Green tea consumption is associated with depressive symptoms in the elderly[1–3]

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ABSTRACT

Background: Green tea is reported to have various beneficial effects (eg, anti–stress response and antiinflammatory effects) on human health. Although these functions might be associated with the development and progression of depressive symptoms, no studies have investigated the relation between green tea consumption and depressive symptoms in a community-dwelling population.

Objective: The aim of this study was to investigate the relations between green tea consumption and depressive symptoms in elderly Japanese subjects who widely consumed green tea.

Design: We conducted a cross-sectional study in 1058 community-dwelling elderly Japanese individuals aged ≥70 y. Green tea consumption was assessed by using a self-administered questionnaire, and depressive symptoms were evaluated by using the 30-item Geriatric Depression Scale with 2 cutoffs: 11 (mild and severe depressive symptoms) and 14 (severe depressive symptoms). If a participant was consuming antidepressants, he or she was considered to have depressive symptoms.

Results: The prevalence of mild and severe and severe depressive symptoms was 34.1% and 20.2%, respectively. After adjustment for confounding factors, the odds ratios (95% CI) for mild and severe depressive symptoms when higher green tea consumption was compared with green tea consumption of ≤1 cup/d were as follows: 2–3 cups green tea/d (0.96; 95% CI: 0.66, 1.42) and ≥4 cups green tea/d (0.56; 95% CI: 0.39, 0.81) (*P* for trend: 0.001). Similar relations were also observed in the case of severe depressive symptoms.

Conclusion: A more frequent consumption of green tea was associated with a lower prevalence of depressive symptoms in the community-dwelling older population. *Am J Clin Nutr* 2009; 90:1615–22.

INTRODUCTION

Depression in late life is a recognized public health problem. Depression can increase the risk of medical illnesses, worsen the outcome of other medical illnesses, and even increase mortality (1, 2).

Many risk factors are recognized as contributors to the occurrence of depressive symptoms. Stress is particularly well established as a factor that can cause depressive symptoms or contribute to the severity of depression (3). Inflammation also is of key importance for central and peripheral hormonal secretion; it also interacts with neurotransmitters and is related to pathophysiologic processes such as neurodegeneration (4). Epidemiologic studies of patients and community dwellers have shown that inflammatory proteins are associated with depressive symptoms (5).

In Asia, green tea, a widely consumed beverage, has been regarded for centuries to possess significant health-promoting effects (6). Many animal studies have suggested that theanine, one of the major amino acids contained in green tea, has a tranquilizing effect on the brain (7). A laboratory study on acute stress showed that the oral intake of theanine lowered the stress response in human participants (8). Several experimental and animal studies have also shown that green tea is an antiinflammatory agent and that it ameliorates the overproduction of proinflammatory cytokines and mediators (9–11). These effects have been attributed largely to the most prevalent polyphenol contained in green tea, catechin, or flavanol (−) epigallocatechin-3-gallate (12).

Thus, we hypothesized that green tea might have a beneficial effect in the primary and secondary prevention of depressive symptoms or psychological distress due to its antagonistic effects on the stress response and inflammation. However, to the best of our knowledge, only a few studies have reported relations between green tea consumption and mental health (13, 14), and a relation concerning depressive symptoms does not appear to have been investigated. Thus, the relation between green tea

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consumption and depressive symptoms in community-dwelling elderly adults, in whom this condition is highly prevalent, remains unclear. In the present study, we investigated the relation between green tea consumption and depressive symptoms in elderly Japanese subjects who consume green tea.

SUBJECTS AND METHODS

Study participants

Our study population comprised subjects aged ≥70 y who resided in the Tsurugaya area of Sendai city, one of the major cities in the Tohoku area of Japan (15, 16). At the time of the study in 2002, there were 2730 individuals aged ≥70 y living in Tsurugaya. All of them were invited to participate in a comprehensive geriatric assessment, which included physical function, cognitive function, and dental status. Of those invited, 1198 participated in the survey and 1178 provided their informed consent for data analysis. The protocol of this study was approved by the Institutional Review Board of the Tohoku University Graduate School of Medicine.

In this study, the depressive symptoms were assessed by using the Geriatric Depression Scale (GDS). Of the 1178 subjects, 1169 completed the GDS (**Figure 1**). Those who did not have any information on diet were excluded (n = 94). Furthermore, subjects who reported cognitive dysfunction (Mini-Mental State Examination score: <18; n = 17) (17) were also excluded. As a result of these exclusions, the final study population comprised 1058 subjects (mean ± SD age: 75.9 ± 4.7 y; men: 42.6%).

Assessment of depressive symptoms

Depressive symptoms were assessed according to the Japanese version (18) of the 30-item GDS. The score ranged from 0 to 30, with greater values indicating increased severity. In this study, 2 cutoffs were used to define different levels of depressive symptoms. The first cutoff was a GDS score ≥11 and/or the use of antidepressants, which indicated relatively mild and severe depressive symptoms. The second cutoff was a GDS score ≥14 and/or the use of antidepressants, indicating relatively severe depressive symptoms.

Assessment of dietary intake

The participants were instructed to fill out a brief self-administered diet-history questionnaire that included 75 food items with specified serving sizes described by natural portions or standard weight and volume measures of the servings commonly

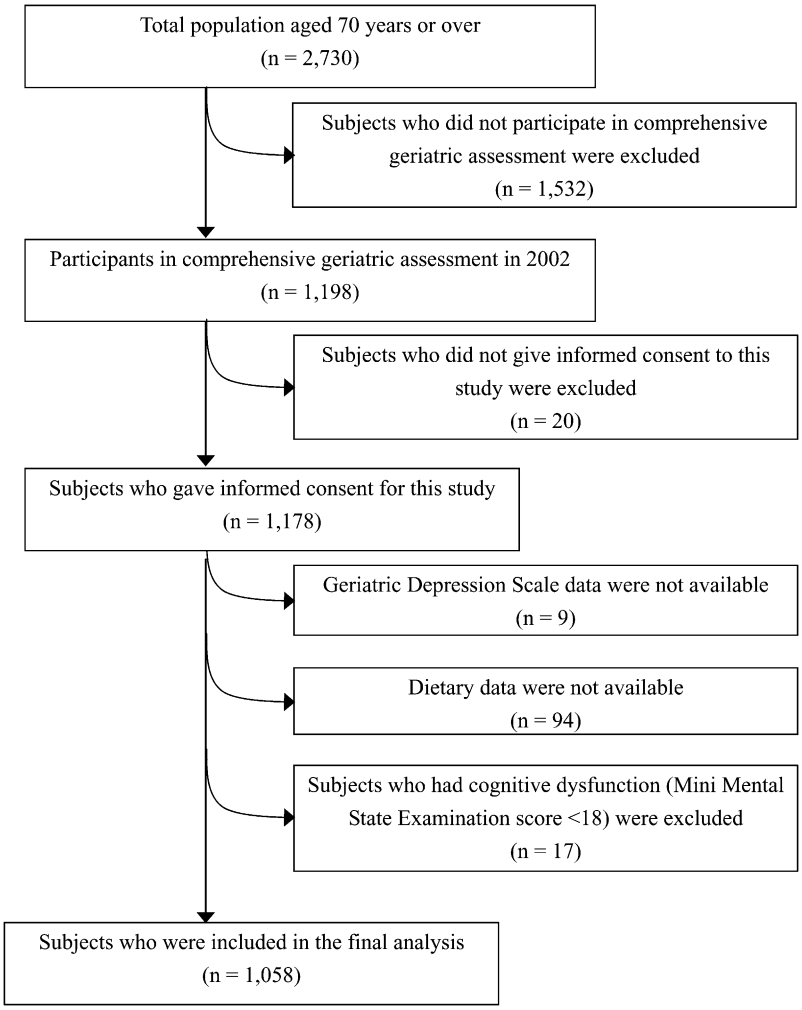

FIGURE 1. Flow chart of the sample selection.

consumed in the study population. The mean daily intake of nutrients was calculated by using an ad hoc computer program developed to analyze the questionnaire. The Japanese food composition tables (19) and others (20) were used as the nutrient database. The reproducibility and validity of the brief self-administered diet-history questionnaire have already been described in detail elsewhere (21).

Participants indicated the mean frequency of consumption of green tea, black or oolong tea, and coffee over the previous 1 mo in terms of the specified serving size by selecting 1 of the 8 frequency categories: almost never, <1 cup/wk, 1 cup/wk, 2–3 cups/wk, 4–6 cups/wk, 1 cup/d, 2–3 cups/d, and ≥4 cups/d. In the study region, the volume of a typical cup of green tea is 100 mL. We summarized these categories in tertile in the following way: green tea (≤1 cup/d, 2–3 cups/d, and ≥4 cups/d), black or oolong tea (almost never, <1 cup/d, and ≥1 cups/d), and coffee (almost never, <1 cup/d, and ≥1 cups/d).

Assessment of other variables

Blood pressure (BP) was measured at home with an HEM747IC device (Omron Life Science Co Ltd, Tokyo, Japan), which uses the cuff oscillometric method to generate a digital display of systolic and diastolic BPs. The mean (±SD) of 15.6 ± 10.4 BP measurements was used as the BP value. Participants who did not measure BP at home on ≥3 d were treated as having missing information on hypertension. Hypertension was defined as a home systolic BP ≥135 mm Hg or a home diastolic BP ≥85 mm Hg or the use of antihypertensive agents (22).

Blood samples were drawn from the antecubital vein, with minimal tourniquet use, while subjects were seated. Specimens were collected in siliconized vacuum glass tubes containing sodium fluoride for blood glucose and no additives for C-reactive protein (CRP) analyses. Blood glucose concentration was measured by using enzymatic methods (Shino-Test, Tokyo, Japan). Diabetes was defined as a casual blood glucose concentration of ≥200 mg/dL or the current use of antidiabetic medication. Highly sensitive CRP concentrations were determined by an immunotechnique that uses a Behring BN II analyzer (Dade Behring, Tokyo, Japan). The BN II assay utilizes a monoclonal antibody coated on polystyrene particles and fixed-time kinetic nephelometric measurements. The detection limit of this assay is 0.02 mg/L. We categorized the study participants on the basis of proposed cutoffs for CRP as low (<1.0 mg/L) or high (at least 1.0 mg/L) (23). The drug information was confirmed by a well-trained pharmacist.

The anthropometric variables (height and body weight) were recorded by using a standard protocol. Body mass index was calculated as weight in kilograms divided by height in meters squared. The sociodemographic variables, which include sex, age, educational level, marital status, cohabitants, perceived social support, and visiting friends, were also assessed. The educational level was assessed by determining the age at completion of schooling and was divided into 2 categories: ≤12 or >12 y (24). Marital status was categorized as follows: married, divorced or widowed, or single. The subjects were also classified as living alone or living with others. Perceived social support (PSS) was evaluated on the basis of the responses (yes or no) to the following 5 questions: "Do you have someone to talk to when you are in trouble?" (PSS1); "Do you have someone to talk to when your physical condition is not good?" (PSS2); "Do you have someone to help you with daily housework?" (PSS3); "Do you have someone to take you to the hospital when you are not feeling well?" (PSS4); and "Do you have someone to take care of you when you are ill and in bed?" (PSS5). These questions were extracted from a previous study on social support and depression among elderly individuals in a rural community (25). A single score was calculated by adding the scores of PSS1–5. The lack of PSS was defined as a PSS score of 0. "Visiting friends" was evaluated on the basis of the responses (yes or no) to the following question: "Do you visit your friends?"

The health-related variables included history of physical illness, pain, cognitive function, instrumental activities of daily living (IADLs), and current medication use. History of physical illness was evaluated on the basis of the responses (yes or no) to questions concerning the history of stroke, ischemic heart disease, cancer, and arthritis. Pain within the previous 4 wk was assessed on the basis of the question, "Have you had any pain recently? If so, how intense was it?" The possible answers were "no pain," "very mild pain," "mild pain," "moderate pain," and "severe pain." Subjects who reported "mild" to "severe" pain were considered to have pain. Cognitive function was assessed with the Mini-Mental State Examination, and scores were classified as belonging to 1 of 3 categories: 18–23, 24–27, and ≥28. The IADL scores were assessed by using the Rouken-Shiki scale (26), and a cutoff of 10/11 was used to determine impairment in IADLs (27).

Information on the smoking ("never," "former," and "current smoking") and drinking ("never," "former," and "current drinking") status of the participants was obtained from a questionnaire survey. Physical activity (PA) was first assessed by a self-reported single question on whether the participant had any PA in the past year. If "yes," further questions were asked about the frequency and duration of walking, brisk walking, and sports. PA was then classified into 3 categories on the basis of the frequency and duration of participation: *1*) "high" (PA ≥3–4 times/wk for ≥30 min each time), *2*) "low" (reporting some PA in the past year, but not enough), and *3*) "none" (no PA). Furthermore, PA was classified into 6 levels on the basis of the above 3 categories and the nature of the physical activity, such as walking, brisk walking, and sports: *1*) level 1 (no walking, brisk walking, or sports), *2*) level 2 (low walking, no brisk walking, no sports), *3*) level 3 (high walking, no brisk walking, no sports), *4*) level 4 (any walking, low brisk walking, no sports), *5*) level 5 (any walking, high brisk walking, no sports), and *6*) level 6 (any walking, any brisk walking, low or high sports). Detailed information has been provided in previous reports (28).

Statistical analysis

The descriptive data have been presented as the mean (with 95% CIs) or as percentages. Depressive symptoms were used as dependent variables, and green tea consumption categories in tertile were used as independent variables. The differences of variables among the green tea consumption categories were examined by analysis of variance for continuous variables or by logistic regression analysis for variables of proportion. For model 1, multiple logistic regression analysis was used to examine relations between green tea consumption and depressive symptoms with adjustment for age; sex; body mass index;

hypertension; diabetes; history of cardiovascular diseases, cancer, or arthritis; high C-reactive protein ($\geq$1.0 mg/L); history of smoking and drinking habits; physical activity (all 6 levels as a categorical variable); cognitive status; impaired IADLs; self-reported body pain; educational level; living alone; and marital status (model 1). For model 2, all of the above variables were used, in addition to serum albumin concentration, total energy intake, intakes per 2000 kcal of energy intake as protein and folate, and consumption frequencies of black or oolong tea (almost never, $<$1 cup/d, and $\geq$1 cups/d) and coffee (almost never, $<$1 cup/d, and $\geq$1 cups/d). For model 3, all variables in models 1 and 2 in addition to lack of PSS and visiting friends were included. The final multivariate logistic analysis was performed with the forced entry of all factors considered to be potential covariates. Bonferroni-corrected *P* values were used for comparisons between groups differing in green tea consumption. All *P* values for linear trends were calculated by using the categories of green tea consumption ($\leq$1 cup/d: 1; 2–3 cups/d: 2; $\geq$4 cups/d: 3). The interactions between green tea consumption and all confounders for having depressive symptoms were tested through the addition of the cross-product terms to the regression model. A difference was defined to be significant when $P < 0.05$. All statistical analyses were performed by using the Statistical Analysis System 9.1 edition for Windows (SAS Institute Inc, Cary, NC).

RESULTS

On the basis of the data obtained from 1058 subjects, 34.1% (361/1058) [27.3% (123/451) of men and 39.2% (238/607) of women] were classified as having mild and severe depressive symptoms and 20.2% (214/1058) [14.9% (67/451) of men and 24.2% (147/607) of women] were classified as having severe depressive symptoms.

The participant characteristics according to their green tea consumption status are presented in **Table 1**. The proportion of women, those with a history of cancer, nonsmokers, visiting friends, and widowed (or divorced) status were significantly higher across the green tea consumption tertiles (*P* for trend: $<$0.0001, 0.04, $<$0.0001, 0.0001, and 0.02, respectively). The proportion of subjects with a history of cardiovascular disease, who were current smokers or ex-smokers, who were married, and who had impaired IADLs, self-reported body pain, and lack of perceived social support was significantly lower across the categories of green tea consumption (*P* for trend: $<$0.01, 0.02, $<$0.0001, $<$0.01, 0.01, 0.03, and 0.04, respectively). Although the difference was not statistically significant, the proportion of nondrinkers was highest in categories with the lowest green tea consumption. The mean folate consumption ($\mu g \cdot d^{-1} \cdot 2000$ kcal) was significantly higher across categories of green tea consumption (*P* for trend $<$ 0.0001). The mean GDS score was significantly lower across the categories of green tea consumption (*P* for trend $<$ 0.0001). There were no apparent associations between high CRP and green tea consumption. Otherwise, no significant difference was observed between categories of green tea consumption.

The adjusted association between categories of green tea consumption and mild and severe or severe depressive symptoms is shown in **Table 2**. The ORs of the depressive symptoms decreased across categories of green tea consumption. In the final multivariate logistic models, the adjusted ORs for mild and severe depressive symptoms across categories of green tea consumption were 1.00 (reference) for $\leq$1 cup/d, 0.96 (95% CI: 0.66, 1.42) for 2–3 cups/d, and 0.56 (95% CI: 0.39, 0.81) for $\geq$4 cups/d (*P* for trend $<$ 0.001). The prevalence of depressive symptoms was 44% lower for participants who consumed $\geq$4 cups green tea/d tea than for those who consumed $\leq$1 cup/d (Bonferroni-corrected *P* value $<$0.01). The ORs of mild and severe depressive symptoms for CRP were 1.00 (reference) for low CRP ($<$1 mg/L) and 1.08 (95% CI: 0.79, 1.48) for high CRP ($\geq$1.0 mg/L). Similar relations were observed even when we used GDS $\geq$14 and the use of antidepressants as a definition of depressive symptoms. When we analyzed the relation between the consumption of other beverages and depressive symptoms, a weak or null relation was observed between the consumption of black or oolong tea or coffee and prevalence of depressive symptoms. The multivariate ORs for mild and severe depressive symptoms according to the frequencies of black or oolong tea consumption were 1.00 (reference) for almost never, 0.82 (95% CI: 0.56, 1.20) for $<$1 cup/d, and 0.71 (95% CI: 0.49, 1.02) for $\geq$1 cups/d (*P* for trend: 0.06), whereas those for coffee were 1.00 (reference) for almost never, 1.01 (95% CI: 0.73, 1.39) for $<$1 cup/d, and 0.82 (95% CI: 0.53, 1.27) for $\geq$1 cups/d (*P* for trend: 0.49). Similar results were also observed when the cutoff $\geq$14 or the use of antidepressants was used to indicate severe depressive symptoms. Eighteen participants consumed antidepressants in this study. Because individuals who were taking monoamine oxidase inhibitors may have been instructed to avoid the intake of green tea, our findings may have been affected. Therefore, we also analyzed the relations between green tea consumption and depressive symptoms in participants not consuming antidepressants. However, this exclusion did not alter our findings. ORs (95% CI) for mild and severe and for severe depressive symptoms across the green tea consumption tertiles were 1.00, 0.96 (95% CI: 0.67, 1.45), and 0.59 (95% CI: 0.40, 0.87) (*P* for trend $<$ 0.01) and 1.00, 0.97 (95% CI: 0.61, 1.54), and 0.51 (95% CI: 0.32, 0.81) (*P* for trend $<$ 0.01), respectively. We observed a similar relation between green tea consumption and depressive symptoms when men and women were separately analyzed. In model 3, the adjusted ORs (95% CI) for mild and severe and for severe depressive symptoms across the categories of green tea consumption were as follows: for men, the values were 1.00, 0.78 (95% CI: 0.41, 1.48), and 0.45 (95% CI: 0.22, 0.91) (*P* for trend: 0.03) and 1.00, 0.96 (95% CI: 0.44, 2.12), and 0.35 (95% CI: 0.14, 0.87) (*P* for trend: 0.02), respectively; for women, the values were 1.00, 1.09 (95% CI: 0.64, 1.86), and 0.65 (95% CI: 0.40, 1.05) (*P* for trend: 0.04) and 1.00, 0.83 (95% CI: 0.46, 1.49), and 0.50 (95% CI: 0.29, 0.87) (*P* for trend: $<$0.01), respectively. We did not observe significant interaction between green tea consumption and sex either for mild and severe or for severe depressive symptoms (*P* for interaction: 0.29 for mild and severe and 0.80 for severe). The tests for interaction between the consumption of green tea and other confounders in the final models were also not statistically significant.

DISCUSSION

The present study examined the relation between green tea consumption and depressive symptoms among a community-

TABLE 1
Subject characteristics according to categories of green tea intake[1]

	Categories of green tea intake			
	≤1 cup/d	2–3 cups/d	≥4 cups/d	*P* for trend[2]
n	286	284	488	
Age (y)	75.5 (75.0, 76.1)[3]	76.4 (75.8, 76.9)	75.9 (75.5, 76.3)	0.10
Female sex (%)	48.3	52.8	65.4	<0.0001
BMI (kg/m^2)	23.8 (23.4, 24.2)	23.8 (23.4, 24.2)	24 (23.7, 24.3)	0.80
Serum albumin (g/dL)	4.33 (4.29, 4.36)	4.33 (4.30, 4.36)	4.34 (4.31, 4.36)	0.82
Hypertension (%)	69.6	64.4	70.5	0.61
Diabetes (%)	9.4	8.8	8.8	0.78
History of CVD (%)	19.9	15.9	12.9	<0.01
History of cancer (%)	5.2	4.9	8.8	0.04
History of arthritis (%)	18.5	18.3	17.8	0.80
High CRP (%)[4]	33.9	32.4	31.4	0.46
Smoking status (%)				
Current smoker	16.4	12.7	10.7	0.02
Ex-smoker	39.2	31.0	23.6	<0.0001
Nonsmoker	42.7	55.3	62.9	<0.0001
Drinking status (%)				
Current drinker	41.6	41.2	38.7	0.40
Ex-drinker	14.7	12.0	10.0	0.055
Nondrinker	39.2	44.0	46.3	0.057
PA > level 3 (%)	37.4	41.9	35.3	0.40
Impaired cognitive function (%)				
18 ≤ MMSE < 24	8.4	6.7	7.2	0.58
24 ≤ MMSE < 28	38.5	34.5	34.4	0.29
Impaired IADLs (%)	14.0	15.1	8.4	<0.01
Visiting friends: "yes" (%)	69.6	72.9	81.5	0.0001
Body pain: "yes" (%)	28.0	21.8	20.1	0.01
Lack of perceived social support: total score = 0 (%)	15.7	16.6	10.7	0.03
Educational level ≤12 y (%)	68.2	68.0	71.7	0.26
Living alone: "yes" (%)	22.7	23.9	25.4	0.39
Marital status (%)				
Married	67.1	60.2	59.4	0.04
Widowed or divorced	29.4	34.2	37.5	0.02
Single	3.5	5.6	3.1	0.59
Nutrient intake				
Total energy intake (kcal/d)	1959.9 (1901.3, 2018.5)	2023.9 (1965.2, 2082.7)	1959.6 (1914.8, 2004.4)	0.19
Total protein ($g \cdot d^{-1} \cdot 2000$ kcal)	82.8 (81.2, 81.2)	81.7 (80.1, 80.1)	83.2 (81.9, 81.9)	0.34
Folate ($\mu g \cdot d^{-1} \cdot 2000$ kcal)	336.2 (324.6, 347.8)	372.4 (360.7, 384.1)	404.0 (395.1, 412.9)	<0.0001
GDS scores	9.9 (9.3, 10.5)	9.8 (9.1, 10.4)	8.3 (7.8, 8.8)	<0.0001

[1] CVD, cardiovascular disease; CRP, C-reactive protein; PA, physical activity; MMSE, Mini-Mental State Examination score; IADLs, instrumental activities of daily living; GDS, Geriatric Depression Scale.
[2] Obtained by using ANOVA for continuous variables and logistic regression analysis for variables of proportion.
[3] Mean; 95% CI in parentheses (all such values).
[4] Serum CRP concentrations ≥1.0 mg/L.

dwelling elderly population aged ≥70 y. Our results suggested that high consumption of green tea was significantly related to a lower prevalence of depressive symptoms.

In this large community-based population study, we adjusted for a considerable number of confounding factors. First, we considered that older age, chronic disease, inflammatory status, body mass index, cognitive impairment, disability, lifestyle factors, and psychological problems were potential confounders. However, adjustments for these confounding factors did not change the significant inverse relation between green tea consumption and depressive symptoms. That is, the inverse relation between the frequency of green tea consumption and depressive symptoms was independent of these factors. Second, the effect of the consumption of folate (29) and other beverages such as black or oolong tea or coffee on depressive symptoms was adjusted. Moreover, depressive symptoms can affect hunger and thirst and thus affect nutritional intake (30, 31). Accordingly, we made adjustments for total energy intake, protein consumption, and serum albumin concentration. However, the adjustment for the consumption of these factors also did not change the significant inverse relation between green tea consumption and depressive symptoms. Third, green tea consumption is a unique form of social activity among the Japanese and this, in itself, may influence the depression status. However, the adjustment for perceived social support and visiting friends did not change the significant inverse relation between green tea consumption and depressive symptoms. The association between green tea consumption and the 2 grades (mild and severe and severe) of

TABLE 2
Adjusted relations between consumption of green tea and mild and severe or severe depressive symptoms[1]

	Categories of green tea consumption			
	≤1 cup/d	2–3 cups/d	≥4 cups/d	*P* for trend[2]
n	286	284	488	
No. of mild and severe depressive symptoms, defined as GDS ≥11 or use of antidepressants	114	111	136	—
Model 1[3]	1.00	0.95 (0.66, 1.36)[4]	0.56 (0.40, 0.78)[5]	<0.001
Model 2[6]	1.00	0.96 (0.66, 1.40)	0.54 (0.37, 0.78)[5]	<0.001
Model 3[7]	1.00	0.96 (0.66, 1.42)	0.56 (0.39, 0.81)[5]	0.001
No. of severe depressive symptoms, defined as GDS ≥14 or use of antidepressants	75	67	72	—
Model 1[3]	1.00	0.91 (0.60, 1.37)	0.48 (0.33, 0.71)[5]	<0.001
Model 2[6]	1.00	0.92 (0.59, 1.42)	0.46 (0.30, 0.72)[5]	<0.001
Model 3[7]	1.00	0.92 (0.59, 1.44)	0.48 (0.31, 0.75)[5]	<0.001

[1] GDS, Geriatric Depression Scale.
[2] Obtained by using multiple logistic regression analysis.
[3] Adjusted for age; sex; BMI; hypertension; diabetes; history of cardiovascular diseases, cancer, or arthritis; high C-reactive protein (≥1.0 mg/L); history of smoking and drinking habits; physical activity (all 6 levels as a categorical variable); cognitive status; impaired instrumental activities of daily living; self-reported body pain; educational level; living alone; and marital status.
[4] Adjusted odds ratio; 95% CI in parentheses (all such values).
[5] Significantly different from green tea consumption of ≤1 cup/d, $P < 0.01$ (Bonferroni-corrected).
[6] Additionally adjusted for serum albumin concentration, total energy intake, intakes per 2000 kcal of energy intake as protein and folate, black or oolong tea consumption, and coffee consumption.
[7] Additionally adjusted for lack of perceived social support and visiting friends.

depressive symptoms was tested in this study. Similar relations were observed consistently in the case of both cutoffs. We also conducted a stratified analysis for sex, and similar relations were also observed when men and women were analyzed separately.

In this study, our primary hypothesis was that green tea may have a potentially beneficial effect on the prevention of depressive symptoms due to its anti–stress response and antiinflammatory effects. However, the antiinflammatory mechanisms were less likely to explain our findings. We did not observe any relations between green tea consumption and CRP. CRP also was not associated with depressive symptoms in this elderly population. Thus, CRP did not explain the inverse relation between green tea consumption and depressive symptoms.

We considered that the other mechanism (ie, the anti–stress response effect) of green tea might explain our findings. Theanine might be a candidate for explaining the observed inverse association between green tea consumption and depressive symptoms. Theanine is one of the major amino acid components in green tea and can pass through the blood-brain barrier (32). Dopamine and serotonin dysfunction is a credible etiological candidate for depressive symptoms (33), and animal neurochemistry studies have suggested that theanine increases the brain serotonin and dopamine concentrations (7). Moreover, theanine is also contained in other kinds of tea, such as black or oolong tea (34). In fact, in the current study, a weak, although not statistically significant, relation was also observed between the consumption of black or oolong tea and the prevalence of depressive symptoms (*P* for trend: 0.06). Thus, these data prove a useful hypothesis that higher consumption of green tea is related to a lower prevalence of depressive symptoms, possibly because it leads to a decrease in the stress response. A further study is required to clarify whether green tea or theanine have a beneficial effect on the prevention and treatment of depressive symptoms.

Our recent findings are also consistent with the present findings. Hozawa et al (13) investigated the relation between the frequency of green tea consumption and psychological distress. The study analyzed 42,093 Japanese individuals aged ≥40 y from the general population residing in the rural area of Japan. The study also showed an inverse relation between the frequency of green tea consumption and psychological distress as assessed by K6 (35). The OR and 95% CI of having psychological distress in subjects who consumed ≥5 cups green tea/d was 0.80 (95% CI: 0.70, 0.91) as compared with the subjects who consumed <1 cup green tea/d after adjustment for the possible confounding factors. The inverse association between green tea consumption and mental ill health was consistently observed whether the population was older (the present study) or middle aged (13), whether urban (the present study) or rural (13), whether being assessed by GDS (the present study) or by K6 (13). We considered that these 2 sets of findings corroborate our conclusion that green tea consumption is associated with mental well-being.

This study has several limitations. First, because the assessments were performed in a public facility, the participants were more active and healthy than those who did not undergo the assessment. Therefore, our results might not represent an elderly general population. Second, the GDS is designed for measuring the intensity of depressive symptoms and not for making a clinical diagnosis of depressive episodes. Therefore, a larger population study that uses a standardized comprehensive structured diagnostic interview should be undertaken to confirm the effect of green tea consumption on depressive symptoms. Third, because this study was a cross-sectional study, we could not conclude whether lower green tea consumption increased the

occurrence of depressive symptoms or whether depressive symptoms lead to a decline in green tea consumption. Therefore, a prospective study or trial should be undertaken to confirm the relation between green tea consumption and depressive symptoms. Fourth, we could not make adjustments for a history of depressive disorders, other psychological variables, and associated medications/supplements because data for these were not obtained. However, because all assessments of this study were carried out in a public facility and participation in the study was voluntary, we considered the prevalence of these factors as likely to have been very low, and therefore we believe that not directly accounting for them in our analyses had little effect on the findings. Moreover, although we adjusted for a considerable number of confounding factors, we cannot exclude the possibility that depressive symptoms are affected by the other dietary habits that correlate with the habitual consumption of green tea. Therefore, an intervention study is necessary for establishing a causal relation between green tea consumption and depressive symptoms.

In the present study, higher green tea consumption (as measured by self-administered questionnaires) was significantly associated with a lower prevalence of depressive symptoms in community-dwelling elderly individuals. This finding suggested that the consumption of green tea may have a potentially beneficial effect on the prevention of depressive symptoms. A prospective study or randomized trials are required to clarify the causality.

The authors' responsibilities were as follows—KN and AH: study concept and design; KN, AH, SK, SE, NN, KO-M, HT, YM, HA, SA, RN, and IT: acquisition of subjects and data; KN, AH, SK, SE, HG, NN, KO-M, HT, YM, MA, SS, HA, SA, and RN: analysis and interpretation of data; KN, AH, HG, and MA: preparation of manuscript; SS, HA, SA, RN, and IT: supervision; and IT: obtaining funding. None of the authors had a conflict of interest.

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