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Pediatrics 2010;126;e623-e630; originally published online Aug 16, 2010;
DOI: 10.1542/peds.2009-3277

Fish and *n*-3 Polyunsaturated Fatty Acid Intake and Depressive Symptoms: Ryukyus Child Health Study

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KEY WORDS

fish, eicosapentaenoic acid, docosahexaenoic acid, depressive symptoms, adolescence

ABBREVIATIONS

PUFA—polyunsaturated fatty acid
EPA—eicosapentaenoic acid
DHA—docosahexaenoic acid
RYUCHS—Ryukyus Child Health Study
BDHQ—brief self-administered diet-history questionnaire
CES-D—Center for Epidemiologic Studies Depression
OR—odds ratio
CI—confidence interval

www.pediatrics.org/cgi/doi/10.1542/peds.2009-3277

doi:10.1542/peds.2009-3277

Accepted for publication May 18, 2010

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

WHAT'S KNOWN ON THIS SUBJECT: Epidemiologic evidence on the role of fish and long-chain *n*-3 PUFA (EPA and DHA) intake on depression during adolescence is sparse.

WHAT THIS STUDY ADDS: The results of this cross-sectional study revealed that higher intake of fish, EPA, and DHA was independently associated with a lower prevalence of depressive symptoms in early male, but not female, adolescents.

abstract

BACKGROUND: Epidemiologic evidence on the role of fish and long-chain *n*-3 polyunsaturated fatty acid intake on depression during adolescence is sparse.

OBJECTIVE: We examined the association between fish, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) intake and depressive symptoms in a group of adolescents.

SUBJECTS AND METHOD: This cross-sectional study, conducted in all public junior high schools in Naha City and Nago City, Okinawa, Japan, included 3067 boys and 3450 girls aged 12 to 15 years (52.3% of the eligible sample). Dietary intake was assessed by using a validated, self-administered diet-history questionnaire. Depressive symptoms were defined as present when participants had a Center for Epidemiologic Studies Depression scale score of ≥16.

RESULTS: The prevalence of depressive symptoms was 22.5% for boys and 31.2% for girls. For boys, fish intake was inversely associated with depressive symptoms (adjusted odds ratio [OR] for depressive symptoms in the highest [compared with the lowest] quintile of intake: 0.73 [95% confidence interval (CI): 0.55–0.97]; *P* for trend = .04). EPA intake showed an inverse association with depressive symptoms (OR: 0.71 [95% CI: 0.54–0.94]; *P* = .04). DHA intake also showed a similar inverse, albeit nonsignificant, association (OR: 0.79 [95% CI: 0.59–1.05]; *P* = .11). In addition, intake of EPA plus DHA was inversely associated with depressive symptoms (OR: 0.72 [95% CI: 0.55–0.96]; *P* = .08). Conversely, no such associations were observed among girls.

CONCLUSIONS: Higher intake of fish, EPA, and DHA was independently associated with a lower prevalence of depressive symptoms in early male, but not female, adolescents. *Pediatrics* 2010;126:e623–e630

Depression is a major public health issue in developed countries. The World Health Organization recently estimated that unipolar depressive disorders remain one of the leading causes of total disability-adjusted life-years.[1] In particular, depression in adolescence is thought to be associated with a range of negative outcomes and substantial risk for morbidity and mortality across the life span.[2] Investigation of factors that influence depression in young people, therefore, is a high priority.

The importance of research into the possible role of dietary factors in depression is emphasized by the fact that diet is modifiable. Long-chain *n*-3 polyunsaturated fatty acids (PUFAs), including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the major source of which is fish, may play various broad roles in brain function and activity and have been suggested to play a role in depression.[3–5] However, epidemiologic evidence for the association of intake of fish, EPA, and DHA with depressive symptoms has been limited and inconsistent.[6–26] In addition, all previous studies have been conducted in adults, with none conducted in a young population. Furthermore, research in non-Western populations has been limited.[19–21]

Using data from the Ryukyus Child Health Study (RYUCHS) (performed in Okinawa, Japan), we conducted a cross-sectional study of the association between intake of fish, EPA, DHA, and EPA plus DHA and depressive symptoms in a group of adolescents in Japan.

SUBJECTS AND METHODS

Study Sample

RYUCHS is a school-based, cross-sectional, self-administered questionnaire survey conducted in Naha City and Nago City (Okinawa).[27–29] Okinawa Prefecture is an island located in the southernmost area of Japan and has a subtropical climate and a total population of almost 1 370 000. Naha City, the largest city in Okinawa Prefecture and located in the south of the island, and Nago City, located in the center of the island (total population: almost 313 000 and 60 000, respectively), are 2 of the 41 municipalities in Okinawa Prefecture. All public elementary and junior high schools in Naha City (n = 35 and 17, respectively) and Nago City (n = 17 and 8, respectively) participated in the RYUCHS between September 2004 and January 2005. The purpose of the RYUCHS was to investigate the associations between various selected factors and child health issues. Assessment of depressive symptoms was conducted only for junior high school students; our study, therefore, was based on data from junior high school students only. The RYUCHS was approved by the ethics committee of the Faculty of Medicine at Fukuoka University.

A set of 2 self-administered questionnaires (ie, a diet-history questionnaire and a lifestyle questionnaire) were distributed by teachers to all junior high school students (n = 12 451). Students were asked to answer the questionnaires by themselves, in cooperation with their parents if necessary. Answered questionnaires were checked by research technicians, and when missing or illogical data were detected, the teachers sent the questionnaires back to the students. Of the 12 451 eligible students, 7912 students (63.5% of the eligible sample) participated in the RYUCHS. Excluded from our analysis were 1234 students with incomplete data on the variables under study. We further excluded 161 students who reported extremely low or high energy intake (ie, less than half the estimated energy requirement for the lowest physical activity category or >1.5 times the estimated requirement for the highest physical activity category according to the *Dietary Reference Intakes for Japanese*[30]: <1000–1225 or >3750–4650 kcal/day, respectively, depending on age and gender). Thus, the final analysis sample consisted of 6517 students (3067 boys and 3450 girls aged 12–15 years [52.3% of the eligible sample]).

Measurements

Dietary habits during the preceding month were assessed by using a brief self-administered diet-history questionnaire (BDHQ) for Japanese children and adolescents.[31] The BDHQ is a 4-page structured questionnaire that inquires about the consumption frequency of selected foods commonly consumed in Japan, general dietary behavior, and usual cooking methods. The BDHQ for children and adolescents was developed on the basis of comprehensive (16-page)[32–35] and brief (4-page)[19,36] versions of a validated self-administered diet-history questionnaire for adults. Estimates of daily intake for foods (58 items in total), energy, and selected nutrients were calculated by using an ad hoc computer algorithm for the BDHQ, which was based on the *Standard Tables of Food Composition in Japan*.[37,38] Fish included the following 5 items: canned tuna, dried fish, small fish with bones, oily fish (sardine, mackerel, Pacific saury, amberjack [yellow tail], Pacific herring, eel, tuna, etc), and other fish (salmon, trout, whitefish, freshwater fish, skipjack, etc). The use of dietary supplements, which is uncommon in Japan (8% of general population),[39] was not incorporated into the analysis. Values of dietary intake were energy-adjusted by using the density method (ie, percentage of energy for energy-providing nutrients and amount per 1000 kcal of energy for other nutrients and foods).[40] The validity of the BDHQ for children and adolescents using dietary biomarkers (erythrocyte fatty acids and serum carotenoids) as the gold standard has been published elsewhere;

briefly, Spearman correlation coefficients in 98 boys and 84 girls aged 13 to 14 years were 0.35 and 0.25 for EPA, 0.22 and 0.43 for DHA, 0.21 and 0.13 for α-carotene, 0.23 and 0.33 for β-carotene, and 0.22 and 0.30 for β-cryptoxanthin, respectively.[31] The BDHQ was answered by students themselves (39.4%), their parents (21.1%), or both (39.5%).

Depressive symptoms were assessed by using a Japanese version[41] of the Center for Epidemiologic Studies Depression (CES-D) scale,[42] which was incorporated into the lifestyle questionnaire. This scale consists of 20 questions that address 6 symptoms of depression experienced during the preceding week, including depressed mood, guilt or worthlessness, helplessness or hopelessness, psychomotor retardation, loss of appetite, and sleep disturbance. Each question is scored on a scale of 0 to 3 according to the frequency of the symptom, which gives a total CES-D score range from 0 to 60. The criterion validity of the CES-D scale has been well established in adult Western[42] and Japanese[41] populations; a score of $\geq$16 is an indication of the presence of depressive symptoms. However, the validity of the CES-D (or optimal cutoff score) has not been investigated in Japanese adolescents. Although there exists several validation studies among adolescents in other countries, suggested optimal cutoff scores (eg, 12, 16, 22, and 24) vary greatly among published reports and populations studied.[43–45] In our study, therefore, depressive symptoms were defined as present when participants had a CES-D score of $\geq$16 based on a validation study of Japanese adults.[41]

The lifestyle questionnaire yielded information on habitual exercise, paternal and maternal educational level, whether the child was living with his or her father, mother, or brother(s) or sister(s), and number of siblings. Body weight and height were self-reported as part of the BDHQ. BMI was calculated as body weight divided by the square of body height (kg/m^2).

Statistical Analysis

All statistical analyses were performed for boys and girls separately by using SAS 9.1 statistical software (SAS Institute, Inc, Cary, NC). Fish consumption (g/1000 kcal) and intake of EPA, DHA, and EPA plus DHA (percentage of energy) were categorized at quintile points on the basis of the distribution of boys and girls. By using logistic regression analysis, crude and multivariate adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for depressive symptoms for each quintile category of dietary intake were calculated. The lowest quintile category of dietary intake was used as a reference category. Multivariate adjusted ORs were calculated by adjusting for potential confounding factors including age (12, 13, 14, or 15 years), habitual exercise (yes or no), paternal and maternal educational level (junior high school, high school, junior college or vocational technical school, or university), whether living with the father, mother, or brother(s) or sister(s) (yes or no), number of siblings (0, 1, 2, or $\geq$3), municipality (Naha City or Nago City), BMI (kg/m^2, continuous), and intake of folate (μg/1000 kcal, continuous) for EPA and DHA or vegetables (g/1000 kcal, continuous), the major source of folate, for fish. Trends of association were assessed by a logistic regression model assigning consecutive integers to the levels of the independent variable. All reported *P* values were 2-tailed, and *P* values of $<$.05 were considered statistically significant.

RESULTS

Characteristics of the participants are listed in Table 1. The prevalence of depressive symptoms was 22.5% for boys and 31.2% for girls. Boys with depressive symptoms were less likely to be young, have exercise habits, have fathers with a high educational level, live with fathers and mothers, and have a large number of siblings, and they had a higher mean value of BMI and a lower mean value of intake of fish, EPA, DHA, EPA plus DHA, vegetables, and folate. Girls with depressive symptoms were less likely to have exercise habits, have fathers and mothers with a high educational level, and live with fathers, and they had a lower mean value of vegetable and folate intake. There was an extremely strong correlation between EPA and DHA intake in both boys (Pearson correlation coefficient: 0.95) and girls (Pearson correlation coefficient: 0.95). Oily fish was the major contributor to dietary EPA plus DHA (49.7% in boys and 49.5% in girls), followed by other fish (20.5% in boys and 21.8% in girls), small fish with bones (10.7% in boys and 10.1% in girls), canned tuna (6.6% in boys and 5.9% in girls), and dried fish (4.5% in boys and 4.8% in girls).

Table 2 lists the ORs and 95% CIs for depressive symptoms according to quintile of intake of fish, EPA, and DHA. Results for crude and adjusted models were generally similar. For boys, after adjustment for potential confounding factors, fish intake was inversely associated with depressive symptoms (adjusted OR for depressive symptoms in the highest [compared with the lowest] quintile of intake: 0.73 [95% CI: 0.55–0.97]; *P* for trend = .04). In addition, EPA intake showed an independent and inverse association with depressive symptoms (adjusted OR: 0.71 [95% CI: 0.54–0.94]; *P* for trend = .04). DHA intake also showed a similar inverse, albeit nonsignificant, association (adjusted OR: 0.79 [95% CI: 0.59–1.05]; *P* for trend = .11). In addition, intake of EPA plus DHA was independently inversely associated with depressive symptoms (adjusted OR: 0.72 [95%

TABLE 1 Characteristics of the Participants

	Boys				Girls			
	All ($N = 3067$)	Participants With Depressive Symptoms ($n = 689$ [22.5%])[a]	Participants Without Depressive Symptoms ($n = 2378$ [77.5%])[b]	P[c]	All ($N = 3450$)	Participants With Depressive Symptoms ($n = 1077$ [31.2%])[a]	Participants Without Depressive Symptoms ($n = 2373$ [68.8%])	P[c]
CES-D score, mean ± SD	12.0 ± 6.5	21.2 ± 5.3	9.3 ± 3.9	—	13.5 ± 8.0	22.8 ± 6.8	9.3 ± 3.8[b]	—
Age, *n* (%)				.03				.46
12 y	441 (14.4)	79 (11.5)	362 (15.2)		509 (14.8)	158 (14.7)	351 (14.8)	
13 y	1093 (35.6)	240 (34.8)	853 (35.9)		1186 (34.4)	364 (33.8)	822 (34.6)	
14 y	910 (29.7)	210 (30.5)	700 (29.4)		1067 (30.9)	323 (30.0)	744 (31.4)	
15 y	623 (20.3)	160 (23.2)	463 (19.5)		688 (19.9)	232 (21.5)	456 (19.2)	
Subjects with habitual exercise, *n* (%)	2573 (83.9)	526 (76.3)	2047 (86.1)	<.001	2252 (65.3)	656 (60.9)	1596 (67.3)	<.001
Paternal educational level, *n* (%)				.009				.006
Junior high school	274 (8.9)	77 (11.2)	197 (8.3)		305 (8.8)	121 (11.2)	184 (7.8)	
High school	1409 (45.9)	336 (48.8)	1073 (45.1)		1677 (48.6)	523 (48.6)	1154 (48.6)	
Junior college or vocational technical school	408 (13.3)	81 (11.8)	327 (13.8)		433 (12.6)	124 (11.5)	309 (13.0)	
University	976 (31.8)	195 (28.3)	781 (32.8)		1035 (30.0)	309 (28.7)	726 (30.6)	
Maternal educational level, *n* (%)				.09				.009
Junior high school	161 (5.3)	48 (7.0)	113 (4.8)		178 (5.2)	73 (6.8)	105 (4.4)	
High school	1535 (50.1)	348 (50.5)	1187 (49.9)		1708 (49.5)	536 (49.8)	1172 (49.4)	
Junior college or vocational technical school	1095 (35.7)	239 (34.7)	856 (36.0)		1283 (37.2)	373 (34.6)	910 (38.4)	
University	276 (9.0)	54 (7.8)	222 (9.3)		281 (8.1)	95 (8.8)	186 (7.8)	
Living with father, *n* (%)	2656 (86.6)	565 (82.0)	2091 (87.9)	<.001	2964 (85.9)	906 (84.1)	2058 (86.7)	.04
Living with mother, *n* (%)	2956 (96.4)	650 (94.3)	2306 (97.0)	.001	3314 (96.1)	1030 (95.6)	2284 (96.3)	.39
Living with brother(s) or sister(s), *n* (%)	2765 (90.2)	609 (88.4)	2156 (90.7)	.08	3144 (91.1)	973 (90.3)	2171 (91.5)	.27
No. of siblings, *n* (%)				.04				.07
0	359 (11.7)	102 (14.8)	257 (10.8)		320 (9.3)	117 (10.9)	203 (8.6)	
1	890 (29.0)	195 (28.3)	695 (29.2)		1040 (30.1)	332 (30.8)	708 (29.8)	
2	1186 (38.7)	260 (37.7)	926 (38.9)		1287 (37.3)	376 (34.9)	911 (38.4)	
≥3	632 (20.6)	132 (19.2)	500 (21.0)		803 (23.3)	252 (23.4)	551 (23.2)	
Municipality, *n* (%)				.008				.05
Naha City	2476 (80.7)	532 (77.2)	1944 (81.8)		2814 (81.6)	858 (79.7)	1956 (82.4)	
Nago City	591 (19.3)	157 (22.8)	434 (18.3)		636 (18.4)	219 (20.3)	417 (17.6)	
BMI, mean ± SD, kg/m^2	19.5 ± 3.2	19.9 ± 3.5	19.4 ± 3.1	.002	19.7 ± 2.8	19.7 ± 2.8	19.7 ± 2.8	.96
Energy intake, mean ± SD, kcal/d	2206 ± 595	2199 ± 604	2209 ± 592	.71	1865 ± 510	1851 ± 521	1872 ± 504	.25
Fish intake, mean ± SD, g/1000 kcal	17.9 ± 8.9	17.3 ± 9.3	18.1 ± 8.8	.03	18.4 ± 9.1	18.1 ± 9.1	18.5 ± 9.2	.35
EPA intake, mean ± SD, % energy	0.050 ± 0.037	0.047 ± 0.037	0.051 ± 0.038	.01	0.048 ± 0.039	0.048 ± 0.038	0.048 ± 0.039	.88
DHA intake, mean ± SD, % energy	0.121 ± 0.065	0.116 ± 0.065	0.122 ± 0.065	.03	0.121 ± 0.066	0.121 ± 0.065	0.121 ± 0.066	.97
EPA + DHA intake, mean ± SD, % energy	0.170 ± 0.101	0.163 ± 0.101	0.173 ± 0.101	.02	0.169 ± 0.103	0.168 ± 0.102	0.169 ± 0.104	.97
Vegetable intake, mean ± SD, g/1000 kcal	111.5 ± 37.9	106.2 ± 37.9	113.0 ± 37.7	<.001	120.0 ± 43.3	115.7 ± 43.5	122.0 ± 43.0	<.001
Folate intake, mean ± SD, μg/1000 kcal	132 ± 31	129 ± 32	133 ± 31	.003	140 ± 35	137 ± 38	141 ± 34	.004

[a] Participants with a CES-D score of ≥16.

[b] Participants with a CES-D score of <16.

[c] *P* values are shown for χ^2 test for categorical variables and for independent *t* test for continuous variables.

TABLE 2 Depressive Symptoms According to Quintile of Fish, EPA, and DHA Intake

	Quintile 1 (Lowest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (Highest)	*P* for Trend
Boys ($N = 3067$), *n*	613	614	613	614	613	
Fish, median, g/1000 kcal	9.1	13.0	16.1	20.2	29.1	
Prevalence, %	26.3	24.4	20.2	22.2	19.3	
Crude OR (95% CI)	1 (reference)	0.91 (0.70–1.17)	0.71 (0.55–0.93)	0.80 (0.62–1.04)	0.67 (0.51–0.88)	.002
Adjusted OR (95% CI)[a,b]	1 (reference)	0.94 (0.72–1.23)	0.79 (0.60–1.04)	0.92 (0.70–1.20)	0.73 (0.55–0.97)	.04
EPA, median, % energy	0.015	0.029	0.040	0.056	0.099	
Prevalence, %	26.6	22.8	21.4	22.6	18.9	
Crude OR (95% CI)	1 (reference)	0.82 (0.63–1.06)	0.75 (0.58–0.98)	0.81 (0.62–1.05)	0.64 (0.49–0.84)	.004
Adjusted OR (95% CI)[a,c]	1 (reference)	0.86 (0.66–1.13)	0.82 (0.63–1.08)	0.89 (0.68–1.17)	0.71 (0.54–0.94)	.04
DHA, median, % energy	0.056	0.084	0.108	0.137	0.201	
Prevalence, %	25.5	23.9	21.0	22.3	19.6	
Crude OR (95% CI)	1 (reference)	0.92 (0.71–1.20)	0.78 (0.60–1.02)	0.84 (0.65–1.09)	0.71 (0.54–0.93)	.01
Adjusted OR (95% CI)[a,c]	1 (reference)	1.01 (0.78–1.32)	0.86 (0.65–1.13)	0.96 (0.73–1.26)	0.79 (0.59–1.05)	.11
EPA + DHA, median, % energy	0.073	0.113	0.148	0.189	0.297	
Prevalence, %	26.6	22.5	20.7	23.5	19.1	
Crude OR (95% CI)	1 (reference)	0.80 (0.62–1.04)	0.72 (0.55–0.94)	0.85 (0.65–1.10)	0.65 (0.50–0.85)	.009
Adjusted OR (95% CI)[a,c]	1 (reference)	0.88 (0.67–1.15)	0.81 (0.62–1.07)	0.95 (0.72–1.24)	0.72 (0.55–0.96)	.08
Girls ($N = 3450$), *n*	690	690	690	690	690	
Fish, median, g/1000 kcal	9.2	13.3	16.7	20.9	30.0	
Prevalence, %	34.4	32.5	27.7	29.4	32.2	
Crude OR (95% CI)	1 (reference)	0.92 (0.74–1.15)	0.73 (0.58–0.92)	0.80 (0.64–1.00)	0.91 (0.73–1.13)	.19
Adjusted OR (95% CI)[a,b]	1 (reference)	0.98 (0.78–1.24)	0.82 (0.65–1.03)	0.89 (0.71–1.13)	1.01 (0.80–1.28)	.79
EPA, median, % energy	0.012	0.028	0.039	0.053	0.095	
Prevalence, %	33.6	31.0	28.1	30.9	32.5	
Crude OR (95% CI)	1 (reference)	0.89 (0.71–1.11)	0.77 (0.61–0.97)	0.88 (0.70–1.11)	0.95 (0.76–1.19)	.66
Adjusted OR (95% CI)[a,c]	1 (reference)	0.93 (0.74–1.17)	0.83 (0.66–1.05)	0.97 (0.77–1.23)	1.05 (0.83–1.33)	.59
DHA, median, % energy	0.055	0.085	0.108	0.136	0.202	
Prevalence, %	33.2	32.3	28.3	29.6	32.8	
Crude OR (95% CI)	1 (reference)	0.96 (0.77–1.20)	0.79 (0.63–1.00)	0.85 (0.67–1.06)	0.98 (0.78–1.23)	.52
Adjusted OR (95% CI)[a,c]	1 (reference)	1.01 (0.81–1.27)	0.85 (0.67–1.08)	0.94 (0.75–1.20)	1.09 (0.86–1.38)	.71
EPA + DHA, median, % energy	0.071	0.114	0.146	0.189	0.295	
Prevalence, %	33.6	30.6	28.0	31.7	32.2	
Crude OR (95% CI)	1 (reference)	0.87 (0.69–1.09)	0.77 (0.61–0.96)	0.92 (0.73–1.15)	0.94 (0.75–1.17)	.76
Adjusted OR (95% CI)[a,c]	1 (reference)	0.91 (0.73–1.15)	0.83 (0.66–1.05)	1.03 (0.82–1.30)	1.05 (0.83–1.33)	.43

Depressive symptoms were defined as present when subjects had a CES-D scale score of ≥16.

[a] Adjusted for age (12, 13, 14, or 15 years), habitual exercise (yes or no), paternal educational level (junior high school, high school, junior college or vocational technical school, or university), maternal educational level (junior high school, high school, junior college or vocational technical school, or university), living with father (yes or no), living with mother (yes or no), living with brother(s) or sister(s) (yes or no), number of siblings (0, 1, 2, or ≥3), municipality (Naha City or Nago City), and BMI (kg/m^2, continuous).

[b] Also adjusted for vegetable intake (g/1000 kcal, continuous).

[c] Also adjusted for folate intake (μg/1000 kcal, continuous).

CI: 0.55–0.96]; *P* for trend = .08). Conversely, no such associations were observed among girls.

DISCUSSION

In this cross-sectional study in Japan, intake of fish, EPA, and DHA was inversely associated with depressive symptoms in boys but not in girls. To our knowledge, this is the first study to show that a higher intake of fish, EPA, and DHA is independently associated with a lower prevalence of depressive symptoms in early adolescence. This cross-sectional study is a valuable addition to the literature that a higher intake of fish, EPA, and DHA is related to a decreased risk of depression. Although more research is needed to confirm the causality of the association, dietary modification to increase the intake of fish, EPA, and DHA may be an important strategy for the prevention of depression.

A number of observational studies have examined the association between fish intake and depressive symptoms, but results have been inconsistent.[6–14,17,18,20–26] Findings for long-chain *n*-3 PUFA intake have also been inconclusive.[14–26] A prospective study of Finnish men failed to reveal an association between depressed mood after 9 years and baseline dietary intake of *n*-3 PUFAs from fish.[14] Null findings regarding *n*-3 PUFAs from fish have also been observed in several studies conducted in the United Kingdom,[15] Australia,[16] Spain,[17] and Denmark.[18] Intake of EPA and DHA was not associated with depressive symptoms in 3 Japanese studies.[19–21] Similar results were observed in Australian[22] and French[23] adults. In contrast, higher

intake of EPA and DHA was associated with a lower risk of depressive symptoms after 3 years in US adults.[24] In a cross-sectional study of elderly Dutch people, a high intake of EPA plus DHA was also associated with fewer depressive symptoms.[25] In addition, dietary intake of *n*-3 PUFAs from fish was associated with decreased depressive symptoms in a cross-sectional study of pregnant UK women.[26] Although the mechanism of the association between a diet high in fish and long-chain PUFAs such as EPA and DHA and a decrease in depressive symptoms is not precisely known, and is in any case beyond the scope of this epidemiologic study, long-chain *n*-3 PUFAs may play an important role in neurotransmitter synthesis, degradation, release, reuptake, and binding, resulting in a pattern of neurotransmitter activity that has been associated with depression.[3–5] Inconsistent findings in these studies may be explained, at least partly, by differences in characteristics, dietary habits, and lifestyle of the populations examined, dietary assessment methods used, definitions of depressive symptoms applied, and potential confounding factors considered.

We are unable to explain why we found an inverse association between the intake of fish, EPA, and DHA and depressive symptoms in boys but not girls. However, it has been suggested that genetic factors play a greater role in the etiology of depression in women than men.[46,47] On this basis, dietary intake might have less influence on depressive symptoms in girls than in boys. Also, animal studies have revealed that females require considerably lower intakes of essential fatty acids than males, and females retain essential fatty acids in tissues more effectively than males under conditions of low intake.[48–50] Thus, most of the girls in this study might have had sufficient intake or reserves of essential fatty acids, resulting in no evident association between depressive symptoms and EPA and DHA intake.

Several limitations of our study warrant mention. First, the cross-sectional nature of the study did not permit the assessment of causality because of the uncertain temporality of the association. As a result, we cannot exclude the possibility that depressive symptoms may lead to a low intake of fish, EPA, and DHA because of loss of appetite and decreased food consumption, for example. However, because energy intake between participants with and without symptoms was similar and nutrient-intake values were energy-adjusted, reverse causality is unlikely. Second, only 52.3% of the eligible sample was included in the analysis, which suggests that selection bias might have been inevitable. In addition, the distribution of various lifestyle and environmental factors in Okinawa, where our study was conducted, may differ from those elsewhere in Japan as well as in other parts of the world, and so the results may not apply to other populations. Third, dietary data were obtained from a self-administered dietary assessment questionnaire (ie, a BDHQ)[31]; although the validity of a BDHQ seems reasonable, as described above, actual dietary habits were not observed, so the results should be interpreted with caution. Fourth, we assessed depressive symptoms by using a widely used questionnaire (ie, CES-D scale)[41,42] rather than structured diagnostic interviews. The absence of a clinical diagnosis may have led to the inclusion of participants with chronic fatigue syndrome or atypical depression, although a similar prevalence of depressive symptoms (30%) was observed among a representative adolescent sample in the United States when the same methodology was used.[45] Finally, although adjustment for a variety of potential confounding variables was done, residual confounding could not be ruled out. In particular, we could not control for personal and family psychiatric history, sociocultural factors, or personal and family relations.

CONCLUSIONS

The results of this Japanese cross-sectional study revealed that higher intake of fish, EPA, and DHA was independently associated with a lower prevalence of depressive symptoms in early male, but not female, adolescents. These findings require confirmation by additional prospective studies and also by trials with a more rigorous assessment of dietary intake and depressive symptoms.

ACKNOWLEDGMENTS

This study was supported by Health and Labor Sciences Research Grants, Research on Allergic Disease and Immunology from the Ministry of Health, Labor, and Welfare, Japan.

We acknowledge the Naha City Municipal Board of Education and Nago City Municipal Board of Education for their valuable support.

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Fish and n-3 Polyunsaturated Fatty Acid Intake and Depressive Symptoms: Ryukyus Child Health Study

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Pediatrics 2010;126;e623-e630; originally published online Aug 16, 2010;
DOI: 10.1542/peds.2009-3277