Table 1. Univariate and multivariate analysis of the associations between psychological distress and demographic, medical, lifestyle, and social factors among the total study population[a]

Variables	No. of persons with psychological distress /No. of participants	Univariate OR (95% CI)	Multivariate OR (95% CI)[b]
Sex			
Male	1146/20 168	1.00 (referent)	1.00 (referent)
Female	1775/23 548	1.35 (1.25–1.46)	1.58 (1.41–1.76)
Age group (years)			
40–44	316/3702	1.00 (referent)	1.00 (referent)
45–49	380/4739	0.93 (0.80–1.09)	0.93 (0.79–1.09)
50–54	390/5712	0.79 (0.67–0.92)	0.79 (0.67–0.93)
55–59	398/6734	0.67 (0.58–0.79)	0.65 (0.56–0.77)
60–64	226/4461	0.57 (0.48–0.68)	0.54 (0.45–0.65)
65–69	240/5091	0.53 (0.45–0.63)	0.52 (0.43–0.63)
70–74	296/5242	0.64 (0.54–0.76)	0.57 (0.47–0.68)
75–79	281/4167	0.78 (0.66–0.92)	0.60 (0.50–0.72)
80–84	214/2347	1.08 (0.90–1.29)	0.74 (0.60–0.91)
≥85	180/1521	1.44 (1.19–1.75)	0.87 (0.69–1.08)
History of diseases			
Hypertension	907/12 658	1.11 (1.03–1.21)	1.17 (1.07–1.28)
Diabetes mellitus	319/3819	1.31 (1.16–1.48)	1.26 (1.11–1.44)
Stroke	156/1012	2.63 (2.21–3.14)	2.12 (1.76–2.57)
Myocardial infarction	122/1147	1.69 (1.40–2.05)	1.51 (1.23–1.86)
Cancer	225/2432	1.46 (1.27–1.68)	1.48 (1.28–1.73)
Smoking status			
Never	1443/22 219	1.00 (referent)	1.00 (referent)
Former	553/9030	0.94 (0.85–1.04)	1.15 (1.01–1.31)
Current	701/9699	1.12 (1.02–1.23)	1.32 (1.17–1.49)
Alcohol drinking status			
Never	1187/17 041	1.00 (referent)	1.00 (referent)
Former	407/3633	1.69 (1.50–1.90)	1.49 (1.31–1.70)
Current	1156/20 840	0.78 (0.72–0.85)	0.94 (0.84–1.04)
Body-mass index			
<18.5 kg/m^2	226/1803	2.12 (1.82–2.45)	1.59 (1.36–1.86)
18.5–24.9 kg/m^2	1689/26 610	1.00 (referent)	1.00 (referent)
≥25.0 kg/m^2	752/12 231	0.97 (0.89–1.06)	0.96 (0.87–1.05)
Time spent walking per day			
<30 min	1426/16 476	1.64 (1.49–1.80)	1.26 (1.14–1.40)
30 min–1 hr	710/14 190	0.91 (0.82–1.02)	0.89 (0.79–0.99)
≥1 hr	658/12 024	1.00 (referent)	1.00 (referent)
Lack of social support:			
(i) to consult when you are in trouble	873/5354	3.46 (3.18–3.77)	2.24 (1.97–2.56)
(ii) to consult when you are in bad physical condition	698/4167	3.39 (3.09–3.72)	1.24 (1.08–1.44)
(iii) to help with your daily housework	852/6701	2.47 (2.27–2.69)	1.12 (0.99–1.27)
(iv) to take you to a hospital	579/3834	2.86 (2.60–3.16)	1.27 (1.10–1.46)
(v) to take care of you	769/5563	2.71 (2.48–2.96)	1.42 (1.25–1.61)
No participation in community activities			
(i) Activities of neighborhood association	1952/22 109	2.26 (2.08–2.46)	1.27 (1.15–1.41)
(ii) Sports or exercise	2090/23 258	2.70 (2.47–2.95)	1.63 (1.47–1.81)
(iii) Volunteering	2307/28 871	2.48 (2.23–2.75)	1.17 (1.03–1.32)
(iv) Social gatherings	2016/22 568	2.48 (2.27–2.71)	1.31 (1.18–1.46)

Abbreviations: OR, odds ratio; CI, confidence interval.
[a]The K6 was used as an indicator of psychological distress,[3,4] with a cut-off point of ≥13 out of 24 points.[15]
[b]In the multivariate models, all variables shown in Table 1 were adjusted for each other.

The statistically significant association between history of hypertension and psychological distress disappeared in all strata. Among men aged 40 to 64 years, there was loss of significant associations with a history of myocardial infarction, history of cancer, being a former smoker, spending less than 30 min per day walking, lacking social support for consultation when in a bad physical condition, lacking social support for transport to a hospital, lacking social support for receiving care, lack of participation in community activities in a neighborhood association, and lack of participation in

Table 2. Multivariate analysis of the association between psychological distress and demographic, medical, lifestyle, and social factors among men aged 40 to 64 years[a]

Variables	No. of persons with psychological distress /No. of participants	Multivariate OR (95% CI)[b]
Age group (years)		
40–44	128/1802	1.00 (referent)
45–49	169/2299	0.99 (0.77–1.27)
50–54	173/2781	0.85 (0.67–1.09)
55–59	168/3269	0.65 (0.50–0.83)
60–64	98/2108	0.55 (0.41–0.73)
History of diseases		
Hypertension	164/2529	1.17 (0.96–1.42)
Diabetes mellitus	98/1030	1.65 (1.30–2.10)
Stroke	24/170	2.42 (1.51–3.89)
Myocardial infarction	18/173	1.62 (0.94–2.76)
Cancer	23/307	1.26 (0.80–1.99)
Smoking status		
Never	97/2099	1.00 (referent)
Former	218/3940	1.19 (0.92–1.54)
Current	405/6087	1.38 (1.09–1.75)
Alcohol drinking status		
Never	107/1622	1.00 (referent)
Former	89/775	1.52 (1.11–2.07)
Current	531/9746	0.89 (0.71–1.11)
Body-mass index		
<18.5 kg/m^2	39/266	2.20 (1.51–3.21)
18.5–24.9 kg/m^2	457/7749	1.00 (referent)
≥25.0 kg/m^2	235/4135	0.94 (0.79–1.12)
Time spent walking per day		
<30 min	330/4418	1.13 (0.94–1.37)
30 min–1 hr	177/3807	0.80 (0.64–0.98)
≥1 hr	217/3847	1.00 (referent)
Lack of social support:		
(i) to consult when you are in trouble	339/2269	2.87 (2.30–3.58)
(ii) to consult when you are in bad physical condition	258/1777	1.11 (0.87–1.41)
(iii) to help with your daily housework	274/2205	1.23 (0.98–1.53)
(iv) to take you to a hospital	185/1340	1.14 (0.86–1.50)
(v) to take care of you	176/1261	1.28 (0.97–1.69)
No participation in community activities		
(i) Activities of neighborhood association	425/5549	1.00 (0.83–1.21)
(ii) Sports or exercise	480/6078	1.35 (1.12–1.63)
(iii) Volunteering	545/7508	1.19 (0.95–1.48)
(iv) Social gatherings	476/5964	1.23 (1.02–1.50)

Abbreviations: OR, odds ratio; CI, confidence interval.
[a]The K6 was used as an indicator of psychological distress,[3,4] with a cut-off point of ≥13 out of 24 points.[15]
[b]In the multivariate models, all variables shown in Table 2 were adjusted for each other.

Table 3. Multivariate analysis of the association between psychological distress and demographic, medical, lifestyle, and social factors among women aged 40 to 64 years[a]

Variables	No. of persons with psychological distress /No. of participants	Multivariate OR (95% CI)[b]
Age group (years)		
40–44	188/1900	1.00 (referent)
45–49	211/2440	0.87 (0.70–1.08)
50–54	217/2931	0.75 (0.60–0.93)
55–59	230/3465	0.65 (0.52–0.81)
60–64	128/2353	0.51 (0.39–0.66)
History of diseases		
Hypertension	162/2225	1.10 (0.90–1.33)
Diabetes mellitus	49/567	1.19 (0.86–1.64)
Stroke	9/61	1.84 (0.87–3.91)
Myocardial infarction	8/48	3.00 (1.34–6.73)
Cancer	55/564	1.58 (1.17–2.13)
Smoking status		
Never	649/10 120	1.00 (referent)
Former	79/819	1.32 (1.02–1.71)
Current	181/1467	1.48 (1.22–1.79)
Alcohol drinking status		
Never	440/6637	1.00 (referent)
Former	104/800	1.55 (1.21–1.98)
Current	391/5197	1.04 (0.89–1.22)
Body-mass index		
<18.5 kg/m^2	79/641	1.49 (1.14–1.93)
18.5–24.9 kg/m^2	636/8876	1.00 (referent)
≥25.0 kg/m^2	248/3423	0.98 (0.84–1.16)
Time spent walking per day		
<30 min	389/5036	0.93 (0.79–1.10)
30 min–1 hr	277/4147	0.91 (0.76–1.09)
≥1 hr	275/3623	1.00 (referent)
Lack of social support:		
(i) to consult when you are in trouble	279/1349	2.20 (1.73–2.79)
(ii) to consult when you are in bad physical condition	256/1254	1.38 (1.07–1.78)
(iii) to help with your daily housework	310/2016	1.15 (0.93–1.42)
(iv) to take you to a hospital	218/1232	1.33 (1.05–1.67)
(v) to take care of you	305/2031	1.40 (1.13–1.74)
No participation in community activities		
(i) Activities of neighborhood association	618/6833	1.26 (1.07–1.48)
(ii) Sports or exercise	702/7344	1.70 (1.43–2.02)
(iii) Volunteering	763/9303	0.97 (0.79–1.19)
(iv) Social gatherings	664/7327	1.20 (1.02–1.42)

Abbreviations: OR, odds ratio; CI, confidence interval.
[a]The K6 was used as an indicator of psychological distress,[3,4] with a cut-off point of ≥13 out of 24 points.[15]
[b]In the multivariate models, all variables shown in Table 3 were adjusted for each other.

community volunteer activities (Table 2). Among women aged 40 to 64 years, there was loss of the significant associations with a history of diabetes mellitus, history of stroke, spending less than 30 min per day walking, and lack of participation in community volunteer activities (Table 3).

Among men aged 65 years or older, there was a loss of the significant associations with age, a history of diabetes mellitus, history of myocardial infarction, being a former smoker, being a current smoker, lacking social support for consultation when in bad physical condition, and lack of participation in community sports or exercise activities (Table 4). Among women aged 65 years or older, there was a loss of the significant associations with a history of diabetes mellitus, being a former smoker, being a current

Table 4. Multivariate analysis of the association between psychological distress and demographic, medical, lifestyle, and social factors among men aged 65 years or older[a]

Variables	No. of persons with psychological distress /No. of participants	Multivariate OR (95% CI)[b]
Age group (years)		
65–69	95/2323	1.00 (referent)
70–74	114/2379	1.01 (0.75–1.35)
75–79	105/1833	0.98 (0.72–1.33)
80–84	65/925	1.01 (0.71–1.43)
≥85	31/449	0.78 (0.49–1.22)
History of diseases		
Hypertension	194/3295	1.23 (0.99–1.53)
Diabetes mellitus	77/1128	1.25 (0.95–1.64)
Stroke	61/445	1.91 (1.39–2.62)
Myocardial infarction	44/544	1.33 (0.94–1.88)
Cancer	63/860	1.39 (1.03–1.87)
Smoking status		
Never	77/1862	1.00 (referent)
Former	222/3925	1.06 (0.80–1.40)
Current	90/1855	1.05 (0.76–1.47)
Alcohol drinking status		
Never	92/1646	1.00 (referent)
Former	149/1524	1.37 (1.03–1.83)
Current	154/4573	0.75 (0.57–1.00)
Body-mass index		
<18.5 kg/m^2	35/343	1.56 (1.04–2.34)
18.5–24.9 kg/m^2	209/4597	1.00 (referent)
≥25.0 kg/m^2	91/1878	1.13 (0.86–1.47)
Time spent walking per day		
<30 min	234/2687	2.14 (1.58–2.88)
30 min–1 hr	80/2767	0.95 (0.67–1.34)
≥1 hr	63/2255	1.00 (referent)
Lack of social support:		
(i) to consult when you are in trouble	112/1039	1.87 (1.35–2.58)
(ii) to consult when you are in bad physical condition	68/614	0.90 (0.59–1.36)
(iii) to help with your daily housework	100/1198	0.92 (0.66–1.28)
(iv) to take you to a hospital	70/572	1.77 (1.18–2.67)
(v) to take care of you	81/682	1.68 (1.16–2.43)
No participation in community activities		
(i) Activities of neighborhood association	299/3693	1.82 (1.32–2.51)
(ii) Sports or exercise	285/3886	1.23 (0.92–1.64)
(iii) Volunteering	326/4641	1.64 (1.11–2.41)
(iv) Social gatherings	278/3477	1.35 (1.00–1.82)

Abbreviations: OR, odds ratio; CI, confidence interval.
[a]The K6 was used as an indicator of psychological distress,[3,4] with a cut-off point of ≥13 out of 24 points.[15]
[b]In the multivariate models, all variables shown in Table 4 were adjusted for each other.

Table 5. Multivariate analysis of the association between psychological distress and demographic, medical, lifestyle, and social factors among women aged 65 years or older[a]

Variables	No. of persons with psychological distress /No. of participants	Multivariate OR (95% CI)[b]
Age group (years)		
65–69	145/2768	1.00 (referent)
70–74	182/2863	1.06 (0.84–1.34)
75–79	176/2334	1.08 (0.84–1.37)
80–84	149/1422	1.31 (1.01–1.69)
≥85	149/1072	1.49 (1.14–1.96)
History of diseases		
Hypertension	387/4609	1.14 (0.98–1.33)
Diabetes mellitus	95/1094	1.01 (0.80–1.28)
Stroke	62/336	1.86 (1.37–2.51)
Myocardial infarction	52/382	1.46 (1.06–2.00)
Cancer	84/701	1.61 (1.25–2.08)
Smoking status		
Never	620/8138	1.00 (referent)
Former	34/346	0.94 (0.64–1.39)
Current	25/290	0.92 (0.59–1.43)
Alcohol drinking status		
Never	548/7136	1.00 (referent)
Former	65/534	1.42 (1.06–1.91)
Current	80/1324	1.01 (0.78–1.31)
Body-mass index		
<18.5 kg/m^2	73/553	1.38 (1.04–1.83)
18.5–24.9 kg/m^2	387/5388	1.00 (referent)
≥25.0 kg/m^2	178/2795	0.84 (0.70–1.02)
Time spent walking per day		
<30 min	473/4335	1.73 (1.37–2.18)
30 min–1 hr	176/3469	1.05 (0.81–1.35)
≥1 hr	103/2299	1.00 (referent)
Lack of social support:		
(i) to consult when you are in trouble	143/697	1.75 (1.29–2.37)
(ii) to consult when you are in bad physical condition	116/522	1.63 (1.14–2.31)
(iii) to help with your daily housework	168/1282	1.13 (0.86–1.48)
(iv) to take you to a hospital	106/690	1.20 (0.88–1.63)
(v) to take care of you	207/1589	1.50 (1.18–1.90)
No participation in community activities		
(i) Activities of neighborhood association	610/6034	1.38 (1.09–1.75)
(ii) Sports or exercise	623/5950	2.22 (1.72–2.85)
(iii) Volunteering	673/7419	1.69 (1.18–2.43)
(iv) Social gatherings	598/5800	1.57 (1.24–1.99)

Abbreviations: OR, odds ratio; CI, confidence interval.
[a]The K6 was used as an indicator of psychological distress,[3,4] with a cut-off point of ≥13 out of 24 points.[15]
[b]In the multivariate models, all variables shown in Table 5 were adjusted for each other.

smoker, and lacking social support for help with daily housework (Table 5).

When we further added current employment status and the duration of education as covariates in the multivariate models, as shown in Table 2 and Table 3, the multivariate-adjusted OR (95% CI) for psychological distress associated with being currently employed was 1.65 (1.30 to 2.09) among men and 1.10 (0.84 to 1.28) among women, respectively, and 0.82 (0.68 to 0.98) among men and 0.93 (0.80 to 1.09) among women for longer duration of education.

In addition, we analyzed the data using different cut-off points (≥9/24, ≥11/24, and ≥15/24), but the results did not substantially change in an analysis of all participants or in stratified analyses (data not shown).

DISCUSSION

The use of general population surveys to measure the extent of mental illness presents many challenges because the diagnostic tools employed tend to be lengthy and cumbersome.[17,18] The results of the present study suggest that use of the K6 scale as a proxy indicator of mental health impairments contributes to the investigation of factors associated with mental health at the population level.

On the basis of baseline cross-sectional data from a new, large, population-based, prospective cohort study, we found that female sex, young and old age, history of hypertension, history of diabetes mellitus, history of stroke, history of myocardial infarction, history of cancer, current smoking, former alcohol drinking, low BMI, shorter daily walking time, lack of social support, and lack of participation in community activities were all associated with psychological distress, even in multivariate analysis. Nevertheless, stratified analysis by sex and age categories (40 to 64 years, 65 years or older) revealed some differences among strata. The present findings indicate that factors associated with psychological distress differ between men and women, and also between middle-aged and elderly people.

We found that, as compared to men, women were more likely to have psychological distress, even in multivariate analysis, which was consistent with 2 previous US studies that used the K6.[5,8] Several studies have also shown that women have a higher risk of anxiety and mood disorders, suggesting that many factors, such as female hormones, personality, coping skills, and sociocultural roles, play a direct role in anxiety and mood disorders, as do socioeconomic status and comorbid conditions.[19–21]

The association of advanced age with psychological distress was substantially attenuated in multivariate analysis, suggesting that the high OR in the univariate model might be due to other variables shown in Table 1. Nevertheless, there was still a U-shaped association between age category (5-year categories from 40 to 44 years to ≥85 years) and the prevalence of psychological distress, with a nadir for those aged 65 to 69 years. This pattern of association is consistent with that of a previous study.[5] In contrast, stratified analysis revealed no apparent association between age and psychological distress among men aged 65 years or older, which suggests that age alone was not associated with psychological distress among men in this age category.

The associations of psychological distress with a history of serious disease were as unsurprising. Similar associations were also reported in a survey conducted in the United States.[5] The strong association between a history of stroke and psychological distress may be due to post-stroke depression.[22] Nevertheless, stratified analyses revealed some differences among sex and age categories. A history of hypertension was not significantly associated with psychological distress in any stratum. Although not significant, point estimates for history of hypertension were all above unity, which is suggestive of relatively small differences among strata. A history of diabetes mellitus was significantly associated with psychological distress only among men aged 40 to 64 years, indicating the potential burden of this disease among middle-aged men. A history of stroke was not significantly associated with psychological distress among women aged 40 to 64 years, but the point estimate was similar to that among women aged 65 years or older, suggesting that the disease burden was similar for women in these 2 age groups. The significant association between a history of myocardial infarction and psychological distress disappeared among men aged 40 to 64 years and 65 years or older, suggesting a potential sex difference in disease burden. A history of cancer was not significantly associated with psychological distress among men aged 40 to 64 years, although the reason for this was unclear.

We also found that former smoking, current smoking, former alcohol drinking, being underweight, and shorter daily walking time were associated with a higher prevalence of psychological distress. In contrast, we observed a lower prevalence among participants with a moderate daily walking time. The results for former smoking,[8] current smoking,[5,8] and being underweight[5] were consistent with previous studies. Stratified analyses yielded reduced point estimates for current smoking among men aged 65 years or older and women aged 65 years or older, suggesting that the smoking habit itself, as well as related factors, was not strongly associated with psychological distress among persons aged 65 years or older, in contrast to those aged 40 to 64 years.

Among the variables studied, lack of social support was most strongly associated with a high prevalence of psychological distress, even in multivariate analysis. Although this is the first large population-based epidemiological study using the K6 in an Asian country, previous studies[23,24] have used other mental health scales, such as the Geriatric Depression Scale (GDS)[25] among Japanese populations. Koizumi et al reported that negative responses to the questions "Do you have someone with whom you can consult when you are in trouble?" and "Do you have someone who can take care of you when you are ill in bed?" were significantly associated with an increase in the risk of depression.[23,24] The finding is consistent with, and supports, the present results for persons aged 65 years or older. The depressive symptoms detected by the GDS and the psychological distress detected by the K6 reflect common underlying factors.

Although lack of social support was strongly associated with a high prevalence of psychological distress, the significant association that had been found with 3 components of deficient social support disappeared on multivariate analysis among men aged 40 to 64 years (Table 2). However, lack of social support for consultation when in trouble remained strongly associated with psychological distress. These results appear to underline the importance of such support among men aged 40 to 64 years.

The association of lack of participation in community activities with psychological distress was substantially attenuated in multivariate analysis, indicating that the high OR in the univariate models could be largely explained by other variables shown in Table 1. Nevertheless, the significant increases in OR in the multivariate model indicate that lack of participation in community activities may also be associated with mental health. Stratified analysis revealed that the significant association between lack of participation in community activities in a neighborhood association disappeared among men aged 40 to 64 years, indicating the relatively low influence of neighborhood community on middle-aged men. Also, the significant association with lack of participation in volunteer activities disappeared among men and women aged 40 to 64 years, but the point estimate among men was similar to that among the total population. However, the lower point estimate on multivariate analysis suggests a relatively weak association with participation in volunteer activities among women aged 40 to 64 years.

Our data showed that being currently employed was associated with a high odds of psychological distress, and that a longer duration of education was associated with a lower odds of psychological distress, among men aged 40 to 64 years. Although the reason is unclear, our data suggest that some socioeconomic factors, such as employment and education, are important among men aged 40 to 64 years.

Our study did have some limitations. First, because of the cross-sectional design, the direction of causation for the associations observed in this report cannot be inferred from the data. Prospective studies that measure the K6 in respondents at baseline, follow the respondents over time, and measure the K6 at the end of follow-up, are needed to clarify these causal relationships.

Second, because the response rate was not high (64.5%), the respondents may not be a representative sample of the source population of Ohsaki City residents. The response rates among men and women aged 40 to 64 years were lower (54.9% and 60.4%, respectively) than those among men and women aged 65 years or older (77.1% and 73.2%, respectively). These relatively low response rates, especially among participants aged 40 to 64 years, should be kept in mind when interpreting the results from prospective, as well as cross-sectional, analyses.

Third, because the K6 does not provide information about the specific psychiatric conditions of respondents, it is difficult to identify what is being measured. However, the particular symptoms included in the K6 make it likely that severe, disabling, mood and anxiety disorders are being identified.[3,4,15,16] Although the K6 focuses on nonspecific psychological distress, the majority of cases detected by this instrument would meet the criteria for certain mental health disorders specified in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition.[3,15]

Finally, no scales, including the present one, have been adequately validated for use as social support questionnaires in the Japanese population. Also, the first question in the questionnaire, "Do you have someone with whom you can consult when you are in trouble?", might be construed to include the participant's family, which may not qualify as social support.

In conclusion, the findings of this cross-sectional study demonstrate that the factors associated with psychological distress differ between men and women, and also between middle-aged and elderly people. These findings underline the importance of considering sex and age categories when attempting to minimize psychological distress in community-dwelling populations. To our knowledge, this is the first large population-based epidemiological study to use the K6 in an Asian country.

ACKNOWLEDGEMENTS

This study was supported by Health Sciences Research Grants (H19-Seisaku-Ippan-026, H18-Choju-Ippan-014) from the Ministry of Health, Labour and Welfare, Japan, and a Grant-in-Aid for Scientific Research (B) (18390191) from the Japan Society for the Promotion of Science.

The authors thank Professor Toshiaki Furukawa and Dr Atsurou Yamada, Department of Psychiatry and Cognitive-Behavioral Medicine, Nagoya City University Graduate School of Medical Sciences, for their valuable comments on the content of the manuscript. The authors also thank Yoshiko Nakata, Mika Wagatsuma, Naoko Sato, and Yuki Takeda for their technical assistance.

No conflicts of interest are declared.

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Green tea consumption is associated with lower psychological distress in a general population: the Ohsaki Cohort 2006 Study[1–3]

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ABSTRACT

Background: Although green tea or its constituents might reduce psychological stress, the relation between green tea consumption and psychological distress has not been investigated in a large-scale study.

Objective: Our aim was to clarify whether green tea consumption is associated with lower psychological distress.

Design: We analyzed cross-sectional data for 42,093 Japanese individuals aged ≥40 y from the general population. Information on daily green tea consumption, psychological distress as assessed by the Kessler 6-item psychological distress scale, and other lifestyle factors was collected by using a questionnaire. We used multiple logistic regression analyses adjusted for age, sex, history of disease, body mass index, cigarette smoking, alcohol consumption, time spent walking, dietary factors, social support, and participation in community activities to investigate the relation between green tea consumption and psychological distress.

Results: We classified 2774 (6.6%) of the respondents as having psychological distress (Kessler 6-item psychological distress scale ≥13/24). There was an inverse association between green tea consumption and psychological distress in a model adjusted for age and sex. Although the relation was largely attenuated when possible confounding factors were adjusted for, a statistically significant inverse association remained. The odds ratio (with 95% CI) of developing psychological distress among respondents who consumed ≥5 cups of green tea/d was 0.80 (0.70, 0.91) compared with those who consumed <1 cup/d. These relations persisted when respondents were stratified by social support subgroups or by activities in communities.

Conclusion: Green tea consumption was inversely associated with psychological distress even after adjustment for possible confounding factors. *Am J Clin Nutr* 2009;90:1390–6.

INTRODUCTION

Mental health is an important component of overall well-being (1). Thus, to determine risk factors for impaired mental health or psychological distress is an important task.

Kessler et al (2) recently compared the projected lifetime risk of any mental disorder as assessed by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) in 17 countries. The risk was the lowest in metropolitan areas in China (18.0%), Nigeria (19.5%), and Japan (24.4%). These values were lower than other countries, such as the United States (55.3%), France (47.2%), and Germany (33.0%). This suggests that some cultural or lifestyle-related features of Japan, such as dietary habit, personality, or social capital, might have a positive effect on mental disorders.

Among these features, green tea consumption is a traditional part of the Japanese lifestyle (3–5), and it has long been considered that drinking green tea is associated with stress relief (6). Actually, recent trials suggest that tea consumption (6) or supplementation with L-theanine (7), which is a constituent of green tea, reduces responses to acute psychological stress when assessed as post-task cortisol (6), heart rate, and salivary immunoglobulin-A (7). Therefore, green tea consumption might be able to reduce psychological distress. However, large-scale studies have not investigated the relation between green tea and psychological distress in the general population. One reason for this might be the difficulties with assessing psychological distress in a general population. However, Kessler et al (8, 9) have developed a short form of screening scales to monitor the prevalence of psychological distress in populations [the Kessler 6-item psychological distress scale (K6)], which we applied in the present study to investigate whether green tea consumption is associated with a lower psychological distress.

SUBJECTS AND METHODS

Study design, setting, and participants

The design of the Ohsaki Cohort 2006 Study has been described in detail (10). In brief, the source population for the

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[2] Supported by Health Sciences Research grants (nos. H21-Choju-Ippan-001, H19-Seisaku-Ippan-026, and H18-Choju-Ippan-014) from the Ministry of Health, Labour and Welfare of Japan and by a Grant-in-Aid for Scientific Research (B) (18390191) from the Japan Society for the Promotion of Science.

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Received June 11, 2009. Accepted for publication August 28, 2009.

First published online September 30, 2009; doi: 10.3945/ajcn.2009.28214.

baseline survey comprised all men and women aged ≥40 y living in Ohsaki City, northeastern Japan, on 1 December 2006.

The baseline survey was conducted between 1 December and 15 December 2006. A questionnaire was distributed by the heads of individual administrative districts to individual households and collected by mail. Of the eligible 77,235 respondents, the 49,855 (26,512 men and 23,343 women; 64.5%) who provided valid responses formed the study cohort. Of the 49,855 respondents, 43,716 (87.7%) completed the K6. We excluded 1623 persons who did not complete the questionnaire regarding green tea consumption. Thus, 42,093 responses were analyzed in this study.

Measurement of psychological distress

The K6 was used as an indicator of psychological distress (8, 9). Respondents were asked about their mental status over the last month by using 6 questions to which they responded by choosing "all of the time" (4 points), "most of the time" (3 points), "some of the time" (2 points), "a little of the time" (1 point), and "none of the time" (0 points). Total point scores ranged from 0 to 24. The questions were as follows: "Over the last month, how often have you felt the following? *1*) nervous, *2*) hopeless, *3*) restless or fidgety, *4*) so sad that nothing could cheer you up, *5*) that everything was an effort, and *6*) worthless. The K6 is based on modern psychometric theory and has already outperformed some existing scales (8, 9). The Japanese version of the K6 was recently developed by using the standard back-translation method and has been validated (11). As suggested by Kessler et al (9), we classified individuals with scores of ≥13/24 as having psychological distress (10). Furukawa et al (12) investigated whether K6 was able to predict 30-d disorders of the DSM-IV as assessed by the World Health Organization Composite International Diagnostic Interview in the Australian National Survey. They showed that K6 was able to detect Composite International Diagnostic Interview/DSM-IV mood and anxiety disorders (area under the receiver operating curve: 0.89; 95% CI: 0.88, 0.90) better than the General Health Questionnaire 12 (AUC: 0.80; 95% CI: 0.78, 0.82).

Measurements of other types of exposure

The survey included questions about the frequency of recent average consumption of green tea, oolong tea, black tea, coffee, and 36 food items, as well as questions regarding alcohol and tobacco consumption, history of disease, body weight, height, and time spent walking per day. The food-frequency questionnaire did not cover a specific period of time but asked about "daily diet." The frequency of green tea consumption was categorized as never, occasionally, or 1–2, 3–4, and >5 cups/d. Within the study region, the volume of a typical cup of green tea is 100 mL.

We conducted a validation study of the food-frequency questionnaire, in which 113 respondents provided four 3-d food records within a period of 1 y and subsequently responded to the questionnaire. The Spearman rank coefficient for the correlation between amounts of consumed green tea according to the questionnaire and amounts consumed according to the food records was 0.71 for men and 0.53 for women; the correlation between consumption measured by the 2 questionnaires administered 1 y apart was 0.63 for men and 0.64 for women (13). Body mass index was calculated as the self-reported body weight (kg) divided by the square of the self-reported body height (m).

The degree of social support available to each individual was assessed by asking the following (14): Do you have someone *1*) whom you can talk to when you are in trouble? *2*) whom you can consult when you do not feel well? *3*) who can help you with your daily housework? *4*) who can take you to a hospital when you feel ill? and *5*) who can take care of you if you become bedridden? This social support questionnaire consisted of 5 questions, each requiring a "yes" or "no" answer. This questionnaire was available only in Japanese. The validity and reliability of the questionnaire were not evaluated.

We also assessed participation in community activities. We asked about how often the respondent participates in the following activities: *1*) neighborhood associations; *2*) sports, exercise, or a hobby; *3*) volunteering for nonprofit organizations; and *4*) participation in other social gatherings. The frequency of these activities was assessed as never, a few times each year, monthly, 2–3 times/month, 1 time/wk, 2–3 times/wk, and ≥4 d/wk.

Ethical issues

We considered the return of completed questionnaires to imply the consent to participate in the study involving a cross-sectional analysis of the baseline survey data and subsequent follow-up of mortality and emigration. The Ethics Committee of Tohoku University Graduate School of Medicine reviewed and approved the study protocol.

Statistical analysis

Baseline characteristics were evaluated by using the analysis of variance for continuous variables and the chi-square test for categorical variables. We also used age-sex-adjusted logistic regression analyses to clarify the age-sex-adjusted relation between green tea consumption and history of diseases. We used multivariate logistic regression analysis to calculate the odds ratios (ORs) and 95% CIs for having psychological distress (a K6 total score of ≥13/24) according to categories of green tea consumption. We established respondents who consumed <1 cup/d green tea as the reference category and examined the relation between green tea consumption and psychological distress by using the following models. Model 1 was age-sex adjusted. Model 2 was adjusted for the following physical risk factors: sex; age (40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and ≥85 y); history of hypertension ("yes," "no"), diabetes mellitus ("yes," "no"), stroke ("yes," "no"), myocardial infarction ("yes," "no"), and cancer ("yes," "no"); smoking status ("never," "former," "current," "missing"); alcohol consumption ("never," "former," "current," "missing"); body mass index (in kg/m^2: <18.5, 18.5–24.9, ≥25.0, missing); and time spent walking (<30 min/d, 30 min to 1 h/d, ≥1 h/d, missing). Model 3 was further adjusted for dietary factors, namely volume of rice intake and frequency of consumption of miso soup, red meat, chicken, fish, green or yellow vegetable, soy products, fruit, coffee, black tea, and oolong tea. Model 4 was fully adjusted and included the answers to the questions about social support ("yes," "no support," "missing") and participation in community activities ("yes," "never," "missing").

TABLE 1
Relation between green tea consumption and the characteristics of the participants of the Ohsaki Cohort 2006 Study[1]

	Green tea consumption (cups/d)				
	<1 (n = 10,770)	1–2 (n = 12,007)	3–4 (n = 10,364)	>5 (n = 8952)	P
Age (y)	58.5 ± 12.5[2]	59.9 ± 12.5	64.6 ± 12.0	67.5 ± 10.8	<0.01
Women [n (%)]	5090 (47)	6093 (51)	5954 (57)	5742 (64)	<0.01
Smoking [n (%)]					
Current	3249 (30)	2829 (24)	1787 (17)	1323 (15)	<0.01
Former	2319 (22)	2589 (22)	2126 (21)	1633 (18)	
Never	4749 (44)	5991 (50)	5721 (55)	5202 (58)	
Alcohol drinking [n (%)]					
Current	5797 (54)	6415 (53)	4573 (44)	3266 (36)	<0.01
Former	1020 (9)	886 (7)	802 (8)	749 (8)	
Never	3603 (33)	4244 (35)	4404 (42)	4311 (48)	
BMI [n (%)]					
18.5 kg/m^2	506 (5)	455 (4)	405 (4)	375 (4)	<0.01
18.5–24.9 kg/m^2	6517 (61)	7454 (62)	6322 (61)	5376 (60)	
≥25 kg/m^2	3077 (29)	3420 (28)	2875 (28)	2466 (28)	
Time spent walking >1 h [n (%)]	3074 (29)	3209 (27)	2717 (26)	2539 (28)	<0.01
History of diseases [n (%)]					
Hypertension	2610 (24)	3191 (27)	3296 (32)	3139 (35)	<0.01
Diabetes mellitus	850 (8)	966 (8)	981 (9)	867 (10)	<0.01
Stroke	278 (3)	269 (2)	233 (2)	183 (2)	<0.01
Myocardial infarction	243 (2)	261 (2)	307 (3)	267 (3)	<0.01
Cancer	483 (4)	571 (5)	656 (6)	643 (7)	<0.01
Volume of rice intake [n (%)]					
>3 bowls/d	1107 (10)	1135 (9)	882 (9)	687 (8)	<0.01
Consumed miso soup almost every day [n (%)]	7790 (72)	9585 (80)	8756 (84)	7715 (86)	<0.01
Frequency of food intake [n (%)]					
Red meat (at least once/wk)	8910 (83)	10225 (85)	8901 (86)	7579 (85)	<0.01
Chicken (at least once/wk)	6163 (57)	7266 (61)	6387 (62)	5432 (61)	<0.01
Fish (almost every day)	1867 (17)	2470 (21)	2814 (27)	3211 (36)	<0.01
Green yellow vegetable (almost every day)	3097 (29)	4176 (35)	4526 (44)	4795 (54)	<0.01
Soy products (almost every day)	4314 (40)	5750 (48)	5971 (58)	5859 (65)	<0.01
Fruit (almost every day)	2509 (17)	3673 (31)	4210 (41)	4626 (52)	<0.01
Frequency of beverage intake [n (%)]					
Coffee ≥1 cup/d	7749 (72)	8843 (74)	6586 (64)	4796 (54)	<0.01
Black tea ≥1 cup/d	937 (9)	2173 (18)	1875 (18)	1677 (19)	<0.01
Oolong tea ≥1 cup/d	1507 (14)	2304 (19)	1845 (18)	1714 (19)	<0.01
Social support [n (%)]					
To consult when you are in trouble (no)	1690 (16)	1567 (13)	1061 (10)	764 (9)	<0.01
To consult when you are in bad physical condition (no)	1335 (12)	1214 (10)	812 (8)	594 (7)	<0.01
To help with your daily housework (no)	1903 (18)	1834 (15)	1476 (14)	1163 (13)	<0.01
To take you to a hospital (no)	1188 (11)	1057 (9)	782 (8)	637 (7)	<0.01
To take care of you (no)	1498 (14)	1460 (12)	1259 (12)	1096 (12)	<0.01
Participation in community activities [n (%)]					
Activities in neighborhood association (any yes)	4659 (43)	5681 (47)	5120 (49)	4352 (49)	<0.01
Sports or exercise (any yes)	4140 (38)	5283 (44)	4707 (45)	4005 (45)	<0.01
Volunteers (any yes)	2854 (27)	3588 (30)	3189 (31)	2736 (22)	<0.01
Social gathering (any yes)	4061 (38)	5271 (44)	4698 (45)	4081 (46)	<0.01

[1] For smoking, alcohol drinking, and BMI, the sum of the number of participants did not match all numbers of participants due to missing information.
[2] Mean ± SD (all such values).

We used several dummy variables to adjust for the aforementioned factors.

Because we considered that social support or community activities might modify the relation between green tea and psychological distress, we further stratified the responses by social support (support in all 5 social support categories and perception of not being supported in ≥1 of 5 social support categories) and community activity (participation in at least one community activity or none) to confirm the relation between green tea consumption and psychological distress. Those who did not answer any questions about social support or participation in community activities were excluded when stratified by social support and participation in communities, respectively. In an analysis of social support and participation in community activities, neither of these was used as the respective covariate. When we calculated the interaction of green tea with social support and participation in community activities, we used cross-product terms of green tea and social support or participation in community activities.

We also analyzed the relation between black tea consumption and psychological distress by using a fully adjusted model (model 4). All data were statistically analyzed by using SAS version 9.1 (SAS Inc, Cary, NC). All statistical tests described here were 2-sided, and $P < 0.05$ was accepted as statistically significant.

RESULTS

The association between green tea consumption and other lifestyle factors is shown in **Table 1**. The mean age, the proportion of women, the proportion of those who had never smoked or never consumed alcohol, as well as the frequency of a history of hypertension and cancer were higher among those who more frequently consumed green tea. This group also consumed more fish, soy products, green and yellow vegetables, and fruit and participated more often in community activities. Conversely, fewer respondents who consumed more green tea felt a lack of social support. Because the relation between green tea consumption and a history of diseases might be strongly confounded by age, we conducted age-sex-adjusted logistic regression analyses. The relation of green tea consumption to hypertension, diabetes, and myocardial infarction was no longer statistically significant when adjusted for age and sex (P for trends ≥ 0.13). However, the inverse association between green tea consumption and history of stroke ($P < 0.001$) and the positive relation between green tea consumption and history of cancer ($P = 0.007$) remained statistically significant.

Overall, 2774 (6.6%) respondents were considered to have psychological distress (K6 $\geq$ 13). The prevalence was the highest (8.4%) and lowest (5.1%) among those who consumed <1 and $\geq$5 cups green tea/d, respectively (*see* **Table 2**). The age-sex-adjusted model (model 1) revealed a close inverse relation between green tea consumption and having psychological distress. In comparison with individuals who consumed <1 cup/d, the ORs (95% CI) of having psychological distress for those who consumed 1–2, 3–4, and $\geq$5 cups/d were 0.79 (0.71, 0.87), 0.68 (0.61, 0.76), and 0.59 (0.52, 0.67), respectively. Although these associations were attenuated when adjusted for other lifestyle factors or a history of disease (model 2), the significant inverse association persisted (P for trend < 0.001). Although adjustment for dietary factors (model 3) and for social support or participation in community activities (model 4) also attenuated the relation, the inverse association between green tea consumption and psychological distress persisted (both P's for trend were <0.001). The adjusted ORs (95% CI) for psychological distress in subjects who consumed 1–2, 3–4, and $\geq$5 cups of green tea/d were 0.95 (0.86, 1.06), 0.89 (0.79, 1.00), and 0.80 (0.70, 0.91), respectively, in model 4, compared with the reference group.

To confirm whether the relation between green tea consumption and psychological distress persisted irrespective of social support or participation in community activities, we also investigated the association stratified in a subgroup by these 2 factors (**Table 3**). Neither an interaction between green tea consumption and social support for psychological distress ($P = 0.91$) nor an interaction between green tea consumption and participation in community activities for psychological distress ($P = 0.08$) was statistically significant.

We also analyzed the relation between the consumption of black tea and psychological distress. Compared with participants who consumed <1 cup black tea/d ($n = 35,431$), the ORs (95% CI) for those who consumed 1–2 cups black tea/d ($n = 2161$), and $\geq$3 cups black tea/d ($n = 516$) were 1.14 (0.95, 1.36) and 1.11 (0.78, 1.58), respectively.

TABLE 2
Relation between green tea consumption and psychological distress, as assessed by the Kessler 6-item psychological distress scale (K6), in the Ohsaki Cohort 2006 Study[1]

	Green tea consumption (cups/d)				
	<1 (n = 10,770)	1–2 (n = 12,007)	3–4 (n = 10,364)	>5 (n = 8952)	P for trend
No. of participants with psychological distress (K6 $\geq$13)	902	808	604	460	—
Prevalence of psychological distress (%)	8.4	6.7	5.8	5.1	—
Model 1[2]	Ref	0.79 (0.71, 0.87)[3]	0.68 (0.61, 0.76)	0.59 (0.52, 0.67)	<0.001
Model 2[4]	Ref	0.83 (0.75, 0.92)	0.73 (0.65, 0.81)	0.64 (0.57, 0.72)	<0.001
Model 3[5]	Ref	0.91 (0.82, 1.01)	0.83 (0.74, 0.93)	0.73 (0.64, 0.83)	<0.001
Model 4[6]	Ref	0.95 (0.86, 1.06)	0.89 (0.79, 1.00)	0.80 (0.70, 0.91)	<0.001

[1] Ref, referent.

[2] Adjusted for age categories (40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and $\geq$85 y) and for sex.

[3] Odds ratio; 95% CI in parentheses (all such values).

[4] Same as model 1 + history of hypertension (yes, no), history of diabetes mellitus (yes, no), history of stroke (yes, no), history of myocardial infarction (yes, no), history of cancer (yes, no), smoking status (never, former, current, missing), alcohol consumption (never, former, current, missing), BMI (in kg/m^2; <18.5, 18.5–24.9, $\geq$25.0, missing), and time spent walking (<30 min/d, 30 min–1 h/d, $\geq$1 h/d, missing).

[5] Same as model 2 + volume of rice intake, frequency of consumption of miso soup, red meat, chicken, fish, green and yellow vegetable, soy product, fruit, coffee, black tea, and oolong tea.

[6] Same as model 3 + social support [ie, *1*) Do you have someone with whom you can consult when you are in trouble? (yes, no, missing), *2*) Do you have someone with whom you can consult when your physical condition is not good? (yes, no, missing), *3*) Do you have someone who can help you with your daily housework? (yes, no, missing), *4*) Do you have someone who can take you to a hospital when you do not feel well? (yes, no, missing), and *5*) Do you have someone who can take care of you when you are ill in bed? (yes, no, missing)] and participation in community activities [ie, How often do you participate in the following activities? *1*) activities in neighborhood association (any yes, never, missing), *2*) sports, exercise, or hobby (any yes, never, missing), *3*) volunteer for a nonprofit organization (any yes, never, missing), and *4*) other social gatherings (any yes, never, missing)].

TABLE 3
Relation between green tea consumption and psychological distress, as assessed by the Kessler 6-item psychological distress scale (K6), stratified by social support and community activity subgroup in the Ohsaki Cohort 2006 Study[1]

	Green tea consumption (cups/d)				
	<1	1–2	3–4	>5	*P* for trend
Social support[2]					
No lack					
No. of participants	7466	8723	7799	6839	
No. of participants with psychological distress (K6 ≥ 13)	414	422	312	259	
Prevalence of psychological distress (%)	5.5	4.8	4.0	3.8	
Multiple adjusted OR (95% CI)[3]	Ref	0.99 (0.86, 1.15)	0.86 (0.73, 1.01)	0.81 (0.68, 0.96)	0.005
Any lack					
No. of participants	3283	3255	2544	2098	
No. of participants with psychological distress (K6 ≥ 13)	484	383	291	201	
Prevalence of psychological distress (%)	14.7	11.8	11.4	9.6	
Multiple adjusted OR (95% CI)[3]	Ref	0.89 (0.77, 1.04)	0.94 (0.80, 1.11)	0.77 (0.64, 0.94)	0.02
Participation in community activities[2]					
Participated					
No. of participants	6830	8281	7285	6246	
No. of participants with psychological distress (K6 ≥ 13)	370	383	288	197	
Prevalence of psychological distress (%)	5.4	4.6	4.0	3.2	
Multiple adjusted OR (95% CI)[3]	Ref	0.99 (0.85, 1.15)	0.98 (0.83, 1.16)	0.82 (0.67, 0.998)	0.08
Did not participate					
No. of participants	3759	3499	2876	2491	
No. of participants with psychological distress (K6 ≥ 13)	500	387	297	245	
Prevalence of psychological distress (%)	13.3	11.1	10.3	9.8	
Multiple adjusted OR (95% CI)[3]	Ref	0.93 (0.80, 1.08)	0.87 (0.73, 1.02)	0.82 (0.69, 0.98)	0.02

[1] OR, odds ratio; Ref, referent; "No lack," participants who perceived that they were supported for all 5 social support categories; "Any lack," participants who perceived that they were not supported for at least one social support category; "Participated," participants who participated in at least one community activity; "Did not participate," participants who did not participate in any community activities.

[2] Social support and participation in community activities were not used as covariates in analyses. *P* values for interaction for social support and participation in community activities were 0.91 and 0.08, respectively.

[3] Model 4 in Table 2 was used for adjustment.

DISCUSSION

We identified an inverse relation between green tea consumption and psychological distress as assessed by K6 in a large-sample cross-sectional study of a Japanese population. We considered that green tea consumption might contribute, at least in part, to a low lifetime risk of any mental disorder in Japan (2).

The main strength of our study is that we investigated a large sample of the general population, which allowed the consideration of many confounding factors, including social support and participation in community activities. Another strength is that we used a practical and tested questionnaire to assess psychological distress (8, 9). Of the 49,855 respondents, 88% completed the K6 [the 6-item scale developed by Kessler et al (8, 9)], which enabled an assessment of risk factors for psychological distress in a general population.

To understand whether green tea was inversely and independently related to psychological distress, we attempted several approaches to control confounding. First, we tested the effects of comorbidities or lifestyle factors on the relation. Both green tea consumption and psychological distress are inversely related with a history of cardiovascular diseases (CVDs) (10) and risk factors for CVD (10, 15, 16). Furthermore, we already reported that green tea consumption is inversely related with CVD mortality (4). Thus, CVD or risk factors for CVD can be confounding factors of the relation between green tea and psychological distress. However, the association persisted although adjustment for these factors attenuated the inverse relation between green tea consumption and psychological distress. Therefore, we considered that the relation was independent of CVD or these risk factors.

We also considered confounding by other dietary factors. Adjustments for other foods were required because the consumption of green tea might be associated with that of other Japanese foods, such as fish or soy products (5). Furthermore, the effect of other beverages on psychological distress also should be adjusted. However, adjustment for dietary factors and beverages did not fully explain the inverse relation between green tea and psychological distress. Therefore, we considered that the relation was independent of other dietary factors or beverages.

Third, we considered the effect of social support or community activities. Because green tea is the most likely beverage to be served during social activities in Japan, its consumption might be merely a marker of social support or community activity (3). In fact, our cross-sectional analyses have already shown a close inverse relation between psychological distress and social support or activities in the community (10). Thus, consideration of these factors is also important to understanding the relation between green tea consumption and psychological distress. However, we show that the inverse association between green tea consumption and psychological distress persisted even after further adjustment for social support and participation in community activities, irrespective of social support subgroup or

subgroup of community activities. Therefore, although other residual confounding factors might exist, we considered that green tea consumption was inversely and independently related to psychological distress.

Only one study has described a relation between green tea consumption and mental illness (17). Shimbo et al (17) investigated 380 Japanese individuals aged 20–69 y and assessed the relation between green tea consumption and a Japanese version of the General Health Questionnaire 12. Although they show that brewed green tea consumption was inversely associated with mental illness (OR: 0.78 for males and 0.77 for females), the relation was not statistically significant. Because the point estimate was large, Shimbo et al (17) might have detected a significant association if a sufficiently large sample had been investigated. Thus, although the assessment methods were different, we considered that our results agreed with their findings.

Some clinical trials have examined the effect of tea (6), L-theanine (7), or high doses of ascorbic acid (18) on responses to psychological stress. Both L-theanine and ascorbic acid are constituents of green tea (16). An investigation of the influence of black tea compared with a caffeine-matched placebo on both acute biological responses and the rate of poststress recovery by using double-blind methodology (6) discovered that 6 wk of tea consumption leads to lower poststress cortisol and greater subjective relaxation. Kimura et al (7) examined whether L-theanine influences the physiologic response under stress by using a mental arithmetic task as an acute stressor. They show that L-theanine intake resulted in a reduction in heart rate and salivary immunoglobulin A responses to an acute stress task relative to a placebo control. Brody et al (18) reported that high-dose ascorbic acid palliates blood pressure, cortisol, and subjective responses to acute psychological stress. These studies consistently show that the acute response to psychological stress was reduced in a group provided with tea or tea constituents. Because reducing physiologic stress might result in reduced psychological distress, these data could be considered as evidence that supports our findings.

These results from clinical trials also suggested that not only green tea but also black tea might have a beneficial effect on psychological distress because the constituents of the 2 types of tea are similar (16). In fact, Hintikka et al (19) have reported an inverse relation between the daily consumption of black tea and the risk of depression, as assessed by a postal questionnaire and the Beck Depression Inventory in a relatively large general Finnish population sample. In our study, however, we did not find any relation between consumption of black tea and psychological distress. We considered that the lack of such an association was due to the less-frequent consumption of black tea in Japan. Any relation between black tea and psychological distress might be masked by frequent consumption of green tea.

This study has some limitations. The first was the cross-sectional design. We could not conclude whether green tea reduces psychological distress or whether individuals without psychological distress are more likely to consume green tea. However, because we clarified an inverse relation between green tea consumption and psychological distress irrespective of social support and participation in community activities, we considered that green tea has a beneficial effect on psychological distress. A prospective study or a clinical trial is required to confirm this notion. Second, the correlation between the amounts of green tea consumed according to the questionnaire and the amounts consumed according to the 3-d food records was not very high (men: 0.71; women: 0.53), especially in women. Because green tea consumption varied day by day, we considered that a certain difference could be acceptable for green tea consumption. However, in any case, questionnaire surveys have some misclassifications regarding green tea consumption. Due to this limitation, we might have underestimated the inverse relation between green tea consumption and psychological distress in this study. Third, although we claimed that social support is an important confounding factor and we stratified according to this variable, the variable is not validated. However, the questionnaire comprised simple questions, and therefore we considered that it could be used for the assessment of social support. In conclusion, we showed that green tea consumption was inversely associated with psychological distress in a cross-sectional study of a large Japanese population.

We thank Yoshiko Nakata, Mika Wagatsuma, and Tomoko Muroi for their technical assistance.

The authors' responsibilities were as follows—AH, SK, NN, and IT: conception and design; SK, NN, KO-M, MK, and TS: acquisition of data; AH, SK, NN, and KN: analysis and interpretation of data; AH: drafting of the manuscript; SK, NN, KO-M, MK, TS, MN, YS, AN, YT, KN, and IT: critical revision of the manuscript for intellectual content; AH: statistical analysis; and IT: obtaining funding and supervision. None of the authors had a conflict of interest.

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The American Journal of Clinical Nutrition

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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[2] Supported by a Grant-in-Aid for Scientific Research (no. 13557031) from the Ministry of Education, Culture, Sports, Science and Technology of Japan, by research grants from the Japan Atherosclerosis Prevention Fund, and by a grant for Comprehensive Research on Aging and Health (H18-choju-014) from the Ministry of Health, Labor, and Welfare of Japan.

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Received June 12, 2009. Accepted for publication September 12, 2009.
First published online October 14, 2009; doi: 10.3945/ajcn.2009.28216.

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

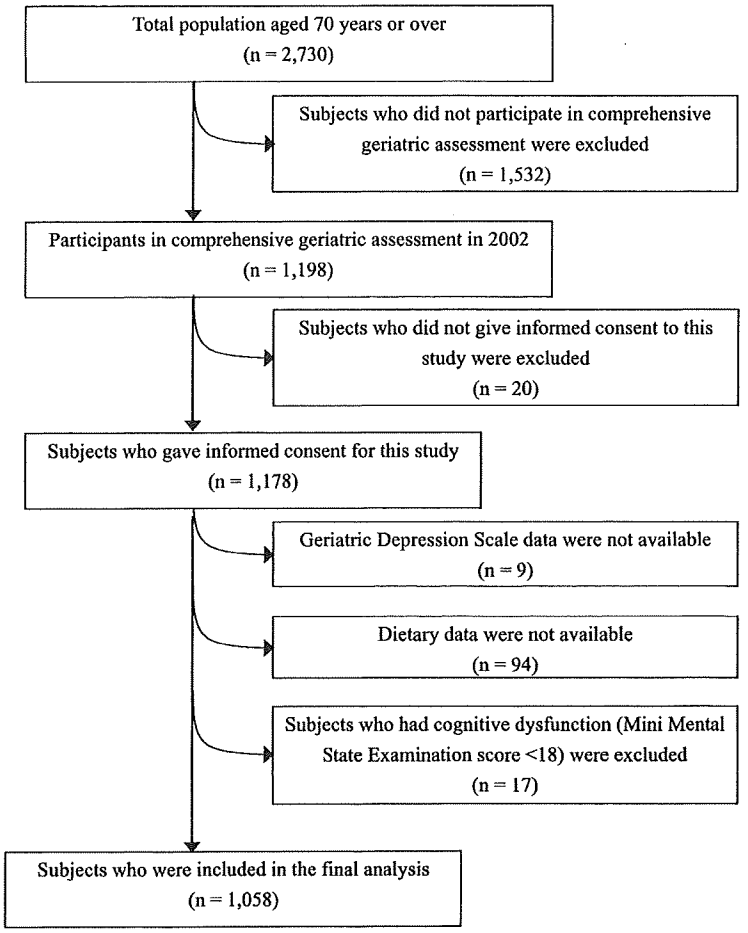

FIGURE 1. Flow chart of the sample selection.

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 (≥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 ≥1 cups/d) and coffee (almost never, <1 cup/d, and ≥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 (≤1 cup/d: 1; 2–3 cups/d: 2; ≥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 ≤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 ≥4 cups/d (*P* for trend < 0.001). The prevalence of depressive symptoms was 44% lower for participants who consumed ≥4 cups green tea/d tea than for those who consumed ≤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 (≥1.0 mg/L). Similar relations were observed even when we used GDS ≥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 ≥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 ≥1 cups/d (*P* for trend: 0.49). Similar results were also observed when the cutoff ≥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 · d^{-1} · 2000 kcal)	82.8 (81.2, 81.2)	81.7 (80.1, 80.1)	83.2 (81.9, 81.9)	0.34
Folate (μg · d^{-1} · 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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