------|--------------------|-------------|--------------------|------|-------------------------------|
|                          | 1–2 times/week or more | Less than once/week or never | Less than one/week or more | Daily | 5–6 times/week or less | 1–2 times/week or more | Less than once/week or never | Daily | p value* | 1–2 times/week or more | Less than once/week or never | Daily | p value* |
| Nuclear reactor accident (n=63 047) |                  |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 23 569 (52.9)      | 9277 (50.1)    | <0.001            | 19 313 (52.1) | 13 533 (52.0) | 0.41                 | 25 731 (52.4) | 7115 (50.9) | 0.001 | 23 362 (51.7) | 9484 (53.1) | <0.001 | 27 359 (52.0) | 5487 (52.5) | 0.18 |
| None (n=63 047)          |                  |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 509 (1.1)         | 187 (1.0)      | 0.08              | 428 (1.2)   | 268 (1.0)      | 0.08                 | 557 (1.1)   | 139 (1.0)   | 0.09  | 518 (1.1)    | 178 (1.0)   | 0.06  | 570 (1.1)    | 126 (1.2)   | 0.15 |
| Living arrangements (n=63 047) |                |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Evacuation shelter or temporary housing | 4743 (10.7) | 1856 (10.0) | <0.01             | 2664 (10.2) | 3935 (10.6) | 0.70                | 5153 (10.5) | 1446 (10.4) | 0.32  | 4579 (10.1)  | 2020 (11.3) | <0.001 | 5441 (10.3)  | 1158 (11.1) | 0.01 |
| Changes in work situation (n=60 077) |               |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 21 856 (51.9)     | 10 262 (57.1)  | <0.001            | 18 994 (53.9) | 13 124 (52.9) | <0.01              | 24 406 (52.3) | 7712 (57.3) | <0.001 | 22 826 (53.1) | 9292 (54.5) | <0.001 | 26 755 (53.5) | 5363 (53.4) | 0.46 |
| Loss of employment (n=63 047) |                |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 8922 (20.0)       | 3780 (20.4)    | 0.16              | 7380 (19.9) | 5322 (20.5)   | 0.05                | 9691 (19.7) | 3011 (21.6) | <0.001 | 9106 (20.2)  | 3596 (20.1) | 0.47  | 10 768 (20.5) | 1934 (18.5) | <0.001 |
| Decreased income (n=63 047) |                |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 7562 (17.0)       | 3951 (21.3)    | <0.001            | 6856 (18.5) | 4657 (17.9)   | 0.03                | 8735 (17.8) | 2778 (19.9) | <0.001 | 8075 (17.9)  | 3438 (19.2) | <0.001 | 9402 (17.9)  | 2111 (20.2) | <0.001 |
| Death of someone close (n=62 081) |              |                   |                   |      |                  |                      |                      |                      |      |                      |                      |      |          |
| Yes                      | 8788 (20.1)       | 3218 (17.6)    | <0.001            | 7198 (19.8) | 4808 (18.7)   | 0.001              | 9466 (19.6) | 2540 (18.4) | 0.001 | 8787 (19.8)  | 3219 (18.3) | <0.001 | 10 220 (19.7) | 1786 (17.4) | <0.001 |

*Obtained from χ² test.
Table 2  Frequency of daily food consumption and percentage of participants with low frequency of food consumption according to psychological distress status

| Frequency of daily food consumption (times/day) | Percentage of participants with food consumption of 25th centile (Q1) or less, % |
|-----------------------------------------------|--------------------------------------------------------------------------|
|                                               | 25th centile (Q1) | Total | Men | 25th centile (Q1) | Total | Men | 25th centile (Q1) | Total | Men | 25th centile (Q1) | Total | Men |
|                                               | Mean | K6<13 | K6≥13 | p Value* | PCL<44 | K6<13 | K6≥13 | P Value* | PCL<44 | K6<13 | K6≥13 | P Value* | PCL<44 | K6<13 | K6≥13 | P Value* | PCL<44 | K6<13 | K6≥13 | P Value* | PCL<44 | K6<13 | K6≥13 | P Value* |
| Rice and bread                                | 1.3  | 0.9   | 17.5  | 21.1  | <0.001 | 17.4  | 20.4  | <0.001 | 21.7  | 25.8  | <0.001 | 21.5  | 25.3  | <0.001 |
| Fish                                          | 0.4  | 0.1   | 12.4  | 16.0  | <0.001 | 12.6  | 14.1  | <0.001 | 13.1  | 16.9  | <0.001 | 13.4  | 14.4  | 0.06  |
| Meat                                          | 0.7  | 0.2   | 22.7  | 26.1  | <0.001 | 22.3  | 26.7  | <0.001 | 25.9  | 27.4  | 0.06  | 25.4  | 29.4  | <0.001 |
| Vegetables (non-juice)                        | 1.5  | 0.5   | 25.3  | 28.5  | <0.001 | 25.7  | 26.2  | 0.23  | 32.0  | 36.8  | <0.001 | 32.4  | 33.6  | 0.10  |
| Vegetable juice                               | 0.1  | 0     | 47.5  | 46.0  | 0.01   | 48.0  | 44.4  | <0.001 | 47.2  | 46.3  | 0.33  | 47.8  | 44.0  | <0.001 |
| Fruits (non-juice)                            | 0.4  | 0.1   | 29.1  | 30.8  | 0.01   | 29.9  | 27.6  | <0.001 | 37.3  | 41.8  | <0.001 | 38.1  | 36.9  | 0.12  |
| Fruit juice                                   | 0.1  | 0     | 41.1  | 42.1  | 0.06   | 41.6  | 39.9  | <0.001 | 41.0  | 42.8  | 0.04  | 41.5  | 39.7  | 0.02  |
| Soya bean products                            | 1.7  | 0.6   | 24.1  | 27.0  | <0.001 | 24.6  | 24.2  | 0.34  | 26.3  | 30.3  | <0.001 | 26.7  | 27.0  | 0.68  |
| Milk                                          | 0.4  | 0     | 27.7  | 31.8  | <0.001 | 28.0  | 29.6  | <0.001 | 30.1  | 34.6  | <0.001 | 30.4  | 31.8  | 0.045 |
| Yogurt and lactobacillus drinks               | 0.4  | 0     | 16.4  | 17.7  | 0.001  | 16.6  | 16.6  | 0.92  | 24.1  | 26.9  | <0.001 | 24.3  | 25.2  | 0.17  |

*p Obtained from χ² test.
| Participants with low-frequency consumption within group, n/N (%) | Total | Men | Women |
|---------------------------------------------------------------|-------|-----|-------|
| **Rice and bread**                                            |       |     |       |
| K6<13                                                         | 9850/56 151 (17.5) | 1 (reference) | 1 (reference) | 1 (reference) |
| K6≥13                                                        | 2047/9715 (21.1) | 1.31 (1.24 to 1.39) | 1.16 (1.08 to 1.25) | 1.25 (1.15 to 1.36) | 1.14 (1.02 to 1.28) |
| **Fish**                                                     |       |     |       |
| K6<13                                                         | 6984/56 151 (12.4) | 1.43 (1.35 to 1.52) | 1.22 (1.12 to 1.32) | 1.37 (1.24 to 1.51) | 1.17 (1.03 to 1.34) |
| K6≥13                                                        | 1550/9715 (16.0) | 1.43 (1.35 to 1.52) | 1.22 (1.12 to 1.32) | 1.43 (1.35 to 1.52) | 1.22 (1.12 to 1.32) |
| **Meat**                                                     |       |     |       |
| K6<13                                                         | 12 756/56 151 (22.7) | 1.20 (1.14 to 1.26) | 1.09 (1.02 to 1.17) | 1.09 (1.00 to 1.18) | 0.99 (0.88 to 1.11) |
| K6≥13                                                        | 2531/9715 (26.1) | 1.20 (1.14 to 1.26) | 1.09 (1.02 to 1.17) | 1.20 (1.14 to 1.26) | 1.09 (1.02 to 1.17) |
| **Vegetables (non-juice)**                                   |       |     |       |
| K6<13                                                         | 13 611/56 151 (25.3) | 1.32 (1.26 to 1.39) | 1.12 (1.04 to 1.20) | 1.32 (1.26 to 1.39) | 1.12 (1.04 to 1.20) |
| K6≥13                                                        | 2637/9715 (28.5) | 1.32 (1.26 to 1.39) | 1.12 (1.04 to 1.20) | 1.32 (1.26 to 1.39) | 1.12 (1.04 to 1.20) |
| **Vegetable juice**                                          |       |     |       |
| K6<13                                                         | 25 532/56 151 (47.5) | 0.94 (0.90 to 0.99) | 1.00 (0.95 to 1.07) | 0.94 (0.90 to 0.99) | 1.00 (0.95 to 1.07) |
| K6≥13                                                        | 4256/9715 (46.0) | 0.94 (0.90 to 0.99) | 1.00 (0.95 to 1.07) | 0.94 (0.90 to 0.99) | 1.00 (0.95 to 1.07) |
| **Fruits (non-juice)**                                       |       |     |       |
| K6<13                                                         | 15 680/56 151 (29.1) | 1.26 (1.20 to 1.32) | 1.13 (1.05 to 1.21) | 1.26 (1.20 to 1.32) | 1.13 (1.05 to 1.21) |
| K6≥13                                                        | 2850/9715 (30.8) | 1.26 (1.20 to 1.32) | 1.13 (1.05 to 1.21) | 1.26 (1.20 to 1.32) | 1.13 (1.05 to 1.21) |
| **Fruit juice**                                              |       |     |       |
| K6<13                                                         | 22 110/56 151 (41.1) | 1.03 (0.99 to 1.08) | 1.03 (0.96 to 1.09) | 1.03 (0.99 to 1.08) | 1.03 (0.96 to 1.09) |
| K6≥13                                                        | 3894/9715 (42.1) | 1.03 (0.99 to 1.08) | 1.03 (0.96 to 1.09) | 1.03 (0.99 to 1.08) | 1.03 (0.96 to 1.09) |
| **Soya bean products**                                       |       |     |       |
| K6<13                                                         | 13 524/56 151 (24.1) | 1.28 (1.22 to 1.35) | 1.08 (1.01 to 1.16) | 1.28 (1.22 to 1.35) | 1.08 (1.01 to 1.16) |
| K6≥13                                                        | 2619/9715 (27.0) | 1.28 (1.22 to 1.35) | 1.08 (1.01 to 1.16) | 1.28 (1.22 to 1.35) | 1.08 (1.01 to 1.16) |
| **Milk**                                                     |       |     |       |
| K6<13                                                         | 14 930/56 151 (27.7) | 1.24 (1.18 to 1.30) | 1.18 (1.10 to 1.26) | 1.24 (1.18 to 1.30) | 1.18 (1.10 to 1.26) |
| K6≥13                                                        | 2937/9715 (32.8) | 1.24 (1.18 to 1.30) | 1.18 (1.10 to 1.26) | 1.24 (1.18 to 1.30) | 1.18 (1.10 to 1.26) |
| **Yogurt and lactobacillus drinks**                          |       |     |       |
| K6<13                                                         | 8811/56 151 (16.4) | 1.22 (1.15 to 1.29) | 1.23 (1.13 to 1.34) | 1.22 (1.15 to 1.29) | 1.23 (1.13 to 1.34) |
| K6≥13                                                        | 1637/9715 (17.7) | 1.22 (1.15 to 1.29) | 1.23 (1.13 to 1.34) | 1.22 (1.15 to 1.29) | 1.23 (1.13 to 1.34) |

n, indicates number in group; N, number of participants.
Model 1: Adjusted for age and sex.
Model 2: Model 1+smoking status, drinking status, perceived health condition, history of mental illness, history of other illness, leisure-time physical activity, sleeping habits, educational attainment, experiences of the Great East Japan Earthquake, living arrangements, changes in work situation, loss of employment, decreased income and death of someone close.

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(1.01 to 1.16), 1.18 (1.10 to 1.26), 1.23 (1.13 to 1.34), respectively (model 2). In the analysis stratified by sex, these positive associations between non-specific mental health distress and low frequency of food consumption were predominantly observed in women (all p<0.05) (model 2).

In the age-adjusted logistic model, traumatic symptoms were positively associated with a low intake frequency for rice and bread, fish, meat, vegetables (non-juice), fruits (non-juice), soya bean products, milk and yogurt or lactobacillus drinks (model 1) (table 4). On the other hand, traumatic symptoms were inversely associated with low frequencies of vegetable juice and fruit juice intake. In the multivariable adjusted model, these associations were replicated for rice and bread, fish, meat, vegetables (non-juice), vegetable juice, fruit juice, milk and yogurt or lactobacillus drinks 1.13 (1.06 to 1.21), 1.14 (1.07 to 1.22), 1.07 (1.01 to 1.15), 1.07 (1.00 to 1.14), 0.92 (0.88 to 0.98), 0.91 (0.86 to 0.96), 1.07 (1.01 to 1.13), 1.14 (1.06 to 1.23), respectively; however, no significant associations for fruits (non-juice) and soya bean products were observed (model 2). In the analysis stratified by sex, these associations between traumatic symptoms and frequency of food consumption were predominantly observed in women (all p<0.05) (model 2).

DISCUSSION

In data from the baseline survey of evacuees of the Great East Japan Earthquake, psychological distress was significantly associated with a low intake frequency for certain foods, including rice and bread, fish, meat, vegetables (non-juice) and dairy products, after adjustment for a number of potentially confounding lifestyle-related and disaster-related variables. These associations were predominantly observed in men.

One previous baseline study from Iwate Prefecture reported that participants in difficult living conditions were likely to have unhealthy dietary patterns and lower intake frequency of certain foods. Another study suggested that evacuees living in shelters experience difficulties in obtaining and preparing meals due to shortages of cooking equipment/utilities and of food generally. However, we found a novel indication that the associations between psychological distress and low frequency of intake of certain foods were independent of several confounding factors, including disaster-related factors like living arrangements, predominantly in women. After a stratified analysis by living arrangement, the association between psychological distress and dietary intake was essentially the same between evacuees living in evacuation shelters or temporary housing and evacuees living in rental housing, relatives’ homes or their own home (see online supplementary tables S1 and S2). In the same way, as a result of the stratified analysis by socioeconomic conditions, the aforementioned association was essentially the same among all evacuees regardless of whether they had suffered from decreased income or not (see online supplementary tables S3 and S4). Thus, the observed low frequency of food consumption could have been caused by psychological distress. However, the low intake frequency of certain foods also could be caused by unexamined factors. For instance, an inability to grow or ingest local Fukushima products due to concerns over radiation contamination could be regarded as a major cause for the low intake frequency of certain foods. Furthermore, other unexamined factors, such as limited accessibility of certain foods, limited affordability and low availability, might have caused low intake frequency of certain foods.

The associations between non-specific mental health distress and the low frequencies for various food groups (refer to table 3) are in accordance with previous studies that carefully tracked dietary patterns of the same food items. However, the associations between non-specific mental health distress and low frequency of intake of meat, vegetables (non-juice), fruits (non-juice) and soya bean products were found only in women. The associations in men disappeared after adjustment for health condition, lifestyle-related and disaster-related factors (refer to model 2 in table 3), which can be interpreted as poor health conditions, lifestyle-related and disaster-related factors causing low frequency of intake of such foods in men. Participants with psychological distress might have lost the motivation to cook or to pay careful attention to their own health by taking meals, as in Japan this task is traditionally carried out more frequently by women. This might be the reason that the association between psychological distress and dietary intake independent from health condition, lifestyle-related and disaster-related factors was predominantly observed in women. In addition, associations between depression and some nutrients such as vitamin B (including folate) and n-3 polyunsaturated fatty acids (n-3PUFAs) have been reported. Therefore, our observed associations between non-specific mental health distress and low intake frequency of fish and vegetables align well with the results of previous studies. Especially interesting against the background of high mental distress and low frequency of dietary intake are the associations between high traumatic symptoms and high consumption of vegetable and fruit juices observed in women in this study. This might be attributable to the fact that vegetable and fruit juices are readily available for consumption with little preparation, which is more favourable from the viewpoint of women, who have more opportunities to cook in Japanese culture. More frequent juice intake may have led to weight gain and even diabetes among evacuees.

From a different viewpoint, participants who did not habitually eat fish, vegetables and probiotic products before the disaster may have been more likely to be in worse mental health condition than participants who did. Previous cohort studies reported that high intake of fish containing n-3PUFAs, vegetables containing vitamin B, probiotic products and a diverse diet rich
| Food Group          | Participants with low-frequency consumption within group, n/N (%) | Total Men | Total Women | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
|---------------------|---------------------------------------------------------------|-----------|-------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Rice and bread      |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 9059/51 934 (17.4)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.27 (1.21 to 1.33) | 1.13 (1.06 to 1.21) | 1.23 (1.14 to 1.32) | 1.10 (1.00 to 1.22) | 1.31 (1.23 to 1.40) | 1.15 (1.05 to 1.26) |
| PCL≥44              | 2838/13 932 (20.4)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.31 (1.24 to 1.39) | 1.14 (1.07 to 1.22) | 1.22 (1.11 to 1.33) | 1.10 (0.98 to 1.25) | 1.37 (1.28 to 1.47) | 1.24 (1.12 to 1.37) |
| Fish                |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 6564/51 934 (12.6)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.22 (1.17 to 1.28) | 1.07 (1.01 to 1.15) | 1.13 (1.06 to 1.22) | 1.13 (1.02 to 1.24) | 1.28 (1.21 to 1.36) | 1.15 (1.06 to 1.25) |
| PCL≥44              | 1970/13 932 (14.1)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.23 (1.18 to 1.29) | 1.07 (1.00 to 1.14) | 1.20 (1.12 to 1.29) | 1.04 (0.95 to 1.15) | 1.26 (1.18 to 1.34) | 1.10 (1.01 to 1.20) |
| Vegetables (non-juice) |                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 12 797/51 934 (25.7)                                          | 1 (reference) | 1 (reference) | 1 (reference) | 0.87 (0.84 to 0.91) | 0.92 (0.88 to 0.98) | 0.86 (0.80 to 0.91) | 0.92 (0.85 to 1.00) | 0.88 (0.84 to 0.93) | 0.93 (0.87 to 0.997) |
| PCL≥44              | 3451/13 932 (26.2)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 0.91 (0.87 to 0.95) | 0.91 (0.86 to 0.96) | 0.91 (0.86 to 0.97) | 0.95 (0.97 to 1.03) | 0.91 (0.86 to 0.95) | 0.89 (0.83 to 0.95) |
| Fruits (non-juice)  |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 14 886/51 934 (29.9)                                          | 1 (reference) | 1 (reference) | 1 (reference) | 1.13 (1.08 to 1.19) | 1.04 (0.97 to 1.10) | 1.12 (1.04 to 1.20) | 1.06 (0.97 to 1.17) | 1.15 (1.08 to 1.22) | 1.02 (0.94 to 1.12) |
| PCL≥44              | 3644/13 932 (27.6)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.17 (1.12 to 1.23) | 1.07 (1.00 to 1.14) | 1.18 (1.10 to 1.27) | 1.00 (0.90 to 1.10) | 1.16 (1.10 to 1.23) | 0.99 (0.91 to 1.08) |
| Fruit juice         |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 20 747/51 934 (41.6)                                          | 1 (reference) | 1 (reference) | 1 (reference) | 0.91 (0.87 to 0.95) | 0.91 (0.86 to 0.96) | 0.91 (0.86 to 0.97) | 0.95 (0.97 to 1.03) | 0.91 (0.86 to 0.95) | 0.89 (0.83 to 0.95) |
| PCL≥44              | 5257/13 932 (39.9)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.17 (1.12 to 1.23) | 1.07 (1.00 to 1.14) | 1.18 (1.10 to 1.27) | 1.00 (0.90 to 1.10) | 1.16 (1.10 to 1.23) | 0.99 (0.91 to 1.08) |
| Soya bean products  |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 12 772/51 934 (24.6)                                          | 1 (reference) | 1 (reference) | 1 (reference) | 1.17 (1.12 to 1.23) | 1.07 (1.00 to 1.14) | 1.18 (1.10 to 1.27) | 1.00 (0.90 to 1.10) | 1.16 (1.10 to 1.23) | 0.99 (0.91 to 1.08) |
| PCL≥44              | 3371/13 932 (24.2)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.12 (1.08 to 1.17) | 1.07 (1.01 to 1.13) | 1.11 (1.04 to 1.18) | 1.13 (1.03 to 1.23) | 1.13 (1.07 to 1.19) | 1.03 (0.95 to 1.11) |
| Milk                |                                                               |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 13 960/51 934 (28.0)                                          | 1 (reference) | 1 (reference) | 1 (reference) | 1.17 (1.12 to 1.23) | 1.07 (1.00 to 1.14) | 1.18 (1.10 to 1.27) | 1.00 (0.90 to 1.10) | 1.16 (1.10 to 1.23) | 0.99 (0.91 to 1.08) |
| PCL≥44              | 3907/13 932 (29.6)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.11 (1.07 to 1.17) | 1.07 (1.01 to 1.13) | 1.11 (1.04 to 1.18) | 1.13 (1.03 to 1.23) | 1.13 (1.07 to 1.19) | 1.03 (0.95 to 1.11) |
| Yogurt and lactobacillus drinks |                         |           |             |         |         |         |         |         |         |         |         |
| PCL<44              | 8260/51 934 (16.6)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.11 (1.05 to 1.17) | 1.14 (1.06 to 1.23) | 1.07 (1.00 to 1.15) | 1.16 (1.05 to 1.28) | 1.16 (1.07 to 1.26) | 1.13 (1.01 to 1.27) |
| PCL≥44              | 2188/13 932 (16.6)                                            | 1 (reference) | 1 (reference) | 1 (reference) | 1.11 (1.05 to 1.17) | 1.14 (1.06 to 1.23) | 1.07 (1.00 to 1.15) | 1.16 (1.05 to 1.28) | 1.16 (1.07 to 1.26) | 1.13 (1.01 to 1.27) |

n, indicates number in group; N, number of participants.
Model 1: Adjusted for age and sex.
Model 2: Model 1+smoking status, drinking status, perceived health condition, history of mental illness, history of other illness, leisure-time physical activity, sleeping habits, educational attainment, experiences of the Great East Japan Earthquake, living arrangements, changes in work situation, loss of employment, decreased income and death of someone close.
PCL, Post-traumatic Stress Disorder Checklist.
in vegetables, fruits, soya bean products, mushrooms and green tea\textsuperscript{24} is associated with reduced depression risk. Similarly, high glycaemic index (GI) diets could be a risk factor for depression.\textsuperscript{25} Although our finding of a low frequency of rice and bread intake correlating with high psychological distress is not in line with this previous result, it does not contradict it. It is not improbable that participants who had a low frequency of rice and bread intake tended to eat ready-to-eat foods, which are often foods with high GI. An investigation of causal correlation in a cohort study of evacuees would thus obtain valuable findings contributing to the prevention and improvement of psychological distress.

Although it is unclear why the results differed by sex, this study has provided important findings. Associations between psychological distress and dietary intake were shown for the first time in evacuees from a major disaster. Therefore, our findings could promote future study as well as serve as reference when preventing or remediating the mental health problems of evacuees.

This study has several limitations. First, the overall response rate was low (40.7%), and there was a relatively high percentage of missing observations in the psychological distress category (10.3%). It should be noted that participants in this study were not always representative of all the residents in Fukushima, and they could enhance or weaken the association between psychological distress and dietary intake. Second, in the respondents to the questionnaire, the 9.3% who responded by proxy were included and this may affect the results. However, in the analysis covering only those who responded in person, almost the same associations between psychological distress and dietary intake were identified, with the exceptions of the association between non-specific mental health distress and fruit juice in men, and traumatic symptoms and vegetable juice in all participants (model 2 in online supplementary tables S5 and S6). Third, we used an FFQ of 19 items, in which some food items consumed by modern Japanese people, such as processed food, fast food, ready-to-eat foods and recently introduced Western foods, were not included. Since evacuees with a low intake frequency of several fresh foods may compensate with these foods, the associations between psychological distress and these foods must be investigated in our further research. Finally, we were not able to calculate either the quantity of each food or participants’ dietary nutrient intake, because we had no information on portion sizes. We cannot therefore conclude that the evacuees actually ate less quantity of the foods we have reported here.

In conclusion, non-specific mental health distress among evacuees after the Great East Japan Earthquake was associated with a low intake frequency of certain foods, such as rice and bread, fish, meat, vegetables (non-juice), fruit (non-juice), soya bean products, milk and yogurt and lactobacillus drinks. In an analogous fashion, traumatic symptoms were associated with a low intake frequency of foods, such as rice and bread, fish, meat, vegetables (non-juice), milk and yogurt and lactobacillus drinks, and inversely associated with a low intake frequency of vegetable and fruit juices. The associations were predominantly observed in women, and were independent of lifestyle-related and disaster-related factors.

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\textbf{REFERENCES}
1. Ohira T, Hosoya M, Yasumura S, et al., Fukushima Health Management Survey Group. Effect of evacuation on body weight after the Great East Japan Earthquake. \textit{Am J Prev Med} 2016;50:553–60.
2. Satoh H, Ohira T, Hosoya M, et al. Evacuation after the Fukushima Daiichi nuclear power plant accident is a cause of diabetes: results from the Fukushima Health Management Survey. \textit{J Diabetes Res} 2015;2015:627390.
3. Suzuki H, Ohira T, Takeishi Y, et al. Increased prevalence of atrial fibrillation after the Great East Japan Earthquake: results from the Fukushima Health Management Survey. \textit{Int J Cardiol} 2015;198:102–5.
4. Yabe H, Suzuki Y, Mashiko H, et al., Mental Health Group of the Fukushima Health Management Survey. Psychological distress after the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident: results of a mental health and lifestyle survey...
through the Fukushima Health Management Survey in FY2011 and FY2012. *Fukushima J Med Sci* 2014;60:57–67.
5. Yasumura S, Hosoya M, Yamashita S, et al. Study protocol for the Fukushima Health Management Survey. *J Epidemiol* 2012;22:375–83.
6. Kawakami N. National survey of mental health measured by K6 and factors affecting mental health status (in Japanese). Research on Applied Use of Statistics and Information, Health Labour Sciences Research Grant 2006/2007.
7. Yokoyama Y, Otsuka K, Kawakami N, et al. Mental health and related factors after the Great East Japan earthquake and tsunami. *PLoS ONE* 2014;9:e102497.
8. Sakuma A, Takahashi Y, Ueda I, et al. Post-traumatic stress disorder and depression prevalence and associated risk factors among local disaster relief and reconstruction workers fourteen months after the Great East Japan Earthquake: a cross-sectional study. *BMC Psychiatry* 2015;15:58.
9. Lai JS, Hiles S, Bisquera A, et al. A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *J Hum Nutr Diet* 2013;26:56–70.
10. Sanhueza C, Ryan L, Foxcroft DR. Diet and the risk of unipolar depression in adults: systematic review of cohort studies. *J Am Coll Nutr* 2014;33:357–62.
11. Blanchard EB, Jones-Alexander J, Buckley TC, et al. Psychometric properties of the PTSD Checklist (PCL). *Behav Res Ther* 1996;34:669–73.
12. Furukawa TA, Kessler RC, Slade T, et al. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. *Psychol Med* 2003;33:357–62.
13. Sakurai K, Nishi A, Kondo K, et al. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. *Psychiatry Clin Neurosci* 2011;65:434–41.
14. Uemura M, et al. BMJ Open 2016;6:e011534. doi:10.1136/bmjopen-2016-011534