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Original Article

Nutrition and Depressive Symptoms in Community-dwelling Elderly Persons in Japan

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A cross-sectional study was conducted to evaluate the association between dietary intake and depressive symptoms in community-dwelling elderly persons. Five-hundred elderly persons aged 65 to 75 years were randomly selected from the population of O city in Okayama Prefecture, Japan. Among 401 respondents (response rate, 80.0%), data from 279 (133 males, 146 females) who completed the questionnaire concerning dietary intake and depressive state were analyzed using logistic regression. Each of 17 dietary intakes was classified into tertiles: high intake, moderate intake, and low intake. The Center for Epidemiology Studies Depression scale (CES-D) was used. Among males, the observed odds ratios (the 95% confidence intervals) for the depressive state were 0.36 (95% CI: 0.13–0.98) in the highest tertile of carotene intake, 0.33 (95% CI: 0.12–0.93) in the highest tertile of vitamin C intake, 0.29 (95% CI: 0.10–0.85) in the highest tertile of carbohydrate intake, and 0.33 (95% CI: 0.12–0.92) in the medium tertile of vitamin E intake. Among females, similar results were observed, but these results were not statistically significant. The results suggested that carbohydrate, carotene, and vitamin C intakes are associated with lowering depressive symptoms among elderly persons dwelling in communities in Japan.

Key words: dietary intake, depressive symptoms, elderly persons, cross-sectional study, gender

Non-clinical depression and depressive disorders are common mental health problems among the elderly [1]. Depression is a strong contributor to poor physical health, lower levels of activities of daily living (ADL), poor quality of life (QOL), and suicide among older populations [2, 3]. On the other hand, dietary habits, nutrient intakes and aging processes are interrelated and are of particular importance among the elderly [4, 5]. Elderly persons are likely to have unbalanced diets, so dietary intake and nutrition greatly influence their health [6].

Recent studies have shown the association between the intake of various nutrients and depression, including fatty acids [7–9], cholesterol [10–12], tryptophan [13], vitamin D [14, 15], vitamin C [16, 17], vitamin E [18, 19], homocysteine [20–22], folate [20–22] and vitamin B12 [2, 22]. These findings have been also replicated in the elderly to some extent. Lipids are associated with depression: Low plasma cholesterol was associated with depressive symptoms in elderly men [10], while another study reported that hyperlipidemia was associated with depression in

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older women in a rural community [23]. The ratio of omega-3 to omega-6 fatty acids decreased among depressed elderly subjects [8], while another study failed to find the association between the dietary intake of omega-3 fatty acid and depression [9]. Vitamins are next associated with depression: Increased plasma ascorbic acid levels were associated with low levels of depression in the elderly aged 60–80 years old [16, 17]. Plasma alpha-tocopherol levels were also reported to be lower among the elderly with major depression compared with healthy controls [18], although this finding was not replicated in female elderly subjects [19]. Vitamin D deficiency [15] and low levels of folate [22] were associated with deteriorated mood in older adults. However, these findings are still inconsistent, depending on gender. In addition, there are few studies from Japan to test or replicate the association of dietary intake with depression in the elderly [23]. Nutritional intake varies among countries; particularly in Japan, people consume low fat and high salt. Such country-specific patterns of nutritional intake may affect the association between diet and depression in the elderly.

In this study, we conducted a cross-sectional study to investigate the association between dietary intake and depressive symptoms (*i.e.*, non-clinical depression) in a random sample of the elderly aged 65 or older living in a community of Japan, by estimating specific nutritional intake using a validated semi-quantitative Food Frequency Questionnaire (FFQ).

Subjects and Methods

Subjects. A self-administered questionnaire which included items and questions related to dietary habits and depression was mailed to a random sample of 500 people aged from 65 to 75 years who were living in O City in Okayama Prefecture on September 1st, 2001. A small pre-test was conducted before the survey, which indicated that people aged over 75 years had a great difficulty in completing the FFQ. Thus, we restricted the sample to those aged 65–75 years. Responses were obtained from 401 people (response rate, 80.0%). After excluding respondents with missing responses to sex, age, depressive score or FFQ, data from 279 respondents (133 males and 146 females) were analyzed.

The design and procedure of the study were reviewed and approved by the Ethics Committee on Epidemiologic Research of the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences on February 19th 2002.

Measures.

1. Dietary intake

Dietary intake was determined using a semi-quantitative FFQ [24, 25]. The respondents were asked to report the frequency of intake of 31 food items during the year prior to the study (based on 8 categories) and the usual portion size of each item (based on 3 categories). The amount of intakes per day for 17 nutrients (total energy, protein, fat, carbohydrates, fiber, calcium, retinol, carotene, vitamin A, vitamin C, vitamin D, vitamin E, salt, cholesterol, saturated fatty acid, mono-unsaturated fatty acid, and poly-unsaturated fatty acid) were calculated based on the reported frequency of intake and portion size [24, 25]. When a respondent did not report the frequency of intake or portion size in the FFQ, the frequency of a food item was classified as "scarcely or never", since we assumed that he/she did eat the food item and thus skipped the item. In addition, any missing data on portion size of a food item was calculated by the mean item score of that food item among other respondents. Intake of each nutrient was categorized into tertiles (high, medium, and low intake) among the entire study population.

2. Depressive symptoms

Depressive symptoms were assessed using the Japanese version of the Center for Epidemiology Studies Depression scale (CES-D) [26, 27]. The CES-D consists of 20 self-reported measures of symptoms experienced in the last week and was scored on a scale of 0 to 3 points. A CES-D score of 16 was used as the cut-off value [26, 27].

3. Other covariates

Other covariates examined included sex, age, chronic diseases, body mass index (BMI), and social support. Average (standard deviation, SD) age was 68.8 (2.93) for men and 68.8 (2.64) for women. Average (SD) BMI was 22.6 (2.75) for men and 23.2 (3.19) for women. Chronic disease was defined as having a present medical history of any of the following 8 chronic diseases based on self-report: hypertension, cerebrovascular disease, heart disease, kidney disease, diabetic mellitus, gout, liver disease, and cancer (prevalence of chronic conditions, 50% for men

and 40% for women). Social support was measured by using a 4-item scale asking whether the respondent "has people around who understand you", "has people around who enjoy your happiness with you", "has people who advise you when needed", and "has people who listen to you when you are distressed about something". We asked the degree of satisfaction for each item (1–4 points), then summed these item scores into a total score, and categorized the participants into 3 groups (high, medium, and low) (36%, 21%, and 43%, respectively, for men; 38%, 23%, and 39%, respectively, for women). Information about activities of daily living (ADL) was also collected by questionnaire for the daily activities of taking a bath, dressing, using the toilet, going to the toilet, going to and getting out of bed, eating, household matters, and going out. All subjects under analysis had no difficulty in pursuing any activity.

Statistical analysis. We compared the prevalence of depressive symptoms (16 or greater of CES-D score) among the tertiles for each nutrition intake, separately for men and women. The lowest tertile was the reference category. Moreover, we estimated the odds ratios and their 95% confidence intervals (95% CI) of depressive symptoms for high and medium categories of each nutrition intake, with the lowest tertile as the reference category, adjusting for age, chronic diseases, BMI, and social support, using multiple logistic regression analysis. All statistical analyses were performed using the SPSS 11.0 software program.

Results

Nutritional intake and depressive scores are presented by sex in Table 1. The intake of calcium, carotene and vitamin C was significantly higher in women than in men ($p<0.05$).

In men, there was a negative association between the intakes of carbohydrate, carotene, and vitamin C with depressive symptoms (Table 2, p for trend$<$ 0.05). The observed odds ratios of depressive symptoms were significantly lower in the highest tertile of carbohydrate intake, carotene intake, and vitamin C intake, compared with the lowest tertile. The odds ratio was also significantly lower in the medium tertile of vitamin E intake, while the trend was only marginally significant ($p<0.10$).

Table 1 Nutritional intake and depressive symptoms (CES-D scores) in men and women aged 65–75 years old living in a community in Japan: Means with standard deviations (SDs)

	Men (n=133)		Women (n=146)		*p*-value
	Mean	SD	Mean	SD	
CES-D score	12.8	6.4	13.0	6.6	
Total energy (kcal)	2,544.0	730.9	2,530.9	561.5	0.766
Protein (g)	114.4	33.1	113.8	25.9	0.857
Fat (g)	84.2	28.9	82.1	22.5	0.501
Carbohydrates (g)	333.3	89.9	342.2	69.9	0.354
Fiber (g)	6.1	1.6	6.4	1.4	0.127
Calcium (mg)	824.8	221.9	876.0	187.9	0.038*
Retinol (mg)	1,154.0	1,114.3	1,001.6	975.5	0.224
Carotene (ug)	5,225.3	1,466.2	5,607.1	1,417.4	0.028*
Vitamin A (IU)	5,820.4	3,233.3	5,630.4	2,883.4	0.604
Vitamin C (mg)	207.9	71.4	225.1	65.6	0.037*
Vitamin D (IU)	157.8	50.0	151.9	41.4	0.286
Vitamin E (mg)	11.8	3.3	12.0	2.7	0.476
Salt (g)	17.7	4.8	17.7	3.8	0.983
Cholesterol (mg)	447.7	142.0	438.3	114.3	0.544
Saturated fatty acid (g)	17.1	5.7	17.0	4.6	0.955
Mono-unsaturated fatty acid (g)	24.8	8.4	24.3	6.7	0.579
Poly-unsaturated fatty acid (g)	18.0	5.2	17.9	4.0	0.778

*$p<0.05$ (Student t test).

Table 2 Association between 17 nutrient intake and depressive symptoms among community-dwelling elderly men in Japan (n = 133): Prevalence, odds ratios and 95% confidence intervals for tertiles of nutrition intake #.

Nutrient intake	Depressive symptoms					
	No.	(CES-D > = 16)		Odds ratio	(95% Confidence Interval)	*p* value for trend
		No	%			
Total Energy						
Low	44	15	34	1.00		0.154
Medium	45	16	36	1.25	(0.47–3.28)	
High	44	8	18	0.44	(0.15–1.30)	
Protein						
Low	44	15	34	1.00		0.279
Medium	45	14	31	1.04	(0.39–2.78)	
High	44	10	23	0.56	(0.20–1.58)	
Fat						
Low	44	17	39	1.00		0.110
Medium	45	13	29	0.84	(0.31–2.25)	
High	44	9	21	0.42	(0.15–1.20)	
Carbohydrate						
Low	44	19	43	1.00		0.024*
Medium	45	12	27	0.59	(0.22–1.56)	
High	44	8	18	0.29	(0.10–0.85)*	
Fiber						
Low	44	18	41	1.00		0.075
Medium	45	12	27	0.69	(0.26–1.83)	
High	44	9	21	0.39	(0.14–1.10)	
Calcium						
Low	44	15	34	1.00		0.462
Medium	45	13	29	1.24	(0.45–3.42)	
High	44	11	25	0.67	(0.24–1.85)	
Retinol						
Low	44	15	34	1.00		0.782
Medium	45	10	22	0.45	(0.16–1.29)	
High	44	14	32	1.19	(0.43–3.29)	
Carotene						
Low	44	15	43	1.00		0.043*
Medium	45	10	22	0.52	(0.19–1.45)	
High	44	10	23	0.36	(0.13–0.98)*	
Vitamin A						
Low	44	15	34	1.00		0.600
Medium	45	13	29	0.67	(0.23–1.70)	
High	44	11	25	0.78	(0.28–2.17)	
Vitamin C						
Low	44	19	43	1.00		0.034*
Medium	45	11	24	0.55	(0.21–1.47)	
High	44	9	21	0.33	(0.12–0.93)*	
Vitamin D						
Low	44	13	30	1.00		0.829
Medium	45	14	31	1.27	(0.46–3.45)	
High	44	12	27	0.89	(0.32–2.46)	
Vitamin E						
Low	44	19	43	1.00		0.058
Medium	45	10	22	0.33	(0.12–0.92)*	
High	44	10	23	0.39	(0.14–1.08)	

Table 2 Continued from opposite page

Nutrient intake	Depressive symptoms					
	No.	(CES-D>=16)		Odds ratio	(95% Confidence Interval)	p value for trend
		No	%			
Salt						
Low	44	16	36	1.00		0.180
Medium	45	14	31	0.81	(0.31–2.12)	
High	44	9	21	0.49	(0.17–1.39)	
Cholesterol						
Low	44	13	30	1.00		0.954
Medium	45	15	33	1.70	(0.60–4.85)	
High	44	11	25	0.98	(0.34–2.82)	
Saturated fatty acid						
Low	44	14	32	1.00		0.288
Medium	45	16	36	1.66	(0.62–4.50)	
High	44	9	21	0.54	(0.19–1.59)	
Mono-unsaturated fatty acid						
Low	44	16	36	1.00		0.129
Medium	45	14	31	0.93	(0.35–2.54)	
High	44	9	21	0.44	(0.15–1.25)	
Poly-unsaturated fatty acid						
Low	44	16	36	1.00		0.111
Medium	45	14	31	0.86	(0.32–2.31)	
High	44	9	21	0.42	(0.15–1.21)	

Multiple logistic regression adjusting for age, chronic diseases, BMI and social support, with the "low" category as a reference.
* $p<0.05$.

In women, any nutrient intake was not significantly associated with depressive symptoms, compared with the lowest tertile. (Table 3).

Discussion

In this study, we found that carbohydrate, carotene, and vitamin C intake were significantly associated with a reduced prevalence of depressive symptoms among men. However, among women, the intake of any nutrient under study was not significantly associated with depressive symptoms.

The observed associations of carotenoid and vitamin C, as well as the marginally significant association of vitamin E, with a reduced prevalence of depressive symptoms among elderly men are similar to those from previous studies [16–19, 29–31]. A higher consumption level of fruits and vegetable has been associated with both better mental health and better physical health [28]. A history of attempted suicide was reported to be associated with a low level of antioxidant vitamins and carotenoids [29]. A sufficient level of vitamin A is required for adult central nervous system function [30]. Vitamin A derivatives, retinoids, are involved in a complex signaling pathway. The major functional implication of retinoic signaling that may alter the expression of components of the serotonergic neurotransmitter system has been suggested in depression [30, 31]. In addition, a previous study found a significant decrease in plasma ascorbic acid levels among patients with major depression as compared to control subjects [32]. A positive association was reported between changes in the plasma ascorbic acid level and changes in mood [16, 17]. Depressive patients have a lower serum Vitamin E concentration than controls [18]. The association between vitamin E and lower depressive symptoms was observed in elderly men, but not in elderly women [19]. Oxidative stress, an imbalance between antioxidants and prooxidants has been suggested to be involved in the pathophysiology of major depression [34]. The brain, including the cell membrane, contains a lot of lipid. Antioxidative defense by carotenoids, vitamin C and vitamin E may protect the brain

Table 3 Association between 17 nutrient intake and depressive symptoms among community-dwelling elderly women in Japan (n = 146): Prevalence, odds ratios and 95% confidence intervals for tertiles of nutrition intake #.

Nutrient intake	Depressive symptoms					
	No.	(CES-D > =16)		Odds ratio	(95% Confidence Interval)	*p* value for trend
		No	%			
Total Energy						
Low	48	18	38	1.00		0.439
Medium	49	14	29	0.69	(0.26–1.80)	
High	49	13	27	0.68	(0.25–1.82)	
Protein						
Low	48	16	33	1.00		0.831
Medium	49	15	31	1.26	(0.48–3.31)	
High	49	14	29	1.11	(0.42–2.94)	
Fat						
Low	48	19	40	1.00		0.476
Medium	49	13	27	0.65	(0.25–1.68)	
High	49	13	27	0.70	(0.26–1.89)	
Carbohydrate						
Low	48	19	40	1.00		0.114
Medium	49	15	31	0.70	(0.27–1.81)	
High	49	11	22	0.44	(0.16–1.22)	
Fiber						
Low	48	19	40	1.00		0.205
Medium	49	16	33	0.78	(0.31–1.98)	
High	49	10	20	0.53	(0.20–1.41)	
Calcium						
Low	48	16	33	1.00		0.459
Medium	49	19	39	1.42	(0.56–3.57)	
High	49	10	20	0.67	(0.24–1.83)	
Retinol						
Low	48	19	40	1.00		0.797
Medium	49	9	18	0.50	(0.18–1.34)	
High	49	17	35	1.14	(0.44–2.94)	
Carotene						
Low	48	21	44	1.00		0.172
Medium	49	13	27	0.55	(0.21–1.40)	
High	49	11	22	0.52	(0.20–1.35)	
Vitamin A						
Low	48	19	40	1.00		0.999
Medium	49	10	20	0.52	(0.20–1.37)	
High	49	16	33	1.00	(0.39–2.58)	
Vitamin C						
Low	48	20	42	1.00		0.117
Medium	49	14	29	0.55	(0.22–1.43)	
High	49	11	22	0.47	(0.18–1.22)	
Vitamin D						
Low	48	17	35	1.00		0.625
Medium	49	10	20	0.56	(0.21–1.53)	
High	49	18	37	1.27	(0.50–3.20)	
Vitamin E						
Low	48	18	38	1.00		0.568
Medium	49	14	29	0.70	(0.27–1.83)	
High	49	13	27	0.76	(0.29–1.98)	

Table 3 Continued from opposite page

Nutrient intake	Depressive symptoms					
	No.	(CES-D>=16)		Odds ratio	(95% Confidence Interval)	*p* value for trend
		No	%			
Salt						
Low	48	17	35	1.00		0.704
Medium	49	15	31	0.85	(0.33–2.19)	
High	49	13	27	0.83	(0.32–2.19)	
Cholesterol						
Low	48	16	33	1.00		0.857
Medium	49	15	31	1.01	(0.39–2.62)	
High	49	14	29	0.92	(0.34–2.43)	
Saturated fatty acid						
Low	48	17	35	1.00		0.925
Medium	49	15	31	1.25	(0.49–3.20)	
High	49	13	27	0.94	(0.35–2.54)	
Mono-unsaturated fatty acid						
Low	48	18	38	1.00		0.591
Medium	49	14	25	0.86	(0.34–2.20)	
High	49	13	27	0.76	(0.29–2.05)	
Poly-unsaturated fatty acid						
Low	48	19	40	1.00		0.486
Medium	49	12	25	0.62	(0.24–1.58)	
High	49	14	29	0.71	(0.27–1.86)	

Multiple logistic regression adjusting for age, chronic diseases, BMI and social support, with the "low" category as a reference.
* $p<0.05$.

from oxidative stress and thus may prevent depressive symptoms among the elderly. The elderly are particularly likely to suffer from undernutrition and to have a low dietary intake of antioxidants. The elderly may be more vulnerable than younger people to oxidative stress leading to neural damage including depression.

In men, carbohydrate intake was significantly associated with a reduced prevalence of depressive symptoms. Depressed subjects tend to consume more carbohydrates in their diets than non-depressed individuals [35], and they show heightened preference for sweet carbohydrate high in fat during depressed episodes [36]. A high carbohydrate intake increases the brain uptake of tryptophan, which in turn stimulates the synthesis of serotonin [37, 38]. Aged people are more sensitive to glycaemic changes [39]. Sufficient carbohydrates may be beneficial in decreasing depressive symptoms among the elderly.

In women, the intake of any nutrients under study was not significantly associated with a reduced prevalence of depression. The intake of nutrients was significantly different in men and women. However, the patterns of the relationships were in general similar to those observed for men. The gender difference in diet intake may affect the findings. Women took in more carotenoid and vitamin C than men. The eating habits and food choices of women were healthier and more closely followed current health recommendations [40]. This may have attenuated the association of carotenoid and vitamin C with depressive symptoms in this sample of elderly women. In addition, women may take more vitamin supplements than men. In this study, we did not obtain information on the supplement intake. If women took more supplements of carotenoid or vitamin C, the association between the dietary intake of these nutrients and depression could be smaller.

In this study, the association between fatty acids and depressive symptoms was not significant. Taking DHA or EPA has been reported to decrease depressive symptoms in previous studies [7]. These fatty acids are important elements in the cell membrane. The FFQ uses in this study may be less sensitive to quantitative measurement of different fatty acid intakes. In the future, it will be necessary conduct a

study on the relationship between these fatty acids and depression among the elderly.

A major limitation of the present study is its cross-sectional nature. The observed associations between several nutrients and depressive symptoms may reflect the effects of depression on nutritional intake. For example, while they were not always significant, lower intakes of nutrients other than cholesterol were generally associated with the symptoms of depression, which may be attributable to poor appetite as a symptom of chronic depression. The findings of the present cross-sectional study should be interpreted with a caution, since they do not infer causal relationships. The possible effects of carbohydrate, carotene, and vitamin C intake on lowering depressive symptoms should be reexamined in a future prospective study and/or an intervention study.

In summary, our findings suggest that carotene and vitamin C intake may be associated with a reduction in depressive symptoms in elderly men. An interventional study is needed to confirm the effects of antioxidant nutrition and other dietary intake in the prevention of depression.

Limitations. The limitation due to the cross-sectional study design was mentioned earlier. Further methodological limitations of this study must also be considered. First, information on dietary intake and depressive symptoms was based on a self-administered questionnaire. People who are interested in health and food are able to recall their dietary intake more readily than others, and therefore there may have been an information bias in the questionnaire responses. Second, the study focused on elderly persons dwelling in the community. The response rate was high at 80%. Missing data, however, resulted in a decrease in the number of subjects for analysis. In a future study, a face-to-face interview, instead of a mailed questionnaire, should be used to collect detailed and correct information on dietary intake.

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