**Dietary fiber intake and depressive symptoms in Japanese employees: the Furukawa
Nutrition and Health Study**

Short running head: Dietary fiber intake and depressive symptoms

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Abstract

Objective: Dietary fiber may play a favorable role in mood through gut microbiota, but epidemiologic evidence linking mood to dietary fiber intake is scarce in free-living populations. We investigated cross-sectionally the associations of dietary intakes of total, soluble, insoluble, and sources of fiber with depressive symptoms among Japanese workers.

Research Methods & Procedures: Participants were 1977 employees aged 19–69 years. Dietary intake was assessed via a validated, brief self-administered diet history questionnaire. Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale. Logistic regression was used to estimate odds ratios of depressive symptoms adjusted for a range of dietary and non-dietary potential confounders.

Results: Dietary fiber intake from vegetables and fruits was significantly inversely associated with depressive symptoms. The multivariable-adjusted odds ratios (95% confidence intervals) for the lowest through the highest tertile of vegetable and fruit fiber were 1.00 (reference), 0.80 (0.60–1.05), and 0.65 (0.45–0.95), respectively (P for trend = 0.03). Dietary intake of total, soluble, insoluble, and cereal fiber was not associated with depressive symptoms.

Conclusion: Higher dietary fiber intake from vegetables and fruits may be associated with lower likelihood of having depressive symptoms.

Keywords: cross-sectional studies; depression; diet; dietary fiber; Japanese

1 **Introduction**

2 Depression is a highly prevalent mental disorder in the general population [1]. It is a major
3 public health issue in terms of reduced productivity, lowers quality of life, and increases
4 mortality [1]. **Experimental and epidemiological evidence suggests that dietary factors**
5 **may play an important role in the development of depression [2-6].** Recent research
6 suggests that the gut–brain axis, a bidirectional communication between the gut microbiota
7 and the brain, functions as a pathway for the gut microbiota to modulate brain function,
8 possibly through endocrine, immune and neural pathway [7]; the
9 hypothalamus–pituitary–adrenal axis regulates cortisol secretion and cortisol can affect
10 immune cells, alter gut permeability and barrier function, and change gut microbiota
11 composition [7]. Conversely, the gut microbiota and probiotics can alter the levels of
12 cytokines, which may influence brain function [7]. In addition, the vagus nerve and
13 tryptophan, the precursor of serotonin, are involved in relaying the influence of the gut
14 microbiota to the brain [7]. Diet modification, especially fiber intake from fruits, vegetables,
15 and other plants, can alter the profile of intestinal microbiota [8]. These findings draw
16 attention to the need for further examination of the association between dietary fiber intake
17 and depressive status.

18 There is a paucity of epidemiological evidence for the association between dietary fiber
19 intake and depressive symptoms in free-living people. Oishi et al. [9] found an inverse, albeit

not statistically significant, association between fiber intake and depressive symptoms among older Japanese adults. Woo et al. [10] reported a statistically significant inverse association between fiber intake and depression score in an older Chinese population. These studies [9, 10], however, did not adjust for potentially important confounders including dietary intake of other nutrients, sleeping habits, and physical activity [2]. In addition, short-chain fatty acids (SCFAs), which are produced by fermentation of dietary fiber by intestinal microbiota, have been suggested to inhibit inflammation [11], a possible mediating factor for depression [12]. The fermentation of fiber by intestinal microbiota varies depending on its sources [13-16] and types [16, 17]; vegetable and fruit or soluble fiber is more readily fermented than cereal or insoluble fiber [13-17]. Yet, no study has examined the association of depressive symptoms with sources (vegetables, fruits, and cereals) and types (soluble and insoluble) of fiber intake. To address these issues, we examined the association between dietary fiber intake and depressive symptoms in a Japanese working population.

Materials and methods

Study design and participants

Data were derived from the Furukawa Nutrition and Health Study. Details of the study procedure were described elsewhere [6, 18, 19]. A nutritional epidemiological survey was conducted undergoing periodic health examination in April 2012 (factory A) and May 2013

(factory B) among employees of a manufacturing company and its affiliates in the Kanto region of Japan. Of 2828 health examination attendants (women, 11%), 2162 agreed to participate in the study with a response rate of 76%. We assessed lifestyle factors such as dietary habits and health status and obtained health examination data. The study protocol was approved by the ethics committee of the National Center for Global Health and Medicine, Japan, and the secondary analysis of the data (the Furukawa Nutrition and Health Study) was approved by the ethics committee of the University of Tokyo. Written informed consent was obtained from each participant.

We excluded 100 participants with a history of the following diseases: cancer ($n = 20$), cardiovascular diseases ($n = 25$), chronic hepatitis ($n = 2$), kidney disease including nephritis ($n = 11$), pancreatitis ($n = 3$), and mental disorder such as depression and neurotic disorder ($n = 45$). Some participants had two or more of these diseases. We excluded these participants to avoid reverse causality, because such conditions might affect dietary habits or depressive status. Of the remaining 2062, we excluded 11 individuals who did not return the study questionnaire ($n = 3$) and dietary questionnaire ($n = 9$). In addition, we further excluded 62 participants who had missing data on covariates of the present analysis. We additionally excluded 12 participants with extreme total energy intake (more than $\text{mean} \pm 3$ standard deviations), leaving 1977 participants (1767 men and 210 women) aged 19–69 years for analysis.

58

59 *Dietary intake*

60 Dietary habits during the preceding one-month period were assessed using a validated brief
61 self-administered diet history questionnaire (BDHQ) [20]. This questionnaire consists of five
62 sections: 1) intake frequency of 46 food and non-alcoholic beverage items, 2) daily intake of
63 rice and miso soup, 3) frequency of drinking and amount per drink for alcoholic beverages, 4)
64 usual cooking method, and 5) general dietary behavior. Dietary intake for 58 food and
65 beverage items, energy, and selected nutrients were estimated using an *ad hoc* computer
66 algorithm for the BDHQ [21] with reference to the Standard Tables of Food Composition in
67 Japan [22, 23]. According to the validation study of the BDHQ using 16-day weighted dietary
68 records as the gold standard, Pearson correlation coefficients in 92 women (31 to 69 years
69 old) and 92 men (32 to 76 years old) for energy-adjusted intake of total, soluble, and insoluble
70 dietary fiber were 0.65 and 0.69, 0.63 and 0.62, and 0.65 and 0.68, respectively [20].

71

72 *Depressive symptoms*

73 Depressive symptoms were assessed using a Japanese version [24] of the Center for
74 Epidemiologic Studies Depression (CES-D) scale [25]. The CES-D scale consists of 20 items
75 addressing six typical depression symptoms, including depressed mood, guilt or worthlessness,
76 helplessness or hopelessness, psychomotor retardation, loss of appetite, and sleep disturbance

experienced during the preceding week. Each item is scored on a scale of 0 to 3 according to the frequency of the symptom and calculated total CES-D score for each participant, ranging from 0 to 60. The criterion validity of the CES-D scale has been well established in both Western [25] and Japanese [24] participants. Depressive symptoms were regarded as present when participants had a CES-D score of ≥ 16 . Another cutoff of ≥ 19 was also used, which might be suitable for the Japanese employees [26].

Laboratory measurements

Blood samples were obtained at the time of health checkup. Venous blood (7 ml) donated for the study was drawn into a vacuum tube. The blood was centrifuged to separate serum. Serum 25-hydroxyvitamin D concentrations were measured at an external laboratory (LSI Medience Corporation, Tokyo, Japan) using a competitive protein binding assay, with the intra-assay coefficients of variation of 10.9% at 13.3 mg/L and 8.9% at 21.3 mg/L.

Other variables

Marital status, job grade, night and rotating shift work, overtime work, smoking, alcohol drinking, sleep duration, physical activity during work and housework or on commuting to work, and leisure-time physical activity were assessed via the survey questionnaire. Physical activity during work and housework or on commuting and leisure time were represented as

the sum of metabolic equivalent (MET) multiplied by the duration of time (in hours) across physical activity with different levels. Psychological work environment was assessed via the Job Content Questionnaire [27], and job strain score was calculated according to a standard procedure. Body height and weight were measured to the nearest 0.1 cm and 0.1 kg, respectively, in a standardized procedure with participants wearing light clothes and without shoes. BMI was calculated as weight in kilograms divided by the square of height in meters.

Statistical analysis

Participants were divided into tertiles of energy-adjusted intake (using a density method) of total, soluble, insoluble, vegetable and fruit, and cereal dietary fiber. The characteristics of the study participants in either means or percentages were presented according to the tertile of total dietary fiber intake. Trend association across tertile categories of total dietary fiber intake was assessed using the Mantel–Haenszel χ^2 test for categorical variables and linear regression analysis for continuous variables. The association of dietary intake of total, soluble, insoluble, vegetable and fruit, and cereal fiber with depressive symptoms was evaluated by a multiple logistic regression analysis. We calculated the odds ratios (ORs) and 95% confidence intervals (CIs) of depressive symptoms for each tertile of total, soluble, insoluble, vegetable and fruit, and cereal fiber intake, using the lowest tertile category as reference. We adjusted for age (year, continuous), sex, and site (surveyed in April 2012 or in May 2013) in the first

115 model. The second model was further adjusted for marital status (married or other); job grade
116 (low, middle, or high); night or rotating shift work (yes or no); overtime work (<10, 10–<30,
117 or ≥30 h/month); job strain (quartile); physical activity at work and housework or while
118 commuting to work (<3, 3–<7, 7–<20, or ≥20 METs-h/day); leisure-time physical activity
119 (not engaged, >0–<3, 3–<10, or ≥10 METs-h/week); smoking (never-smoker, former smoker,
120 current smoker consuming <20 cigarettes/day, or current smoker consuming ≥20
121 cigarettes/day); alcohol drinking (nondrinker, drinker consuming 1-3 days/month, weekly
122 drinker consuming <1, 1–<2, or ≥2 *go*/day; one *go* contains approximately 23 g of ethanol),
123 green tea (≤ 1, 2–3, or ≥ 4 cups/day), coffee (< 1, 1, or ≥ 2 cups/day) ; sleep duration (<6,
124 6–6.9, or ≥7 hours/day); body mass index (kg/m², continuous); total energy intake (kcal/day,
125 continuous); and intake of folate (μg/1000 kcal, continuous), vitamin B6 (mg/1000 kcal,
126 continuous), vitamin B12 (μg/1000 kcal, continuous), n-3 polyunsaturated fatty acids (%
127 energy, continuous), magnesium (mg/1000 kcal, continuous), and zinc (mg/1000 kcal,
128 continuous). One *go* of sake is 180 ml of Japanese rice wine, which contains approximately
129 23 g of ethanol. In addition to covariates in model 2, serum 25-hydroxyvitamin D
130 concentrations (ng/ml) was further adjusted (n = 1774). **The nutritional factors we adjusted**
131 **for have been associated with depressive symptoms in our previous reports [6, 28, 29] as**
132 **well as other studies [4, 5, 30-34].** Trend association was tested by assigning ordinal numbers
133 (1–3) to tertile categories of intake of each kind of dietary fiber (i.e., total, soluble, insoluble,

vegetable and fruit, and cereal fiber). Additionally, we analyzed the data stratified by age (<41 years or $\geq$ 41 years, based on median age). Interaction was examined by using the likelihood ratio test. An interaction term was generated by multiplying the dichotomized variable of age by tertiles of total, soluble, insoluble, vegetable and fruit, and cereal fiber intake (treated as continuous variables, with ordinal numbers assigned to each level) and added to the multivariate model. Two-sided *P*-values of less than 0.05 were considered statistically significant. All analyses were performed using Stata version 12.1 (StataCorp, College Station, TX, USA).

Results

Participant characteristics by tertiles of energy-adjusted total fiber intake are presented in Table 1. Compared with participants with low total fiber intake, participants with higher total fiber intake were older and more likely to be women and physically active during leisure time, and drank green tea more frequently, but they were less likely to have job strain and be in low-ranking job positions, night or rotating shift workers, smokers, alcohol drinkers, and engaged in physical activity at work and housework or while commuting to work, respectively (*P* for trend < 0.05). Mean values of dietary intake of soluble fiber, insoluble fiber, vegetable and fruit fiber, cereal fiber, folate, vitamin B6, vitamin B12, n-3 polyunsaturated fatty acids, magnesium, and zinc increased significantly with increasing intake of total fiber (*P*

for trend < 0.05).

The ORs of depressive symptoms according to tertile categories of dietary intake of total, soluble, insoluble, and different sources of fiber (i.e., vegetable and fruit fiber and cereal fiber) are shown in Table 2. In an age-, sex-, and workplace-adjusted model (model 1), dietary intake of total, soluble, insoluble, and vegetable and fruit fiber was significantly associated with decreased prevalence of depressive status. After further adjustment for other covariates (model 2), only dietary fiber intake from vegetables and fruits remained statistically significant; the multivariable-adjusted ORs (95% CI) for the lowest through the highest tertile of vegetable and fruit fiber intake were 1.00 (reference), 0.80 (0.60–1.05), and 0.65 (0.45–0.95), respectively (P for trend = 0.03). When other cutoff values for the definition of depressive status were used (CES-D ≥ 19 , which might be suitable for the Japanese worker) [26], similar association was also observed, although the association was not statistically significant; the multivariable-adjusted ORs (95% CI) of having depressive symptoms were 0.69 (0.44–1.07) in the highest versus lowest tertiles of vegetable and fruit fiber intake (data not shown in table). Dietary intake of total, soluble, insoluble and cereal fiber was not significantly associated with the depressive symptoms after adjusting for multiple confounders (model 2). The results were virtually unchanged after additional adjustment for serum 25-hydroxyvitamin D concentrations. The interaction by age did not reach statistical significance for all and each type of fiber (P value for interaction = 0.78, 0.84, 0.96, 0.65, and

0.28 for total fiber intake, soluble fiber intake, insoluble fiber intake, vegetable and fruit fiber intake, and cereal fiber intake, respectively).

Discussion

In this cross-sectional study, we found that higher intake of dietary fiber derived from vegetables and fruits was associated with a lower prevalence of depressive symptoms in Japanese workers, even after adjusting for a wide variety of potentially important dietary (including folate, vitamin B6, vitamin B12, n-3 polyunsaturated fatty acids, magnesium, zinc, coffee, and green tea) and non-dietary confounders. In contrast, dietary intake of total, soluble, insoluble, and cereal fiber was not associated with depressive symptoms. This is among few studies [9, 10] addressing the association between dietary fiber intake and depressive status and is the first to examine the association by source and type of dietary fiber.

The null association for total dietary fiber in the present study disagrees with those of previous studies [9, 10]. In a Chinese study among 3394 community-dwelling older adults, total fiber intake was significantly associated with a decreased prevalence of depressive symptoms [10]. In a small study among older Japanese adults (133 men and 146 women), there was an inverse, albeit statistically non-significant, association between total fiber intake and depressive symptoms [9]. The elderly are more likely to have comorbidities, which may affect both lifestyle and mental status and thus could be a source of bias in epidemiologic

study. The two previous studies, however, didn't adjust for potentially important confounders including dietary intake other than fiber, sleep, and exercise [9, 10]. In the present study, the association between total fiber intake and depressive status, which was statistically significant in minimally-adjusted model, was largely attenuated after multivariate adjustment, suggesting the importance of confounder control in the study on fiber intake and mental health.

In analyses by fiber source, a more pronounced association was observed for vegetable and fruit fiber intake than for cereal fiber intake, suggesting that dietary fiber from vegetables and fruits has a greater potential of improving mood than does cereal fiber. The stronger association for vegetable and fruit fiber could be ascribed to its more readily fermentable properties compared with cereal fiber [13-16]. SCFAs are produced through fermentation of dietary fiber by intestinal microbiota and may improve inflammation [11], an important underlying mechanism of depression [12]. In addition, inulin and oligofructose, which are mainly presented in vegetables and fruits [35, 36], have been shown to increase bifidobacteria [37-39]. Moreover, lactic acid bacteria from raw fruits and vegetables have been suggested to have functional features as probiotic candidates [40]. The colon's fermentation capacity may be modified after probiotic intake, and intake of certain lactic acid bacteria will increase the number of probiotics such as lactobacilli or bifidobacteria in human feces [41]. These probiotics may be beneficial against depression [42, 43]. As regards type of fiber, soluble fiber has greater fermentability and, thus, could synthesis more SCFAs than

210 insoluble fiber [44, 45]. The present study, however, did not find clear difference in the
211 association between soluble and insoluble fiber intake. A recent study among apparently
212 healthy older adults showed that both soluble and insoluble fiber intake were associated with
213 increased fecal SCFAs concentrations [46]. Further epidemiological studies should explore
214 whether the association between fiber intake and depression differs by type of fiber.

215 The lower odds of depressive symptoms associated with higher fiber intake from
216 vegetables and fruits is partially supported by studies that examined the association of
217 individual foods or dietary patterns with depression. Intake of vegetables and/or fruits has
218 been associated with lower prevalence or risk of depression in some cross-sectional [10, 47]
219 and a prospective study [48]. In addition, vegetables and fruits were major contributors to the
220 dietary patterns that showed inverse association with depression [49].

221 The mechanism linking depression to dietary fiber is unclear, but several possibilities
222 have been suggested. An emerging body of evidence suggests that the gut microbiota is
223 potentially important to depression given its ability to influence neurotransmitters such as
224 serotonin [50], inflammation, oxidative stress [51], and the stress response [52]. Fiber can
225 alter the composition of the intestinal flora [17], and bacteria in the gastrointestinal tract can
226 communicate with the central nervous system [53]. In addition, SCFAs, neuroactive bacterial
227 metabolites of dietary fibers, can modulate brain and behavior [7].

228 The major strengths of this study include its high participation rate (response rate

76%) and adjustment for known and potential risk factors for depressive symptoms. However, our study also had several limitations. First, an association derived from a cross-sectional study does not necessarily indicate causality. Second, despite adjustment for numerous potential confounders, we cannot rule out the possibility that the observed associations are due to unmeasured confounders and residual confounding. For instance, patients with irritable bowel syndrome (IBS) are at high risk of depression [54] and phytochemicals found in fruits and vegetables have antidepressant properties [55], but the present study lacked these data. Third, we were unable to tease apart the effects of soluble and insoluble fiber due to their high inter-correlation ($r = 0.93$). Finally, because the study participants were Japanese manufacturing workers, caution is required in generalizing the present findings.

Conclusion

Higher intake of dietary fiber derived from vegetables and fruits was associated with a significantly lower odds of depressive symptoms in Japanese employees even after adjustment for a variety of potential confounders including depression-related nutrients. The present finding based on cross-sectional observation requires confirmation in prospective studies. Further investigation into gut microbiota composition and SCFAs would contribute to the understanding of mechanisms whereby dietary fiber protects against depression.

248 **Conflict of interest**

249 The authors declare no conflicts of interest. T.K., M.E., H.T., R. I., and I. Kabe are health
250 professionals at the Furukawa Electric Corporation.

251

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Table 1 Characteristics of participants by tertiles of total fiber intake

	Total fiber intake			P-trend [*]
	T 1 (low)	T 2	T 3 (high)	
Number of subjects	659	659	659	
Total fiber intake (mean, g/1000 kcal)	4.0	5.5	7.6	
Age (mean $\pm$ s.d., year)	41.4 $\pm$ 9.6	41.6 $\pm$ 9.8	43.6 $\pm$ 10.6	<0.001
Sex (women, %)	6.2	9.9	15.8	<0.001
Site (survey in April 2012, %)	52.2	56.2	58.6	0.019
Marital status (married, %)	63.0	67.1	68.0	0.055
Job grade (low, %)	71.9	69.8	65.1	0.007
Night or rotating shift work (yes, %)	28.2	20.0	11.4	<0.001
Overtime work (≥ 30 hours/month, %)	27.2	27.2	25.2	0.42
Job strain (mean $\pm$ s.d.)	0.50 $\pm$ 0.12	0.48 $\pm$ 0.12	0.47 $\pm$ 0.12	<0.001
Physical activity at work and housework or on commuting to work (≥ 20 METs-hours/day, %)	29.6	20.9	18.1	<0.001
Leisure-time physical activity (≥ 10 METs-hours/week, %)	22.2	27.8	28.1	0.014
Smoking status (current, %)	38.7	26.9	21.1	<0.001
Alcohol drinking (current [†] , %)	62.1	52.8	44.2	<0.001
Green tea consumption (≥ 1 cup/day, %)	41.4	44.8	53.3	<0.001
Coffee consumption (≥ 1 cup/day, %)	63.0	66.8	63.3	0.91
Sleep duration (<6 hours/day, %)	38.9	39.8	42.0	0.24
BMI (mean $\pm$ s.d., kg/m ²)	23.4 $\pm$ 3.5	23.1 $\pm$ 3.2	23.1 $\pm$ 3.2	0.06
Daily dietary intake (mean $\pm$ s.d.)				
Total energy (kcal/day)	1790 $\pm$ 505	1829 $\pm$ 473	1771 $\pm$ 486	0.52
Soluble fiber (g/1000 kcal)	0.9 $\pm$ 0.2	1.4 $\pm$ 0.2	1.9 $\pm$ 0.4	<0.001
Insoluble fiber (g/1000 kcal)	3.0 $\pm$ 0.5	4.0 $\pm$ 0.3	5.4 $\pm$ 1.0	<0.001
Vegetable and fruit fiber (g/1000 kcal)	1.5 $\pm$ 0.6	2.5 $\pm$ 0.6	4.0 $\pm$ 1.5	<0.001
Cereal fiber (g/1000 kcal)	1.6 $\pm$ 0.5	1.8 $\pm$ 0.5	1.8 $\pm$ 0.6	<0.001
Folate (μ g/1000 kcal)	121 $\pm$ 34	155 $\pm$ 33	215 $\pm$ 64	<0.001
Vitamin B6 (mg/1000 kcal)	0.53 $\pm$ 0.12	0.59 $\pm$ 0.11	0.71 $\pm$ 0.14	<0.001
Vitamin B12 (μ g/1000 kcal)	3.9 $\pm$ 1.8	4.4 $\pm$ 2.0	4.9 $\pm$ 2.5	<0.001
N-3 polyunsaturated fatty acids (% energy)	1.0 $\pm$ 0.3	1.2 $\pm$ 0.3	1.3 $\pm$ 0.4	<0.001
Magnesium (mg/1000 kcal)	106 $\pm$ 18	123 $\pm$ 16	148 $\pm$ 25	<0.001
Zinc (mg/1000 kcal)	3.8 $\pm$ 0.6	4.2 $\pm$ 0.5	4.5 $\pm$ 0.6	<0.001
Serum 25-hydroxyvitamin D concentrations (mean $\pm$ s.d., ng/ml) [‡]	21.4 $\pm$ 5.6	21.6 $\pm$ 5.2	21.5 $\pm$ 5.1	0.76

Abbreviations: s.d., standard deviation, BMI, body mass index; METs; Metabolic Equivalents; T, tertile

^{*} On the basis of the Mantel–Haenszel χ^2 test for categorical variables and linear regression analysis for continuous variables, assigning ordinal numbers 1–3 to tertile categories of total fiber intake.

[†] Alcohol consumption of at least one day per week.

[‡] In the analysis of participants who had data on serum 25-hydroxyvitamin D concentrations ($n=1774$).

Table 2 Odds ratios and 95% confidence intervals for depressive symptoms according to tertile of total fiber, soluble fiber, insoluble fiber, and sources of fiber intake

	CES-D (15/16)			P for trend*
	T1(low)	T2	T3 (high)	
Total fiber (median, g/1000 kcal)	4.1	5.5	7.1	
Subjects with/without depressive symptoms	216/443	178/481	154/505	
Model 1 [†]	1.00 (ref)	0.77 (0.60-0.97)	0.66 (0.51-0.84)	0.001
Model 2 [‡]	1.00 (ref)	0.94 (0.71-1.25)	0.93 (0.63 -1.38)	0.71
Soluble fiber (median, g/1000 kcal)	1.0	1.4	1.9	
Subjects with/without depressive symptoms	210/449	183/476	155/504	
Model 1 [†]	1.00 (ref)	0.82 (0.65-1.05)	0.68 (0.53-0.87)	0.002
Model 2 [‡]	1.00 (ref)	0.998 (0.75-1.32)	0.99 (0.68 -1.44)	0.96
Insoluble fiber (median, g/1000 kcal)	3.1	4.0	5.1	
Subjects with/without depressive symptoms	222/437	171/488	155/504	
Model 1 [†]	1.00 (ref)	0.69 (0.55-0.88)	0.64 (0.50-0.82)	<0.001
Model 2 [‡]	1.00 (ref)	0.85 (0.64-1.12)	0.88 (0.60 -1.31)	0.46
Vegetable and fruit fiber (median, g/1000 kcal)	1.4	2.4	3.8	
Subjects with/without depressive symptoms	229/430	172/487	147/512	
Model 1 [†]	1.00 (ref)	0.69 (0.54-0.88)	0.58 (0.45-0.74)	<0.001
Model 2 [‡]	1.00 (ref)	0.80 (0.60-1.05)	0.65 (0.45 -0.95)	0.03
Cereal fiber (median, g/1000 kcal)	1.2	1.6	2.2	
Subjects with/without depressive symptoms	193/466	176/483	179/480	
Model 1 [†]	1.00 (ref)	0.86 (0.67-1.09)	0.85 (0.67-1.09)	0.20
Model 2 [‡]	1.00 (ref)	0.89 (0.68-1.16)	0.86 (0.65-1.14)	0.30

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; ref, reference; T, tertile

* Based on multiple logistic regression analyses, assigning ordinal numbers of 1–3 to the tertile categories of the independent variable.

[†] Adjusted for age (year, continuous), sex, and site (survey in April 2012 or in May 2013).

[‡] Adjusted for age (year, continuous), sex, site (survey in April 2012 or in May 2013), marital status (married or other), job grade (low, middle, or high), night or rotating shift work (yes or no), overtime work (<10, 10–<30, or ≥30 h/month), job strain (quartile), physical activity at work and housework or while commuting to work (<3, 3–<7, 7–<20, or ≥20 METs-h/day), leisure-time physical activity (not engaged, >0–<3, 3–<10, or ≥10 METs-h/week), smoking (never-smoker, former smoker, current smoker consuming <20 cigarettes/day, or current smoker consuming ≥20 cigarettes/day), alcohol drinking (nondrinker, drinker consuming 1–3 days/month, weekly drinker consuming <1, 1–<2, or ≥2 go/day; one go contains approximately 23 g of ethanol), green tea (≤ 1, 2–3, or ≥ 4 cups/day), coffee (< 1, 1, or ≥ 2 cups/day), sleep duration (<6, 6–6.9, or ≥7 hours/day), body mass index (kg/m², continuous), total energy intake (kcal/day, continuous), and intake of folate (μg/1000 kcal, continuous), vitamin B6 (mg/1000 kcal, continuous), vitamin B12 (μg /1000 kcal, continuous), n-3 polyunsaturated fatty acids (% energy, continuous), magnesium (mg/1000 kcal, continuous), and zinc (mg/1000 kcal, continuous).