

SHORT REPORT

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Association between frequency of fried food consumption and resilience to depression in Japanese company workers: a cross-sectional study

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Abstract

Background: Long-chain n-3 and n-6 polyunsaturated fatty acids (LC n-3/n-6 PUFA) play important roles in emotional regulation. We previously reported an association between fish consumption, which is major source of LC n-3 PUFA, and resilience to depression, where resilience is the ability to cope with stress in the face of adversity. Although the traditional Japanese dietary pattern of high fish consumption is associated with low depressive symptoms, the current Japanese diet pattern has become westernized. Westernized diets contain excessive amounts of LC n-6 PUFA due to high intake of vegetable oils commonly used in fried food and are associated with risk of depression. The aim of this study was to examine the association between frequency of fried food consumption and resilience to depression.

Methods: Participants were 715 Japanese company workers. The Center for Epidemiologic Studies Depression Scale (CES-D) was used to measure depressive symptoms, and the 14-item Resilience Scale (RS-14) was used to measure resilience. Frequency of fish and fried food consumption was assessed using a self-report questionnaire based on the Food Frequency Questionnaire. Regression analyses using Preacher and Hayes' bootstrap script were used to adjust for demographic factors, frequency of physical exercise, and fish consumption.

Results: Significant associations were identified between frequency of fried food consumption and total CES-D score (path c, $B = 0.72$; $P < 0.01$), between frequency of fried food consumption and total RS-14 score (path a, $B = -1.73$, $P < 0.01$), and between total RS-14 score and CES-D score (path b, $B = -0.35$; $P < 0.01$). The association between fried food consumption and total CES-D score was not significant when we controlled for RS-14 score. Bootstrapping results showed that there was a significant positive indirect association between frequency of fried food and CESD score through RS-14 (95 % bias-corrected and accelerated confidence interval = 0.34 to 0.92).

Conclusion: Frequency of fried food consumption was associated with lower resilience to depression. Further nutritional interventional studies to increase resilience and prevent depression are warranted.

Keywords: Westernized diet, Fried food consumption, Depressive symptoms, Resilience

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Background

In 1998, Hibbeln reported a negative association between the prevalence of depression and fish consumption in a cross-national analysis [1]. Japan had the highest level of fish consumption and the lowest prevalence of depression [1]. Furthermore, the Japanese diet was associated with low depressive symptoms in both a large cohort study of Japanese workers and a cross-sectional study [2, 3]. The traditional Japanese diet has recently become more westernized. Consumption of fats and oils in 2010 was more than four times that in the 1950s, whereas fish consumption had not changed substantially [4].

Westernized diets have been demonstrated to elevate the risk of depression [5–7], perhaps due to too much linoleic acid, a long-chain n-6 polyunsaturated fatty acid (LC n-6 PUFA) found in vegetable oils and processed foods that are consumed in high quantities in the current westernized diet [8]. An imbalance in the intake of LC n-6 PUFAs and LC n-3 PUFAs may affect emotional regulation and may cause mental disorders, including depression [9]. Fried foods cooked with large amounts of vegetable oil are among the most common westernized foods in Japan.

We previously reported an association between fish consumption and resilience to depression [10]. Resilience, which is generally defined as the ability to cope with stress in the face of adversity [11], is important for preventing depression. Resilience has been associated with regulation of emotions [12–14] and negatively associated with depression [15]. Therefore, frequent fried food intake may affect depressive symptoms by attenuating resilience. The aim of this study was to investigate the association between the frequency of fried food consumption and resilience to depression.

Methods

Participants and procedures

This study was conducted by using a database which was collected in a previous study [10, 16]. We approached 2159 workers at six separate worksites of a large company located in an urban area of Japan. Among them, 741 (34.3 %) agreed to participate in the study. Next, full data, with no missing responses to items related to the subscales used in this study, were available for 715 participants. Data from these 715 participants were included in the analysis among them.

Measures

We collected data on sex, marital status (married or not), educational attainment (university/college graduate or not), and job status (management position or not).

Frequency of fish consumption was measured using the following question: “How often do you usually eat fish or fish meals such as *Sashimi* (raw fish) and/or

Yakizakana (grilled fish)? Please consider the last six months.” The following question assessed the frequency of fried food consumption: “How often do you usually eat fried food? Please consider the last six months.” Six response options were given for each question: almost never, 1–3 times/month, 1–2 times/week, 3–4 times/week, 5–6 times/week, and every day.

The CES-D is used to assess depressive symptoms [17] and consists of 20 items. The total score ranges from 0 to 60, with a higher score indicating more severe depression. The Japanese version has been shown to be a reliable and valid instrument [18].

Resilience was assessed with the 14-item Resilience Scale (RS-14). Each item is rated on a 7-point Likert scale (total score range, 14–98), with a higher score indicating more resilience [19]. The RS was developed based on a qualitative study of people who had adapted successfully after experiencing a recent loss, such as loss of a spouse, health, or employment [19–23]. The Japanese version has been shown to be valid and reliable [11].

Physical exercise was evaluated by asking, “The next question is about your physical exercise habits. In the last six months, how often did you do relatively hard exercise for more than 20 min, such as jogging or running, cycling, aerobics, or stepping exercise?” The response options were as follows: 1) never, 2) 1–3 times a month, 3) 1–2 times a week, and 4) 3 or more times per week.

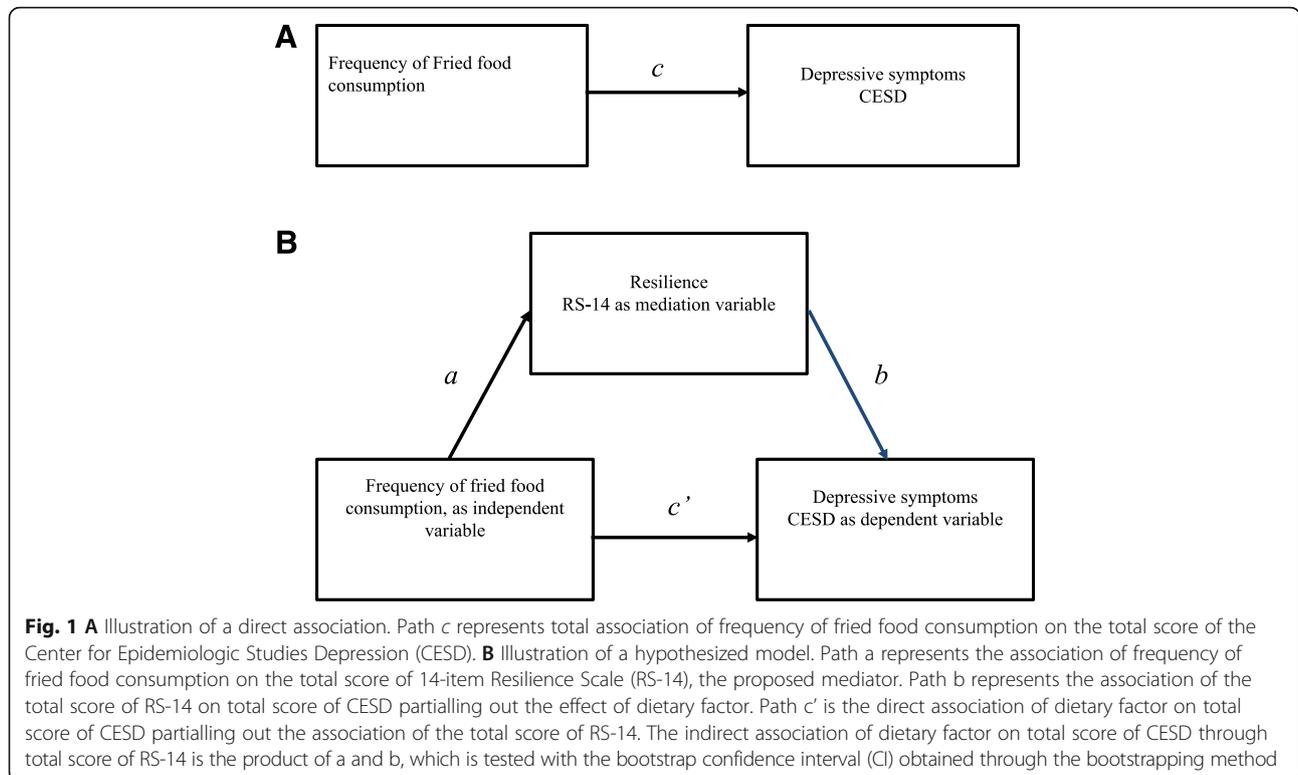
Statistical analysis

All statistical analyses were performed with SPSS, version 23 (SPSS Inc., Chicago, IL). Alpha levels were all set at $P < 0.05$ (two-tailed). To test the mediation model and assess any indirect association, we conducted regression analyses using Preacher and Hayes’ bootstrap script [24] ($n = 5000$ bootstrap samples), which can handle non-parametric data. The bias-corrected and accelerated confidence intervals (BCACI) were set at 95 %. The use of 95 % confidence intervals is equivalent to testing for significance at the level of $\alpha = 0.05$.

Figure 1 a and b illustrate the hypothesized mediation model that fried food intake affected depression (the total CES-D score) by attenuating resilience (the total RS-14 score). The dependent variable was total CES-D score, the independent variable was the frequency of fried food consumption, and the mediator was RS-14 score. Age, sex, educational attainment, marital state, job status, physical exercise, and frequency of fish consumption were used as control variables.

Results

All 715 participants were Japanese. Mean age \pm standard deviation (SD) was 39.9 ± 9.4 years (range = 21–66 years), 596 (83.4 %) were men, and 466 (65.2 %) were married. Most (590, 82.5 %) had graduated from college



or university. Regarding working status, 67 (9.4 %) were in management positions. Mean scores \pm SD on the five parameters assessed were 63.5 ± 11.0 on RS-14, 10.5 ± 7.5 on CES-D, 3.0 ± 0.9 for the frequency of fish consumption score, 2.0 ± 1.1 for the frequency of physical exercise, and 3.6 ± 1.1 for the frequency of fried food consumption score. The scores of 3.0 and 3.6 here means that, on average, participants ate fish 1–2 times per week and fried food 3–4 times per week.

As shown in Table 1, there were significant associations between frequency of fried food consumption and total CES-D score (path *c*, $B = 0.72$; $P < 0.01$), between frequency of fried consumption and total RS-14 score (path *a*, $B = -1.73$, $P < 0.01$) and between total RS-14 score and CES-D score (path *b*, $B = -0.35$; $P < 0.01$).

Table 1 Mediation analysis and bootstrap results for the resilience-mediated relationship between fried food consumption frequency and depression

	B	SE	t	P	BCACI
a path ^a	-1.73	0.39	-4.46	<0.01	
b path ^a	-0.35	0.02	-15.82	<0.01	
c' path ^a	0.11	0.23	0.485	0.63	
c path ^a	0.72	0.27	2.71	<0.01	
ab (c-c') path					[0.34 0.92]

SE Standard error, BCACI bias-corrected and assessed confidence interval
^aRegression coefficient between each pair of variables corresponding to the ends of the path indicated with the symbol in Fig. 1

When controlling for the effects of total RS-14 score, there was no longer a significant association between fried food consumption and total CES-D score. When the size of the indirect association of frequency of fried food on CESD score through RS-14 score was estimated, the bootstrap 95 % CI did not include zero (95 % BCACI = 0.34 to 0.92), which indicated that the indirect association was significant.

Discussion

The findings of this study are consistent with the hypothesis that more frequent fried food consumption decreases resilience, and is therefore associated with developing depression. Decreasing the intake of fried food, which contains high levels of linoleic acid from vegetable oils, and consuming fish, which is major source of LC n-3 PUFA, may be important for promoting resilience to depression.

However, this was a cross-sectional study, so we could not determine causal relationships between the factors. Resilience has been reported to be associated with health-promoting behavior or compliance with treatment of physical illness [25, 26]. Another possible association is that low resilience promotes fried food consumption and results in depressive symptoms. However, in this case, an alternative mediation analysis, which was conducted to enter resilience as independent variable, fried food consumption as a mediator variable,

and depressive symptoms as dependent variables, did not demonstrate significant indirect association (data not shown). Diet is a possible indicator of overall lifestyle patterns and health-related behaviors mutually associated with depressive illness. For example, fried food intake might be associated with a lifestyle factor, such as consuming snack foods and beverages, that has been associated with depression [27]. The possibility exists that residual confounding by such uncontrolled or unmeasured factors may have distorted genuine associations.

Other limitations were as follows. First, most of the participants were men, were highly educated, and worked for a large Japanese company that provides good job security and a relatively good balance of effort and reward. Second, the response rate was not high and therefore the finding may not be widely generalizable. Third, information on frequency of fried food consumption was self-reported, and non-differential misclassification may be inevitable and could attenuate the observed associations. In addition, there are many sources of LC n-6 PUFA other than fried food. A specific food frequency questionnaire for PUFA intake was not used in this study [28].

Conclusion

The results of the current study suggest that frequency of fried food consumption is associated with lower resilience to depression, independent of frequency of fish consumption. Double-blind, randomized, placebo-controlled nutritional intervention trials on resilience to depression are needed.

Abbreviations

BCACI: Bias-corrected and accelerated confidence interval; CES-D: The center for epidemiologic studies depression; CI: Confidence interval; RS-14: 14-item resilience scale

Acknowledgments

The authors thank Koichi Iwata and Toshinari Saeki for their cooperation with the research. We also express special thanks to Mss. Akutsu and Kamoshida for data management and to all participants in this study. We also thank Masami Kashimura for his advice on statistical issues. Dr Yoshikawa has received research support from a Research Promotion Grant of Nippon Medical School and has received lecture fees from Dainippon Pharmaceutical Co., Ltd. and Mochida Pharmaceutical Co., Ltd. Dr. Nishi has received research grants from the Japan Society for the Promotion of Science, the National Center of Neurology and Psychiatry Japan, the Ministry of Health, Labour and Welfare, and Japan Agency for Medical Research and Development, and a lecture fee from Otsuka Pharmaceutical Co., Ltd., and a manuscript fee from Sumitomo Dainippon Pharma Co., Ltd. Dr. Matsuoka has received research support from the Japan Science and Technology Agency, CREST; an Intramural Research Grant for Neurological and Psychiatric Disorders from the National Center of Neurology and Psychiatry Japan, a grant from Pfizer Health Research Foundation; and lecture fees from Ono Pharmaceutical Co. Ltd., Mochida Pharmaceutical Co. Ltd., Takeda Pharmaceutical Company Ltd., Suntory Wellness Ltd., DHA & EPA Association, and Otsuka Pharmaceutical Co., Ltd.

Funding

This study was supported by grants from the Foundation for Total Health Promotion and CREST, Japan Science and Technology Agency.

Availability of data and materials

The datasets generated during the current study are not publicly available, because when this research plan was approved by the institutional review boards of both the National Disaster Medical Center and the companies, these matter was not included and not discussed, therefore, we did not obtain consent from the participants about this matter. Furthermore, we have thought that this matter has potentially sensitive topic for companies, which are not willing to disclose their employee's data in details. But the datasets are available from the corresponding author on reasonable request.

Authors' contributions

The authors alone are responsible for the content and writing of the paper. EY participated in the study to a significant extent and worked on study conception and design; data collection and carried out the development of this manuscript and data analysis. DN participated in the study to a significant extent and worked on study conception and design; data collection, analysis, and interpretation; and drafting and editing the manuscript. YM participated in the study to a significant extent and worked on study conception and design, data collection, and drafting and editing the manuscript. All authors contributed to the intellectual content of the article and read and approved the submitted manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

This study was approved by the institutional review boards of both the National Disaster Medical Center and the companies. All participants have provided written informed consent.

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Received: 13 August 2016 Accepted: 13 September 2016

Published online: 15 September 2016

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