Original Article

Impact of eating alone and nutrient intake on psychological distress among older Japanese adults: A cross-sectional study

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Background and Objectives: This study aimed to examine whether eating alone, folate intake, and n-3 PUFA intake are independently associated with psychological distress in older adults. **Methods and Study Design:** We analyzed cross-sectional data from 1011 study participants aged ≥65 years in Japan. We assessed psychological distress using the Kessler 6 scale, whether the participants ate alone or with others, folate and n-3 PUFA intake using a short food frequency questionnaire. **Results:** Of the 1011 study participants, 465 (46.0%) were male and mean (SD) age was 71.6 (4.8) years. In a multivariable logistic regression analysis, the odds ratio (OR) for psychological distress in participants eating alone compared to those eating with others was 1.32 (95% confidence interval [CI], 0.76–2.31). The ORs in the second and third tertiles compared to the first tertile, which had the lowest folate intake, were 0.92 (95% CI, 0.62–1.37) and 1.12 (95% CI, 0.73–1.73), respectively. The ORs in the second and third tertiles compared to the first tertile, which had the lowest n-3 PUFA intake, were 0.83 (95% CI, 0.56–1.24) and 0.95 (95% CI, 0.62–1.45), respectively. Also, the OR in those eating alone combined with the first tertile of n-3 PUFA intake compared to those eating with others with the third tertile was 2.18 (95%CI, 1.05–4.55). **Conclusions:** Although eating alone combined with low n-3 PUFA intake was associated with psychological distress in older adults, eating alone, folate intake, and n-3 PUFA intake were not independently associated with psychological distress.

Key Words: eating alone, folate, n-3 PUFA, depression, older adults

INTRODUCTION

Depression is one of the most common mental disorder in older adults. Depression can worsen the course of chronic illnesses and increase the risk of frailty and mortality.[1–3] It is also associated with an increased risk of long-term care needs among older Japanese adults.[4, 5] Japan's population is rapidly aging, and the proportion of population aged 65 years and older has reached 29.0% by 2022.[6] Preventing or delaying the incidence or worsening of conditions requiring long-term care is an important issue for Japan to improve the quality of life of older adults and control social security expenditures, including those of medical and long-term care. Therefore, efforts to prevent depression among community-dwelling older adults are required as a preventive measure for long-term care.

Eating alone and nutrient intake may act as modifiable risk factors of depression in older adults. Several observational studies suggest that eating alone is associated with the onset of depressive symptoms among older adults.[7–11] Folate and n-3 polyunsaturated fatty acids (n-3 PUFA) are among the most suggested nutrients to be related with depression. Several observational studies have found that low intake or tissue concentrations of folate and n-3 PUFA may be associated with an increased risk of depression.[12–14] Folate is involved in the 1-carbon metabolism that generates S-adenosylmethionine, which may be related to mental health. n-3 PUFA modulate inflammatory responses and are considered potential candidates in the prevention and treatment of depression.

Eating alone and nutrient intake may confound each other's relationship with depression, as eating alone could be linked to reduced food or caloric intake in older adults.[15–17] For example, eating alone may be associated with depression owing to the association between lower nutrient intake and depression. However, most of the previous studies focused on the impact of either eating alone or nutrient intake on depression, and the independent impacts of eating alone and nutrient intake on depression remain unclear. Therefore, this study aimed to examine

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whether eating alone, folate intake, and n-3 PUFA intake are independently associated with psychological distress, which refers to non-specific psychological symptoms including depressed mood and anxiety, among older adults. Additionally, we explored whether eating alone combined with low folate intake or low n-3 PUFA intake is associated with psychological distress, as both eating alone and low nutrient intake may increase the risk of psychological distress.

If lower nutrient intake, rather than eating alone, is associated with psychological distress, interventions to improve nutritional status of older adults who eat alone, such as support for food shopping or meal preparation and nutritional guidance, would help prevent psychological distress among them. Alternatively, if eating alone, rather than lower nutrient intake, is associated with psychological distress, creating opportunities for older adults who eat alone to eat meals together in the community would be effective in preventing psychological distress. Therefore, it would be helpful to elucidate the relationship between eating alone, nutrient intake, and psychological distress to find effective interventions to prevent psychological distress in older adults.

METHODS

Study design and participants

This was a cross-sectional analysis of the Kanagawa "ME-BYO" Prospective Cohort Study (ME-BYO cohort), a prospective cohort study conducted in Kanagawa Prefecture, Japan. The ME-BYO cohort is part of the Japan Multi-Institutional Collaborative Cohort Study (J-MICC Study), a collaborative genomic cohort study conducted by 13 research groups in 12 prefectures in Japan using a standardized protocol.[18] Details of the J-MICC Study have been described previously.[19] People aged 18 to 95 years who lived or worked in Kanagawa Prefecture were recruited as participants in the ME-BYO cohort. The baseline recruitment and survey began in 2016 and are ongoing in 2022.

We collected baseline data from 3918 participants in the ME-BYO cohort recruited from September 2016 to April 2022. Of those participants, we selected 1135 aged ≥65 years who were recruited between April 2018 and April 2022, when the Kessler 6 (K6) scale was assessed. Of the 1135 participants, 124 participants who had missing values on the K6 scale, eating status (whether they ate alone for breakfast and dinner), or nutrient intake or who did not have breakfast or dinner were excluded. Consequently, 1011 participants were included in the analysis.

Measurements

We conducted a self-administered questionnaire and health examination in the ME-BYO cohort. The study participants were able to complete the questionnaire on their own. While filling it out, they had access to trained support stuff, who could clarify any problem points. The self-administered questionnaire asked about basic characteristics including demographic and education, lifestyle characteristics including alcohol consumption, smoking, sleeping, exercise, and diet, and clinical characteristics including medication and supplements, disease history, psychological stress, and female reproductive history.[19] We used the following items from the self-administered questionnaire and the health examination data.

Psychological distress

Psychological distress was assessed using the K6 scale of a self-administered questionnaire. Detailed information on the K6 scale has been described previously.[20, 21] Briefly, the K6 scale is a 6-question screening scale for non-specific psychological distress, with a total score from 0 to 24. The Japanese version of the scale, which was translated and validated, was used.[21] In this study, scores ≥5 were defined as "psychological distress." The K6 cutoff-point ≥5 has been previously used to screen for mood or anxiety disorders, including major depressive disorder, with a sensitivity of 100.0% and specificity of 68.7% in a Japanese community population.[22]

Eating status

Eating status was assessed using a questionnaire; participants were asked, "Who do you usually eat breakfast/dinner with?" The answer choices for the question included "I eat alone", "I eat with the whole family," "I eat with someone from my family," "I eat with non-family members", and "I do not eat." Those who answered "I eat alone" for both breakfast and dinner were assigned to the eating alone group, while those who answered "I eat with the whole family," "I eat with someone from my family," or "I eat with non-family members" for either breakfast or dinner were assigned to the eating with others group. Those who answered "I do not eat" for either breakfast or dinner were excluded in this analysis because they could not be categorized into the eating alone or eating with other groups.

Nutrient assessment

Nutrient intake was assessed using a short food frequency questionnaire (FFQ), as described in previous studies.[23–25] Briefly, the FFQ inquired about habitual dietary intake during the past year for 47 foods/recipes and frequency in eight categories: never or seldom, 1–3 times/month, 1–2 times/week, 3–4 times/week, 5–6 times/week, once/d, twice/d, and more than three times/d. For staple foods (rice, bread, and noodles), the FFQ also asked about the portion/serving size. From the responses, the daily intake of folate and n-3 PUFA was estimated using a program developed at the Department of Public Health, Nagoya City University School of Medicine,[23] and adjusted for total energy intake using the residual model. The daily intake of folate and n-3 PUFA was estimated from natural foods. A previous study validating the FFQ relative to three-day weighed diet records suggested that the FFQ could be applied to rank individuals according to the consumption of energy and nutrients selected in dietary studies in the middle-aged Japanese population.[24]

Items for covariates

From the self-administered questionnaire, information on sex, age, living status (living with others or living alone), working status (working or non-working), education (elementary school/junior high school/high school graduate or junior college/technical school/university/graduate school graduate), annual income, the 5-item ENRICHD Social Support Inventory (the 5-item ESSI) as a measure

of social support[26] were collected. Medical histories (hypertension, diabetes or hyperglycemia, angina or myocardial infarction, and stroke) were assessed using the results of the self-administered questionnaire and health examination. Hypertension was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, use of blood pressure-lowering medications, or a history of hypertension. Diabetes or hyperglycemia was defined as HbA1c level ≥6.5%, use of glucose-lowering medications, or a history of diabetes. Angina or myocardial infarction was defined as respondents having a history of angina or myocardial infarction. Stroke was defined as respondents having a history of a stroke. Height and weight were measured, and body mass index (BMI) was calculated.

Statistical analysis

The chi-square test was used to compare categorical variables between groups. A non-paired t-test was used to compare continuous variables between groups. To examine whether eating alone and the intakes of folate and n-3 PUFA were independently associated with psychological distress, multivariable logistic regression analysis was performed. We calculated odds ratios (ORs) and 95% confidence intervals (CIs) for psychological distress in eating alone compared to eating with others as the reference, and tertiles of folate and n-3 PUFA intake (low, medium, or high intake) compared to the first tertile (low intake) as the reference. We tested two models in this analysis. Model 1 was adjusted for sex and age. Model 2 was adjusted for sex, age, living status, working status, education, annual income, social support, BMI, and medical histories (hypertension, diabetes or hyperglycemia, angina or myocardial infarction, and stroke). Additional multivariable logistic regression analysis was performed to examine whether a combination of eating status and folate intake or eating status and n-3 PUFA intake was associated with psychological distress. Because it is possible that the relationship between psychological distress and folate intake or n-3 PUFA intake is not necessarily linear, the combinations was treated as categorical variables to examine the relationship between psychological distress and each combination. The combinations included eating with others and high folate or n-3 PUFA intake, eating with others and medium folate or n-3 PUFA intake, eating with others and low folate or n-3 PUFA intake, eating alone and high folate or n-3 PUFA intake, eating alone and medium folate or n-3 PUFA intake, and eating alone and low folate or n-3 PUFA intake. The OR and 95% CI of each combination for psychological distress were calculated, compared to the combination of eating with others and high folate or n-3 PUFA intake as the reference. Statistical significance was set at an alpha level of 0.05. All statistical analyses were performed using Stata/SE 17.0 for Windows (StataCorp LLC, College Station, Texas) and R (version 4.3.2; R Core Team, Vienna, Austria).

Ethics approval and consent to participate

This study was conducted according to the principles of the Declaration of Helsinki. All research procedures were approved by the Institutional Review Board of the Kanagawa Cancer Center Research Ethics Review Committee (28KEN-36). Written informed consent was obtained from all the participants in the ME-BYO cohort.

RESULTS

Of 1011 study participants, 465 (46.0%) were male and 546 (54.0%) were female (Table 1). The mean (SD) age of the participants was 71.6 (4.8) years, in the range of 65–90 years. Of 1011 participants, 303 (30.0%) showed psychological distress at ≥5 on the K6 scale and 191 (18.9%) ate alone. Characteristics of study participants by eating status, folate intake, or n-3 PUFA intake are showed in Supplementary Tables 1–3.

Multivariable logistic regression analyses showed that eating alone, folate intake, and n-3 PUFA intake were not significantly associated with psychological distress (Table 2). In Model 2, the OR in those who ate alone compared to those who ate with others was 1.32 (95% CI, 0.76–2.31). The ORs in the medium and high folate intake groups compared to the low intake group were 0.92 (95% CI, 0.62–1.37) and 1.12 (95% CI, 0.73–1.73), respectively. The ORs in the medium and high n-3 PUFA intake groups compared to the low intake group were 0.83 (95% CI, 0.56–1.24) and 0.95 (95%CI, 0.62–1.45), respectively. Among the covariates, annual income, social support, and BMI were significantly associated with psychological distress.

Additional analyses showed that the combination of eating status and folate intake was not significantly associated with psychological distress (Table 3). However, the OR in those who ate alone combined with low n-3 PUFA intake compared to those who ate with others combined with high n-3 PUFA intake was significantly above 1 (OR, 2.18 [95%CI, 1.05–4.55]) (Table 4).

The proportions of low, medium, and high folate and n-3 PUFA intake groups differed significantly between those who ate alone and those who ate with others (folate, $p = 0.002$; n-3 PUFA, $p = 0.004$) (Table 5). Those who ate alone had a higher proportion of low folate and n-3 PUFA intake than those who ate with others (folate, 44.0% vs. 30.9%; n-3 PUFA, 42.4% vs. 31.2%).

DISCUSSION

This cross-sectional study among older Japanese adults showed that eating alone, folate intake, and n-3 PUFA intake were not independently associated with psychological distress. This result was inconsistent with previous studies among Japanese adults that showed an association between eating alone and depressive symptoms,[7–10] between folate intake and depressive symptoms,[27, 28] or between n-3 PUFA intake and depressive symptoms.[29–31] Although previous studies showed that the association between eating alone and depressive symptoms, between folate intake and depressive symptoms, or n-3 PUFA intake and depressive symptoms varies by sex or living status, the sex-stratified and living status-stratified analyses in this study did not alter this result (Supplementary Tables 4 and 5). The result was also unchanged in multivariable logistic regression analysis adjusted for total energy intake (Supplementary Table 6). This inconsistency may be due to differences in the background of participants in this and previous studies. This study recruited

Table 1. Characteristics of study participants with and without psychological distress

Variables	Without PD (K6 <5) n = 708	With PD (K6 ≥5) n = 303	Total n = 1011	*p*-value[†]
Sex				
Male	341 (48.2%)	124 (40.9%)	465 (46.0%)	0.034
Female	367 (51.8%)	179 (59.1%)	546 (54.0%)	
Age (years)	71.4 (4.7)	72.1 (5.0)	71.6 (4.8)	0.037
Eating status				
Eating with others	584 (82.5%)	236 (77.9%)	820 (81.1%)	0.087
Eating alone	124 (17.5%)	67 (22.1%)	191 (18.9%)	
Total energy intake (kcal/d)	1593.0 (431.9)	1584.0 (427.8)	1590.3 (430.5)	0.760
Folate intake				
Tertile (range)				
Low (<428 μg/d)	237 (33.5%)	100 (33.0%)	337 (33.3%)	0.356
Medium (428–607 μg/d)	244 (34.5%)	93 (30.7%)	337 (33.3%)	
High (>607 μg/d)	227 (32.1%)	110 (36.3%)	337 (33.3%)	
n-3 PUFA intake				
Tertile (range)				
Low (<1946 mg/d)	237 (33.5%)	100 (33.0%)	337 (33.3%)	0.958
Medium (1946–2448 mg/d)	237 (33.5%)	100 (33.0%)	337 (33.3%)	
High (>2448 mg/d)	234 (33.1%)	103 (34.0%)	337 (33.3%)	
Living status				
Living with others	628 (88.7%)	258 (85.2%)	886 (87.6%)	0.069
Living alone	76 (10.7%)	45 (14.9%)	121 (12.0%)	
Missing	4 (0.6%)	0 (0.0%)	4 (0.4%)	
Working status				
Working	218 (30.8%)	73 (24.1%)	291 (28.8%)	0.026
Non-working	463 (65.4%)	220 (72.6%)	683 (67.6%)	
Missing	27 (3.8%)	10 (3.3%)	37 (3.7%)	
Education[‡]				
<13 years	340 (48.0%)	153 (50.5%)	493 (48.8%)	0.400
≥13 years	362 (51.1%)	145 (47.9%)	507 (50.2%)	
Missing	6 (0.9%)	5 (1.7%)	11 (1.1%)	
Annual income				
<3 million yen	413 (58.3%)	201 (66.3%)	614 (60.7%)	0.009
≥3 million yen	283 (40.0%)	94 (31.0%)	377 (37.3%)	
Missing	12 (1.7%)	8 (2.6%)	20 (2.0%)	
Social Support-the 5-item ESSI				
Tertile (range)				
Low (5–19)	241 (34.0%)	138 (45.5%)	379 (37.5%)	<0.001
Medium (20–23)	241 (34.0%)	97 (32.0%)	338 (33.4%)	
High (24–25)	210 (29.7%)	57 (18.8%)	267 (26.4%)	
Missing	16 (2.3%)	11 (3.6%)	27 (2.7%)	
BMI (kg/m^2) [§]	23.0 (3.1)	22.4 (2.9)	22.9 (3.1)	0.002
Hypertension				
Yes	413 (58.3%)	180 (59.4%)	593 (58.7%)	0.675
No	249 (35.2%)	102 (33.7%)	351 (34.7%)	
Missing	46 (6.5%)	21 (6.9%)	67 (6.6%)	
Diabetes or hyperglycemia				
Yes	90 (12.7%)	43 (14.2%)	133 (13.2%)	0.545
No	600 (84.8%)	254 (83.8%)	854 (84.5%)	
Missing	18 (2.5%)	6 (2.0%)	24 (2.4%)	
Angina or myocardial infarction				
Yes	39 (5.5%)	21 (6.9%)	60 (5.9%)	0.385
No	644 (91.0%)	272 (89.8%)	916 (90.6%)	
Missing	25 (3.5%)	10 (3.3%)	35 (3.5%)	
Stroke				
Yes	30 (4.2%)	12 (4.0%)	42 (4.2%)	0.856
No	657 (92.8%)	280 (92.4%)	937 (92.7%)	
Missing	21 (3.0%)	11 (3.6%)	32 (3.2%)	

PD, psychological distress; n-3 PUFA, n-3 polyunsaturated fatty acids.
Data expressed as n (%) or Mean (SD)
[†]The chi-square test was used for categorical variables and a non-paired t-test was used for continuous variables. Participants with missing values were excluded from the tests.
[‡]Education of <13 years included elementary school/junior high school/high school graduate; education of ≥13 years included junior college/technical school/university/graduate school graduate.
[§]Means and standard deviations were calculated for the total participants except for 14 participants with missing BMI values.

Table 2. Association of eating alone, folate intake, and n-3 PUFA intake with psychological distress

Variables	n	Model 1† n = 1011		Model 2‡ n = 806	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Eating status					
Eating alone (ref: Eating with others)	191	1.23 (0.88–1.74)	0.229	1.32 (0.76–2.31)	0.325
Folate intake					
Low	337	1.00 (ref)		1.00 (ref)	
Medium	337	0.87 (0.62–1.24)	0.448	0.92 (0.62–1.37)	0.679
High	337	1.08 (0.75–1.55)	0.692	1.12 (0.73–1.73)	0.591
n-3 PUFA intake					
Low	337	1.00 (ref)		1.00 (ref)	
Medium	337	0.95 (0.68–1.34)	0.782	0.83 (0.56–1.24)	0.365
High	337	0.93 (0.64–1.35)	0.705	0.95 (0.62–1.45)	0.808
Sex					
Female (ref: Male)	546	1.37 (1.03–1.82)	0.031	1.03 (0.69–1.52)	0.901
Age		1.03 (1.00–1.06)	0.028	1.02 (0.99–1.06)	0.190
Living status					
Living alone (ref: Living with others)	121			0.94 (0.49–1.83)	0.862
Working status					
Working (ref: Not working)	291			0.82 (0.57–1.18)	0.286
Education					
≥13 years (ref: <13 years)	507			0.88 (0.64–1.21)	0.423
Annual income					
≥3 million yen (ref: <3 million yen)	377			0.64 (0.43–0.95)	0.028
Social support					
Low	379			1.00 (ref)	
Medium	338			0.68 (0.47–0.98)	0.038
High	267			0.47 (0.31–0.71)	<0.001
BMI				0.94 (0.89–0.99)	0.023
Medical histories					
Hypertension	593			1.03 (0.73–1.46)	0.850
Diabetes or hyperglycemia	133			1.23 (0.79–1.93)	0.359
Angina or myocardial infarction	60			1.37 (0.73–2.58)	0.326
Stroke	42			0.95 (0.43–2.13)	0.908

OR, odds ratio for psychological distress; CI, confidence interval; ref, reference; n-3 PUFA, n-3 polyunsaturated fatty acids.
†Model 1, adjusted for sex and age
‡Model 2, adjusted for sex, age, living status, working status, education, annual income, social support, BMI, and medical histories.

volunteers who willingly chose to participate, in contrast to most previous studies, which either invited all participants or randomly selected them. Thus, the participants in this study may have better social relationships and health than those in previous studies and the average older Japanese adults. Those with poorer social relationships and health may be more susceptible to the impact of eating alone and nutrient intake on depressive symptoms or psychological distress. Therefore, the independent associations of eating alone, folate intake, and n-3 PUFA intake with depressive symptoms or psychological distress may be easily influenced by background and may not be relevant to all older adults. This finding does not support interventions that promote eating with others and the intake of folate and n-3 PUFA to prevent psychological distress among older adults. In this study, lower annual income, social support, and BMI were associated with psychological distress. The association between BMI and psychological distress may be related to decreased appetite caused by depression. Lower income, an aspect of socioeconomic status, and social support may increase the risk of depression.[32, 33] The results suggested that socioeconomic status and social support, rather than eating alone and the intake of folate and n-3 PUFA, have a greater impact on preventing psychological distress among older adults.

However, this study suggested that eating alone combined with low n-3 PUFA intake may increase the risk of psychological distress, even though eating alone and low n-3 PUFA intake independently do not have this effect. A previous study also showed that eating alone combined with low dietary variety increased the risk of long-term care needs compared to eating with others combined with high dietary variety, although eating status and dietary variety were not independently associated with long-term care needs.[34] The combination of eating alone and low nutrient intake may increase the risk of psychological distress and long-term care needs, even though the impact of each factor may be modest. Further research is required to elucidate the interaction between eating status and nutrient intake.

The proportion of individuals with low folate and n-3 PUFA intake was higher among those who ate alone compared to those who ate with others. Folate is found in vegetables, fruits, and the liver. Among n-3 PUFAs, α-linolenic acid is found in vegetable oils, while eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are found in fish. This was consistent with a previous study showing that older adults who ate alone consumed several food groups, including green vegetables, fruits, fish, and oil, less frequently than those who ate with others.[16] Older adults who ate alone have someone to help with food

Table 3. Association of the combination of eating status and folate intake with psychological distress

Variables	n	Model 1† n = 1011		Model 2‡ n = 806	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Eating status and folate intake					
Eating with others					
High intake	279	1.00 (ref)		1.00 (ref)	
Medium intake	288	0.76 (0.53–1.10)	0.145	0.78 (0.51–1.18)	0.245
Low intake	253	0.86 (0.59–1.26)	0.436	0.76 (0.48–1.19)	0.229
Eating alone					
High intake	58	0.90 (0.48–1.64)	0.737	0.87 (0.36–1.99)	0.742
Medium intake	49	1.06 (0.54–1.99)	0.870	0.88 (0.35–2.09)	0.768
Low intake	84	1.27 (0.76–2.12)	0.357	1.46 (0.72–2.94)	0.290
Sex					
Female (ref: Male)	546	1.36 (1.03–1.81)	0.032	1.02 (0.69–1.52)	0.910
Age		1.03 (1.00–1.06)	0.025	1.02 (0.99–1.06)	0.191
Living status					
Living alone (ref: Living with others)	121			0.93 (0.48–1.81)	0.840
Working status					
Working (ref: Not working)	291			0.83 (0.57–1.18)	0.300
Education					
≥13 years (ref: <13 years)	507			0.88 (0.64–1.21)	0.426
Annual income					
≥3 million yen (ref: <3 million yen)	377			0.65 (0.44–0.96)	0.032
Social support					
Low	379			1.00 (ref)	
Medium	338			0.68 (0.47–0.98)	0.038
High	267			0.46 (0.30–0.70)	<0.001
BMI				0.93 (0.88–0.99)	0.017
Medical histories					
Hypertension	593			1.04 (0.74–1.47)	0.834
Diabetes or hyperglycemia	133			1.24 (0.79–1.93)	0.349
Angina or myocardial infarction	60			1.39 (0.73–2.59)	0.311
Stroke	42			0.94 (0.40–2.05)	0.878

OR, odds ratio for psychological distress; CI, confidence interval; ref, reference.
†Model 1, adjusted for sex and age
‡Model 2, adjusted for sex, age, living status, working status, education, annual income, social support, BMI, and medical histories

shopping and receive food from neighbors or relatives less frequently than those who eat with others.[15] Therefore, it may be difficult for older adults who eat alone to prepare a variety of foods and be exposed to information or social norms in regards to a healthy diet. In previous observational studies, a high dietary intake of folate and vitamin B-6 was associated with a reduced risk of mortality from stroke, coronary heart disease, and heart failure.[35] n-3 PUFA, especially EPA and DHA, may be associated with a reduced risk of coronary heart disease and cognitive impairment.[36–38] Therefore, a low intake of folate and n-3 PUFA in older adults who eat alone may affect health outcomes other than psychological distress, suggesting the need to support their adequate nutritional intake.

This study provided new findings on the association between eating alone, nutrient intake, and psychological distress. However, several limitations were noted. First, due to the cross-sectional nature of this study, the causal relationship between exposure and outcome variables remains uncertain. There could be reverse causality, in which people with psychological distress have lower appetite, leading to eating alone and decreased n-3 PUFA intake. Analysis of longitudinal data from this cohort study is required. Second, the results may not be generalizable to all older Japanese adults. As discussed above, the participants of this study may have better social relationships and health than the average older Japanese population because of sampling bias. Further studies including participants with poor social relationships and health are needed. In addition, the proportion of participants with a K6 score ≥5 in this study (30.0%) was higher than the proportion of participants aged 65 years and older with a K6 score ≥5 in the Comprehensive Survey of Living Conditions conducted nationwide by the Ministry of Health, Labour and Welfare in 2019 (24.8%),[39] suggesting that the participants in this study had different backgrounds from the average older Japanese population. Third, this study assessed psychological distress as the outcome variable; as psychological distress referred to non-specific psychological symptoms and was not limited to depressive symptoms, the associations of eating alone and nutrient intake with depression could have been diluted. Previous studies have employed outcome variables as depressive symptoms assessed using screening scales for depression, such as the 15-item Geriatric Depression Scale and the Center for Epidemiologic Studies Depression Scale, or a psychiatrist-based diagnosis of major depressive disorder. Thus, this difference in the outcome variable between this and previous studies may be related to inconsistencies in the results between this and previous studies. Therefore, outcomes need to be assessed by a

Table 4. Association of the combination of eating status and n-3 PUFA intake with psychological distress

Variables	n	Model 1† n = 1011		Model 2‡ n = 806	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Eating status and n-3 PUFA intake					
Eating with others					
High intake	290	1.00 (ref)		1.00 (ref)	
Medium intake	274	1.02 (0.71–1.47)	0.907	0.92 (0.60–1.40)	0.689
Low intake	256	0.90 (0.61–1.31)	0.581	0.81 (0.52–1.26)	0.352
Eating alone					
High intake	47	0.94 (0.47–1.82)	0.863	0.94 (0.38–2.21)	0.888
Medium intake	63	0.94 (0.51–1.69)	0.848	0.65 (0.27–1.48)	0.319
Low intake	81	1.70 (1.01–2.85)	0.042	2.18 (1.05–4.55)	0.037
Sex					
Female (ref: Male)	546	1.39 (1.05–1.84)	0.023	1.03 (0.70–1.53)	0.864
Age		1.04 (1.01–1.07)	0.017	1.03 (0.99–1.07)	0.105
Living status					
Living alone (ref: Living with others)	121			0.91 (0.46–1.79)	0.783
Working status					
Working (ref: Not working)	291			0.85 (0.59–1.21)	0.366
Education					
≥13 years (ref: <13 years)	507			0.90 (0.65–1.24)	0.505
Annual income					
≥3 million yen (ref: <3 million yen)	377			0.63 (0.42–0.94)	0.023
Social support					
Low	379			1.00 (ref)	
Medium	338			0.71 (0.49–1.02)	0.064
High	267			0.46 (0.30–0.70)	<0.001
BMI				0.93 (0.88–0.99)	0.014
Medical histories					
Hypertension	593			1.04 (0.74–1.48)	0.804
Diabetes or hyperglycemia	133			1.26 (0.79–1.96)	0.324
Angina or myocardial infarction	60			1.36 (0.72–2.54)	0.333
Stroke	42			1.01 (0.43–2.20)	0.989

OR, odds ratio for psychological distress; CI, confidence interval; ref, reference; n-3 PUFA, n-3 polyunsaturated fatty acids
†Model 1, adjusted for sex and age
‡Model 2, adjusted for sex, age, living status, working status, education, annual income, social support, BMI, and medical histories

Table 5. Comparison of folate and n-3 PUFA intake between groups eating with others and eating alone

	Eating with others n = 820	Eating alone n = 191	*p*-value†
Folate intake			
Low	253 (30.9%)	84 (44.0%)	0.002
Medium	288 (35.1%)	49 (25.7%)	
High	279 (34.0%)	58 (30.4%)	
n-3 PUFA intake			
Low	256 (31.2%)	81 (42.4%)	0.004
Medium	274 (33.4%)	63 (33.0%)	
High	290 (35.4%)	47 (24.6%)	

n-3 PUFA, n-3 polyunsaturated fatty acids.
Data expressed as n (%)
†The chi-square test was used.

diagnosis of clinical depression. Fourth, the definition of eating alone varied between this and previous studies. However, the prevalence of eating alone in this study (18.9%) was comparable to that in previous studies (approximately 13–33%).[7–10] Therefore, we believe that eating alone in this study evaluated, to a certain extent, the same characteristics as eating alone in previous studies. Fifth, in this study, folate and n-3 PUFA intake were assessed using a self-administered questionnaire, which may have caused misclassification. Objective assessments, such as serum concentrations of folate and n-3 PUFA, are needed. Sixth, this study focused on folate and n-3 PUFA. However, other nutrients or total diets indicated as dietary patterns may be associated with the risk of depressive symptoms among older adults.[40] Dietary patterns should be assessed using dietary pattern indices, factor analysis, and reduced rank regression. Seventh, although hypertension, diabetes or hyperglycemia, angina or myocardial infarction, and stroke were included in the covariates, the management status of these diseases could not be considered. Thus, the effect of these chronic diseases may not have been accurately adjusted for. Eighth,

we excluded study participants with missing values from the analyses. Multivariable logistic regression analyses were performed, including missing values as variables (Supplementary Tables 7–9). In the analysis, eating alone, folate intake, and n-3 PUFA intake were not independently associated with psychological distress, as in the original analysis (Supplementary Table 7). However, the analysis estimated a lower odds ratio for psychological distress in those eating alone combined with low n-3 PUFA intake compared to those eating with others combined with high n-3 PUFA than the original analysis (Supplementary Table 9). The association between eating alone combined with low n-3 PUFA intake and psychological distress needs to be evaluated in studies with larger sample sizes.

Conclusion

Eating alone, folate intake, and n-3 PUFA intake were not independently associated with psychological distress among older adults in this study. This finding does not support interventions that promote eating with others and the intake of folate and n-3 PUFA to prevent psychological distress among older adults. On the other hand, eating alone combined with low n-3 PUFA intake was associated with psychological distress in this study. It suggests that attention should be paid to the risk for psychological distress in older adults who eat alone and have low n-3 PUFA intake.

SUPPLEMENTARY MATERIALS

All supplementary tables and figures are available upon request.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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