

Fermented Food Consumption and Psychological Distress in Pregnant Women: A Nationwide Birth Cohort Study of the Japan Environment and Children's Study

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Health benefits of fermented foods are attracting attention worldwide, and they have been traditionally eaten in Japan. Moreover, a recent study showed the association between the higher intake of yogurt and lower prevalence of depressive symptoms during pregnancy. Psychological problems, such as anxiety and depression, during pregnancy are serious health concerns and may increase the risk of adverse outcomes in children. In this study, we explored the association between fermented food consumption and psychological distress in 10,129 pregnant Japanese women, using the fixed data of the Japan Environment and Children's Study (JECS), an ongoing nation-wide birth cohort study. Food consumption was assessed with a semi-quantitative food frequency questionnaire (FFQ), and the Kessler 6-item psychological distress scale (K6) was administered to eligible women during their second or third trimester to eliminate overlap with the period of hyperemesis gravidarum. The mean median gestation in the subjects was 24.8 weeks. In total, 9,030 subjects completed the K6 questionnaire and FFQ. Importantly, the prevalence of the K6 score of ≥ 13 was 3.1% (280 subjects). This value was lower compared to precedent studies, which may reflect that cooperative and health conscious subject participated in the survey. The multivariate logistic regression analysis indicates that the intake of yogurt, lactic acid beverages, cheese, Japanese pickles, miso soup, or fermented soybeans was not significantly associated with a K6 score of ≥ 13 . In conclusion,

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the present cohort study shows no association between fermented food consumption and psychological distress symptoms during the second or third trimester of pregnancy.

Keywords: fermented foods; Japan Environment and Children's Study; pregnant women; psychological distress; the second or third trimester of pregnancy

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Introduction

Psychological distress, such as anxiety and depression, during pregnancy are serious health concerns. Reported prevalence rates of antenatal anxiety disorders range between 6.6% and 24% (Andersson et al. 2003; Sutter-Dallay et al. 2004), and the prevalence rates of antenatal depression might be as high as 20%, worldwide (Marcus et al. 2003; Bowen and Muhajarine 2006a; Faisal-Cury and Rossi Menezes 2007). Anxiety and depression during pregnancy are associated with an increased risk of preterm delivery, preeclampsia, birth difficulties, and postpartum depression (Dayan et al. 2002; Bodnar and Wisner 2005; Bowen and Muhajarine 2006b; Orr et al. 2007).

Antenatal anxiety, depression, and stress also increase the risk of a wide range of adverse outcomes in children, including emotional problems, symptoms of attention deficit hyperactivity disorder, and impaired cognitive development (Talge et al. 2007; Stein et al. 2008; Pawlby et al. 2009; Glover 2014, 2015). Children of depressed mothers also have more frequent respiratory problems and diarrhea (Stewart 2007).

Previous studies have shown an association between nutrients and depressive symptoms during pregnancy, and suggest that higher intakes of eicosapentaenoic acid, docosahexaenoic acid, and calcium are independently associated with lower prevalence of depressive symptoms in pregnant women (Miyake et al. 2013, 2015). A cross-sectional study of approximately 1,700 pregnant Japanese women found that a higher intake of yogurt was independently associated with lower prevalence of depressive symptoms during pregnancy (Miyake et al. 2015).

Recently, fermented milk products with probiotics were reported to affect activity in brain regions that control the central processing of emotion and sensation in healthy women (Tillisch et al. 2013). Animal models have also demonstrated potential signaling mechanisms, such as microbiota-produced signaling molecules and mucosal immune mechanisms, through which probiotics and gut microbiota influence brain activity (Bravo et al. 2011; McNulty et al. 2011; Neufeld et al. 2011; Cryan and Dinan 2012; Foster and McVey Neufeld 2013; Mayer et al. 2015; Mohammadi et al. 2016).

The Japanese Ministry of the Environment launched a large-scale epidemiological research project, termed The Japan Environment and Children's Study (JECS), in January 2011 (Kawamoto et al. 2014). JECS is an ongoing nationwide birth cohort study, which aims to recruit approximately 100,000 pregnant women and their partners over a

period of three years, collect biological samples, and record data on their children from birth, to the age of 13.

In the present study, we analyzed a data set from JECS, which included approximately 10,000 pregnant Japanese women, to investigate associations between psychological distress and the consumption of fermented foods such as yogurt, lactic acid beverages, cheese, Japanese pickles, miso soup, and fermented soybeans. We limited the target period of the dietary survey to the second and third trimesters to eliminate overlap with the period of hyperemesis gravidarum.

Materials and Methods

Study subjects

The JECS protocol has been published elsewhere (Kawamoto et al. 2014; Michikawa et al. 2015) and was approved by the Ministry of the Environment's Institutional Review Board on Epidemiological Studies on April 6, 2010 (no. 100406001). Informed, written consent was obtained from all participants. The present study is based on the data set jecs-ag-ai-20131008, which was released in October 2013. Registration for JECS was initiated in January 2011, on a nationwide basis, and the primary fixed data were created. This data includes 10,129 pregnant women who had given birth as of December 2011. For the JECS, participants were recruited through the 15 Regional Centers located in Hokkaido, Miyagi, Fukushima, Chiba, Kanagawa, Koshin, Toyama, Aichi, Kyoto, Osaka, Hyogo, Tottori, Kochi, Fukuoka, and South Kyushu and Okinawa (Fig. 1).

Measurements

All data was obtained from self-reported questionnaires completed by pregnant women; the "M-T2 questionnaire" for mothers during mid-late trimester pregnancy was conducted during the second or third trimester.

Exposures

Exposures in this study were the intake of probiotics, prebiotics, and other fermented foods, such as yogurt, lactic acid beverages, fermented milk, cheese, milk, Japanese pickles, miso soup (miso pastes are produced by fermenting soybeans, rice, barley, and wheat with salt and malt), fermented soybeans, and beans. Exposure was assessed with a semi-quantitative food frequency questionnaire (FFQ), which was comprised of a list of foods with standard portion sizes commonly consumed in Japan (Yokoyama et al. 2016). Participants were asked to report the daily, weekly, or monthly frequency of their consumption of a portion size of fermented foods, during the second or third trimester of pregnancy.

Outcome

The Kessler 6-item psychological distress scale (K6) is widely used as a screening tool for psychological distress in the general population (Kessler et al. 2002, 2003). It is preferred for the screening of

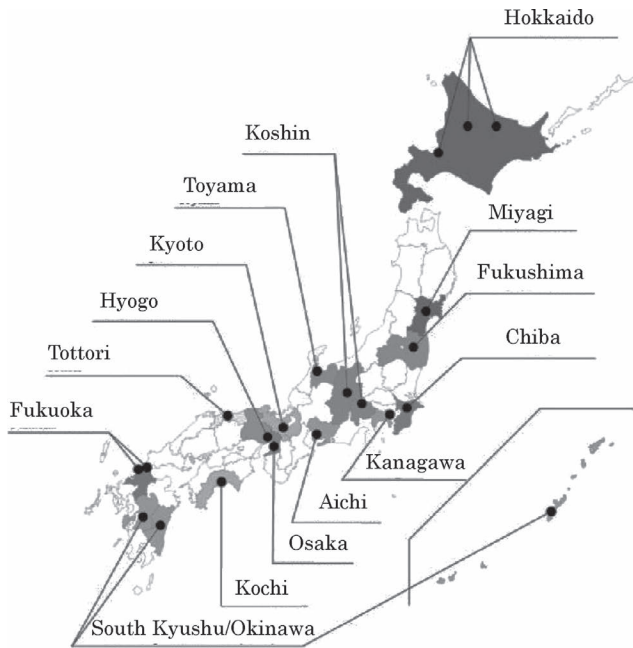


Fig. 1. Location of the 15 Regional Centers of JECS. The participants were recruited through the 15 Regional Centers of the Japan Environment and Children's Study (JECS).

DSM-IV mood or anxiety disorders, because of its brevity and consistency across subsamples. The K6 consists of six questions with five possible responses (0-4) for each question: none of the time (0 points), a little of the time (1 point); some of the time (2 points); most of the time (3 points); and all of the time (4 points).

The six questions are as follows: "During the past 30 days, how often have you felt the following: (1) nervous; (2) hopeless; (3) restless or fidgety; (4) so depressed that nothing would cheer you up; (5) that everything was an effort; and (6) worthless?" The total score ranges between 0 and 24. Following the suggestion of Kessler et al. (2003), we classified women with K6 scores of ≥ 13 as having psychological distress. This cutoff point was used in previous studies that implemented the Japanese version of K6 (Hozawa et al. 2009; Watanabe et al. 2015). The Japanese version of the K6 demonstrates a screening performance essentially equal to that of the original English version (Furukawa et al. 2003, 2008).

Covariates

Information regarding parity, body mass index, marital status, family structure, number of childbirths, and mood after pregnancy was confirmed, and history of infertility treatment and mental health disorders was ascertained with a baseline questionnaire. In a follow-up questionnaire and the FFQ, participants also reported age, gestation, academic history, employment, household income, International Physical Activity Questionnaire short score, present smoking status, husband's present smoking status, secondhand smoking status, alcohol consumption level, total intake, drink consumption level (e.g., green tea, oolong tea, black tea, and coffee), presence of health complications or disease (e.g., hypertension, diabetes, mental health disorders, other pregnancy complications, gestational hypertension, gestational diabetes, other obstetric labor complications), intimate partner violence (IPV), and social capital (SC) during the second or third trimester of pregnancy.

The JECS questionnaire for women during the second or third trimester (the M-T2 questionnaire) includes IPV-related questions, which are answered across four response options: (1) never, (2) rarely, (3) sometimes, and (4) often. For the assessment of psychological IPV, the participants were asked, "Have you ever been insulted or reviled by your partner during the present pregnancy?" Hereafter, "during pregnancy" refers to the present pregnancy unless otherwise specified. For the assessment of physical IPV, the women were asked "Have you ever been hit or beaten by your partner due to a fight during pregnancy, resulting in injury?" To determine the incidence of IPV in the study, we considered the answers "rarely," "sometimes," and "often" to indicate the presence of psychological or physical IPV.

The M-T2 also includes SC-related questions. The following questions were answered across the five response options (1) never, (2) rarely, (3) sometimes, (4) frequently, and (5) always. Question 1: "Are there any contactable persons who show love and affection to you?" Question 2: "Are there any people who mentally support you, such as providing consultation to resolve problems and helping with difficult decision-making?" Question 3: "Do you contact persons who are familiar to you and trustworthy as frequently as you desire?" To determine the SC of the study participants, we considered the answers "sometimes," "frequently," and "always" to indicate the presence of SC.

The following SC-related question was answered across the three response options (1) none, (2) one to two, and (3) three or more: "How many relatives or friends do you have with whom you can freely consult?" To determine the SC of the study participants, we considered the answer "three or more" to indicate the presence of SC.

Statistical analysis

In this study, we used a multivariate logistic regression analysis to assess the risk of psychological distress related to fermented food consumption. Miyake et al. (2015) previously reported that a higher intake of yogurt may be associated with a lower prevalence of psychological distress in pregnant women, so here we assessed the effect of yogurt in detail. In particular, it was included as a continuous predictor in a working model, and a linear spline interpolation with one knot was used to represent a nonlinear association between food intake and the prevalence of psychological distress due to food refusal and overeating. The selection of the optimal location for the knot was based on Akaike's information criteria (Akaike 1973). All other exposures were categorized into quartile groups. All exposures and covariates that were statistically significant in the univariate analyses were included in the working multivariate logistic model.

In the main analysis, subjects with "no answer" outcomes were excluded, and incomplete covariates were categorized into a "no answer" category. To assess the robustness of our main results, we performed multiple imputation analyses with a fully conditional specification method (van Buuren 2007). Ten data sets were created, with "no answer" values replaced by imputed values based on a model that incorporated both exposure and covariates. These data sets were then combined using Rubin's rule (Rubin 1987).

The Wald test evaluated the null hypothesis that each effect in the model was 0. The Wald test was used for evaluation of each effect in see Tables 2-7. All P values are two-tailed with significance set at < 0.05 and all analyses were performed using SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC).

Results

Study subjects

Subjects lost to follow-up during the second or third trimester of pregnancy ($n = 632$) and those with still or multiple births ($n = 228$ and 92 , respectively), energy intakes outside of the predefined limits (< 500 Kcal/day or $> 5,000$ Kcal/day; $n = 87$), or uncompleted K6 surveys ($n = 60$) were excluded. In total, 9,030 subjects completed the

K6 questionnaire and FFQ at M-T2 questionnaire (Fig. 2). The participants of the 15 Regional Centers and Core Center of JECS was shown in Table 1. The location of Core Center wasn't provided in the data set jecs-ag-ai-20131008. The participants of JECS were distributed nationwide from the north, Hokkaido, to the south, Okinawa.

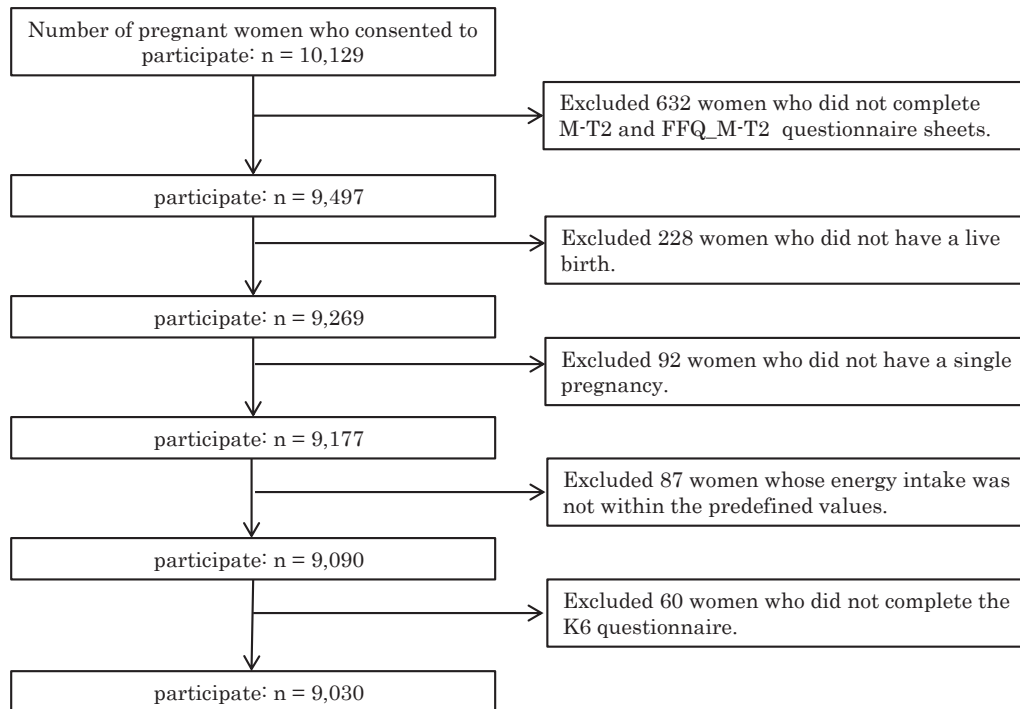


Fig. 2. Participants flow diagram.

The study analyzed 9,090 out of the 10,129 pregnant women which provided primary fixed data for the Japan Environment and Children's Study (JECS).

Questionnaire for mothers during the second or third trimester pregnancy (M-T2 questionnaire), a semi-quantitative food frequency questionnaire (FFQ), Kessler 6-item psychological distress scale (K6).

Table 1. Participants of the 15 Regional Centers and Core Center of the Japan Environment and Children's Study (Total = 9,030).

unit center	n	%
Hokkaido	617	6.8
Miyagi	1004	11.1
Fukushima	553	6.1
Chiba	469	5.2
Kanagawa	443	4.9
Koshin	783	8.7
Toyama	684	7.6
Aichi	376	4.2
Kyoto	141	1.6
Osaka	979	10.8
Hyogo	446	4.9
Tottori	291	3.2
Kochi	723	8.0
Fukuoka	811	9.0
South Kyusyu and Okinawa	670	7.4
Core Center	40	0.4

Characteristics of subjects

Tables 2-7 showed the participant characteristics and proportion of psychological distress. The mean age and

median gestation in the subjects was 31.0 years and 24.8 weeks, respectively. The prevalence of psychological distress during the second or third trimester of pregnancy was

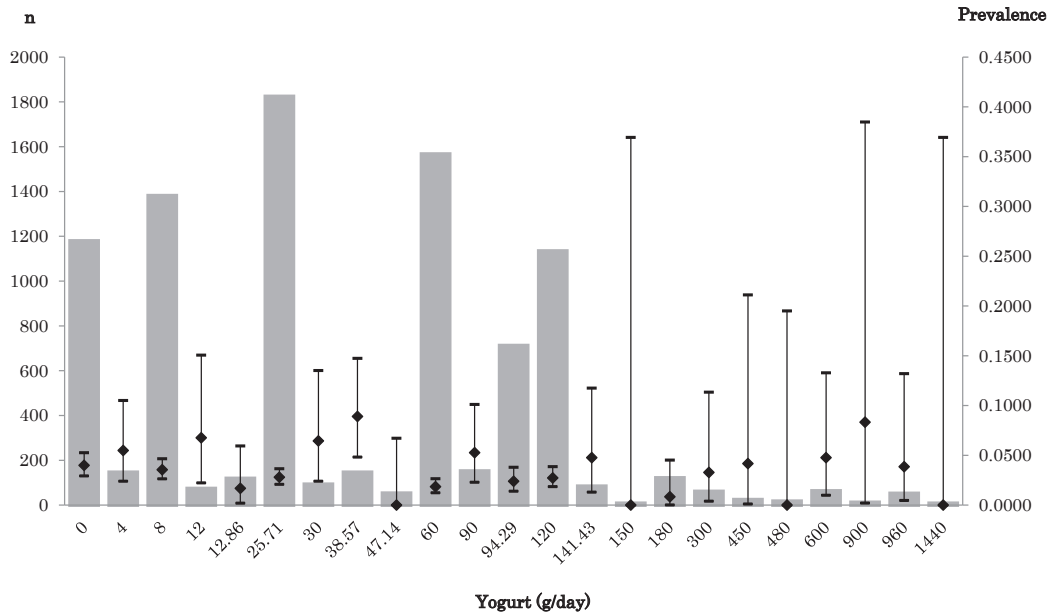


Fig. 3. Prevalence of K6 ≥ 13 and yogurt intake. The mark [♦] is a prevalence of K6 ≥ 13 and bars are 95% confidence intervals. The histogram is a yogurt intake frequency (Total = 9,030).

Table 2. Characteristics of subjects and Univariate analysis for Exposures (Fermented related foods).

		total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
Yogurt (g/day)	< 60	5015	(55.5)	181	(3.6)	0.991	0.986-0.996		0.004
	≥ 60	4015	(44.5)	99	(2.5)	1.001	1.000-1.002		
Lactic acid beverage (ml/day)	0	5445	(60.3)	150	(2.8)	1			0.07
	< 80	2239	(24.8)	81	(3.6)	1.325	1.007-1.744	0.04	
	≥ 80	1346	(14.9)	49	(3.6)	1.334	0.961-1.744	0.09	
Cheese (g/day)	0	1872	(20.7)	72	(3.9)	1			0.04
	0 << 2.5	2689	(29.8)	86	(3.2)	0.826	0.600-1.136	0.24	
	2.5 << 5	2352	(26.0)	54	(2.3)	0.587	0.411-0.841	0.004	
	> 5	2117	(23.4)	68	(3.2)	0.830	0.592-1.163	0.28	
Milk (ml/day)	0	1576	(17.5)	60	(3.8)	1			0.09
	0 << 200	4696	(52.0)	152	(3.2)	0.845	0.623-1.146	0.28	
	200-400	2065	(22.9)	51	(2.5)	0.640	0.438-0.935	0.02	
	> 400	693	(7.7)	17	(2.5)	0.635	0.368-1.097	0.10	
Japanese pickles (g/day)	0	1826	(20.2)	63	(3.5)	1			0.73
	0 << 5	3296	(36.5)	95	(2.9)	0.831	0.601-1.148	0.26	
	5 << 10	1598	(17.7)	51	(3.2)	0.923	0.634-1.343	0.67	
	> 10	2310	(25.6)	71	(3.1)	0.887	0.629-1.253	0.50	
Fermented soybeans	< 1 time/month	1777	(19.7)	59	(3.3)	1			0.81
	1-3 times/month	2302	(25.5)	75	(3.3)	0.981	0.693-1.387	0.91	
	1-2 times/week	2984	(33.0)	86	(2.9)	0.864	0.617-1.210	0.40	
	≥ 3 times/week	1967	(21.8)	60	(3.1)	0.916	0.636-1.320	0.64	
Miso soup (cup/week)	≤ 2	2733	(30.3)	110	(4.0)	1			0.008
	3-4	1841	(20.4)	53	(2.9)	0.707	0.507-0.986	0.04	
	5-6	2379	(26.3)	58	(2.4)	0.596	0.431-0.823	0.002	
	≥ 7	2077	(23.0)	59	(2.8)	0.697	0.505-0.962	0.03	
Beans (g/day)	≤ 15	1899	(21.0)	77	(4.1)	1			0.01
	15 << 30	2152	(23.8)	66	(3.1)	0.749	0.536-1.046	0.09	
	30 << 60	2578	(28.5)	60	(2.3)	0.564	0.400-0.794	0.001	
	> 60	2401	(26.6)	77	(3.2)	0.784	0.568-1.082	0.14	

The Kessler 6-item psychological distress scale (K6; total point scores ranged from 0 to 24. We classified individuals with scores of ≥13/24 as having psychological distress.), COR (crude odds ratio), CI (confidence interval), The Wald test evaluates the null hypothesis that each effect in the model is 0 (Wald test).

Table 3. Characteristics of subjects and Univariate analysis for Covariates (Information from the baseline questionnaire; Social, Life-style, and Pregnancy-related items).

		total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
Parity	Primipara	3278	(36.3)	81	(2.5)	1			0.02
	Multipara	5281	(58.5)	186	(3.5)	1.441	1.106-1.877	0.01	
	no answer	471	(5.2)	13	(2.8)	1.120	0.619-2.028	0.71	
BMI (kg/m ²)	means +/- SD	21.2 +/- 3.3							
	<18.0	1454	(16.1)	45	(3.1)	1.057	0.760-1.471	0.74	0.07
	18.0 ≤ < 25.0	6447	(71.4)	189	(2.9)	1			
	≥ 25.0	911	(10.1)	41	(4.5)	1.560	1.105-2.203	0.01	
no answer	218	(2.4)	5	(2.3)	0.777	0.316-1.909	0.58		
Marital status	married, common-law marriage (live together)	8277	(91.7)	247	(3.0)	1			0.02
	married, common-law marriage (live apart)	296	(3.3)	8	(2.7)	0.903	0.442-1.844	0.78	
	unmarried, divorce, lost	369	(4.1)	18	(4.9)	1.667	1.021-2.722	0.04	
	no answer	88	(1.0)	7	(8.0)	2.810	1.285-6.144	0.01	
Family structure	nuclear family	6874	(76.1)	199	(2.9)	1			0.13
	extended family	2084	(23.1)	78	(3.7)	1.304	0.999-1.703	0.05	
	no answer	72	(0.8)	3	(4.2)	1.460	0.456-4.675	0.52	
Number of children	0	3752	(41.6)	98	(2.6)	1			0.02
	1	3488	(38.6)	107	(3.1)	1.180	0.894-1.558	0.24	
	≥ 2	1757	(19.5)	73	(4.2)	1.616	1.187-2.200	0.002	
	no answer	33	(0.4)	2	(6.1)	2.407	0.568-10.195	0.23	
Mood after pregnancy is confirmed	happy	5668	(62.8)	132	(2.3)	1			<.0001
	unplanned but happy	2374	(26.3)	85	(3.6)	1.557	1.181-2.054	0.002	
	unplanned and puzzled, troubled, nothing	917	(10.2)	60	(6.5)	2.936	2.146-4.018	<.0001	
	no answer	71	(0.8)	3	(4.2)	1.850	0.575-5.956	0.30	
Experiences of infertility treatment	no	8350	(92.5)	261	(3.1)	1			0.12
	yes	605	(6.7)	14	(2.3)	0.734	0.426-1.265	0.27	
	no answer	75	(0.8)	5	(6.7)	2.217	0.888-5.535	0.09	
History of a mental health disorder	no	8317	(92.1)	207	(2.5)	1			<.0001
	yes	664	(7.4)	72	(10.8)	4.766	3.599-6.311	<.0001	
	no answer	49	(0.5)	1	(2.0)	0.816	0.112-5.942	0.84	

BMI (body mass index), SD (standard deviation).

3.1% (280 subjects).

Prevalence of psychological distress and intake of yogurt

Fig. 3 showed a histogram that indicates the prevalence of psychological distress and its 95% confidence interval (CI). The median intake of yogurt was 25.71 g/day, which corresponds to approximately 1 cup of yogurt (120 g) consumed by a Japanese woman once or twice per week. We fit a linear spline model with one knot to this data, and the estimate of the optimal knot for yogurt intake was 60 g/day.

Univariate analysis for fermented related foods

Lower yogurt intake was significantly associated with a lower prevalence of psychological distress (crude odds ratio [COR]: 0.991; 95% CI: 0.986-0.996; P = 0.0009) within the range of 0 to 60 g/day. However, at 60 g/day or more, higher yogurt intake was not associated with lower prevalence (COR: 1.001; 95% CI: 1.000-1.002; P = 0.20). Associations between psychological distress and the intake of cheese, miso soup, and beans were investigated using a univariate analysis. Higher intakes of these foods tended to

be associated with lower prevalence of psychological distress. The univariate analysis showed no associations between psychological distress, and the intake of lactic acid beverages, milk, Japanese pickles, or fermented soybeans (Table 2).

Multivariate regression analysis for fermented related foods

Associated covariates were parity, body mass index, marital status, number of children, mood after pregnancy, history of mental health disorders, age, academic history, job type, household income, International Physical Activity Questionnaire short score, present smoking status, husband's present smoking status, secondhand smoking status, total intake, intake of black tea, mental health disorder, other obstetric labor complications, IPV, and SC. In multivariate logistic regression model included these covariates, "the adjusted effects" of yogurt, cheese, miso soup, and beans were not significantly associated with the prevalence of psychological distress during the second or third trimester of pregnancy (Table 8). Notably, the results obtained with the multiple imputation method corroborated those of the main analysis. In healthy pregnant women without

Table 4. Characteristics of subjects and Univariate analysis for Covariates (Information from the follow-up questionnaire; Social, Lifestyle, and Pregnancy-related items).

	means +/- SD	total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
Age (years)									
	≤24	935	(10.4)	55	(5.9)	2.283	1.613-3.231	<.0001	<.0001
	25-29	2559	(28.3)	89	(3.5)	1.316	0.973-1.780	0.07	
	30-34	3189	(35.3)	85	(2.7)	1			
	35-39	1960	(21.7)	39	(2.0)	0.741	0.505-1.088	0.13	
	≥ 40	358	(4.0)	10	(2.8)	1.049	0.540-2.040	0.89	
	no answer	29	(0.3)	2	(6.9)	2.710	0.635-11.568	0.18	
Gestation (weeks)	median (IQR)	24.8 (21.6 - 28.0)							
	no answer	8	(0.1)						
Academic history	college, university	5694	(63.1)	136	(2.4)	1			<.0001
	senior high school	2839	(31.4)	110	(3.9)	1.647	1.276-2.127	0.0001	
	junior high school	458	(5.1)	31	(6.8)	2.967	1.984-4.436	<.0001	
	no answer	39	(0.4)	3	(7.7)	3.406	1.036-11.195	0.04	
Job type	homemaker	4316	(47.8)	167	(3.9)	1			<.0001
	full time	2951	(32.7)	57	(1.9)	0.489	0.361-0.663	<.0001	
	part time or other	1695	(18.8)	52	(3.1)	0.786	0.573-1.079	0.14	
	no answer	68	(0.8)	4	(5.9)	1.553	0.559-4.315	0.40	
Household income (×10 ³ yen/year)	< 4,000	3487	(38.6)	73	(2.6)	1.616	1.214-2.152	0.001	0.0001
	4,000 ≤ < 6,000	2812	(31.1)	144	(4.1)	1			
	≥ 6,000	2171	(24.0)	46	(2.1)	0.812	0.559-1.180	0.27	
	no answer	560	(6.2)	17	(3.0)	1.175	0.687-2.007	0.56	
IPAQ (mets · min/week)	0	1969	(21.8)	65	(3.3)	1.516	0.991-2.317	0.05	0.002
	0 < <= 350	1674	(18.5)	43	(2.6)	1.170	0.740-1.852	0.50	
	350 < <= 700	1498	(16.6)	33	(2.2)	1			
	700 < <= 1750	1574	(17.4)	39	(2.5)	1.128	0.706-1.803	0.62	
	> 1750	1881	(20.8)	80	(4.3)	1.972	1.3-07-2.975	0.001	
	no answer	434	(4.8)	20	(4.6)	2.145	1.218-3.777	0.01	
Present smoking status	never	5046	(55.9)	122	(2.4)	1			<.0001
	ever	3440	(38.1)	122	(3.6)	1.484	1.150-1.915	0.002	
	smoking	482	(5.3)	34	(7.1)	3.063	2.069-4.534	<.0001	
	no answer	62	(0.7)	2	(3.2)	1.345	0.325-5.567	0.68	
Present smoking status of husband	never	2276	(25.2)	62	(2.7)	1			<.0001
	ever	2406	(26.6)	48	(2.0)	0.727	0.496-1.064	0.10	
	smoking	4185	(46.3)	162	(3.9)	1.438	1.068-1.936	0.02	
	no answer	163	(1.8)	8	(4.9)	1.843	0.867-3.918	0.11	
Secondhand smoking status	no	5404	(59.8)	125	(2.3)	1			<.0001
	yes	3594	(39.8)	154	(4.3)	1.891	1.487-2.403	<.0001	
	no answer	32	(0.4)	1	(3.1)	1.362	0.185-10.058	0.76	
Alcohol consumption level	never	3038	(33.6)	97	(3.2)	1			0.99
	ever	5592	(61.9)	172	(3.1)	0.962	0.747-1.239	0.77	
	drinking	357	(4.0)	11	(3.1)	0.964	0.512-1.816	0.91	
	no answer	43	(0.5)	0	(0.0)	<.0001	<.001-> 999.999	0.97	

IQR (interquartile range), IPAQ (the International Physical Activity Questionnaire) short scoring.

Table 5. Characteristics of subjects and Univariate analysis for Covariates (Information from the follow-up questionnaire; Total energy and Drink consumption).

	means +/- SD	total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
Total energy (kcal/day)									
	500 ≤ < 1200	1482	(16.4)	51	(3.4)	1.327	0.912-1.930	0.14	0.005
	1200 ≤ < 1600	2849	(31.6)	72	(2.5)	0.965	0.685-1.359	0.84	
	1600 ≤ < 2000	2408	(26.7)	63	(2.6)	1			
	2000 ≤ < 5000	2291	(25.4)	94	(4.1)	1.593	1.151-2.203	0.005	
Green tea (cup/day)*	0	3347	(37.1)	102	(3.1)	1			0.76
	< 1	3102	(34.4)	91	(2.9)	0.961	0.722-1.281	0.79	
	1-2	1162	(12.9)	37	(3.2)	1.046	0.714-1.533	0.82	
	> 2	1419	(15.7)	50	(3.5)	1.162	0.824-1.639	0.39	
Oolong tea (cup/day)*	0	5751	(63.7)	157	(2.7)	1			0.051
	< 1	2317	(25.7)	89	(3.8)	1.424	1.093-1.855	0.01	
	1-2	462	(5.1)	18	(3.9)	1.445	0.879-2.376	0.15	
	> 2	500	(5.5)	16	(3.2)	1.178	0.698-1.986	0.54	
Black tea (cup/day)*	0	5390	(59.7)	147	(2.7)	1			0.01
	< 1	3139	(34.8)	107	(3.4)	1.259	0.977-1.621	0.07	
	≥ 1	501	(5.5)	26	(5.2)	1.952	1.273-1.621	0.002	
Coffee (cup/day)*	0	4146	(45.9)	146	(3.5)	1			0.10
	< 1	2779	(30.8)	70	(2.5)	0.708	0.530-0.945	0.02	
	1-2	1359	(15.0)	38	(2.8)	0.788	0.549-1.132	0.20	
	> 2	746	(8.3)	26	(3.5)	0.989	0.647-1.513	0.96	

*A cup of tea is approximately 120 mL.

Table 6. Characteristics of subjects and Univariate analysis for Covariates (Information from the follow-up questionnaire; Occurrence of complications or disease).

		total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
Hypertension	no	8879	(98.3)	272	(3.1)	1			0.12
	yes	151	(1.7)	8	(5.3)	1.770	0.860-3.645	0.12	
Diabetes	no	8903	(98.6)	277	(3.1)	1			0.63
	yes	127	(1.4)	3	(2.4)	0.754	0.238-2.383	0.63	
Mental health disorder	no	8957	(99.2)	271	(3.0)	1			<.0001
	yes	73	(0.8)	9	(12.3)	4.507	2.220-9.151	<.0001	
Other pregnancy complication	no	8087	(89.6)	252	(3.1)	1			0.81
	yes	943	(10.4)	28	(3.0)	0.951	0.640-1.414	0.81	
Hypertensive disorders of pregnancy	no	8751	(96.9)	270	(3.1)	1			0.78
	mild	187	(2.1)	6	(3.2)	1.041	0.458-2.370	0.92	
	severe	92	(1.0)	4	(4.4)	1.428	0.520-3.917	0.49	
Gestational diabetes	no	8819	(97.7)	273	(3.1)	1			0.85
	yes	211	(2.3)	7	(3.3)	1.074	0.501-2.304	0.85	
Other obstetric labor complication	no	5263	(58.3)	143	(2.7)	1			0.01
	yes	3767	(41.7)	137	(3.6)	1.351	1.065-1.715	0.01	

Table 7. Characteristics of subjects and Univariate analysis for Covariates (Information from the follow-up questionnaire; Intimate partner violence and Social capital).

		total (n = 9,030)		13 ≤ K6 (n = 280)		COR	95%CI	P	Wald test
		n	(%)	n	(%)				
<i>Intimate partner violence (IPV)</i>									
Have you ever been insulted or reviled by your partner during the present pregnancy?	no	7856	(87.0)	183	(2.3)	1			<.0001
	yes	1097	(12.1)	94	(8.6)	3.930	3.038-5.083	<.0001	
	no answer	77	(0.9)	3	(3.9)	1.700	0.531-5.442	0.37	
Have you ever been hit or beaten by your partner due to a fight during pregnancy, resulting in injury?	no	8776	(97.2)	250	(2.9)	1			<.0001
	yes	194	(2.1)	29	(15.0)	5.995	3.962-9.071	<.0001	
	no answer	60	(0.7)	1	(1.7)	0.578	0.080-4.189	0.59	
<i>Social capital (SC)</i>									
Are there any contactable people who show love and affection to you?	yes	7898	(87.5)	207	(2.6)	1			<.0001
	no	1035	(11.5)	72	(7.0)	2.778	2.107-3.662	<.0001	
	no answer	97	(1.1)	1	(1.0)	0.387	0.054-2.789	0.35	
Are there any people who mentally support you, such as providing consultation to resolve problems and helping with difficult decision-making?	yes	8131	(90.0)	210	(2.6)	1			<.0001
	no	866	(9.6)	68	(7.9)	3.214	2.422-4.266	<.0001	
	no answer	33	(0.4)	2	(6.1)	2.433	0.579-10.235	0.23	
Do you contact persons who are familiar to you and trustworthy as frequently as you desire?	yes	7667	(84.9)	190	(2.5)	1			<.0001
	no	1327	(14.7)	90	(6.8)	2.863	2.212-3.706	<.0001	
	no answer	36	(0.4)	0	(0.0)	<.0001	<.001> 999.999	0.98	
How many relatives or friends do you have with whom you can freely consult do you have?	≥ 3	5495	(60.9)	107	(2.0)	1			<.0001
	0-2	3518	(39.0)	173	(4.9)	2.604	2.039-3.327	<.0001	
	no answer	17	(0.2)	0	(0.0)	<.001	<.001> 999.999	0.98	

mental health disorders (9,030 subjects), “the adjusted effects” of yogurt, cheese, miso soup, and beans were not significantly associated with the prevalence of psychological distress during the second or third trimester of pregnancy (data not shown).

Discussion

The present cohort study demonstrated that the consumption of yogurt and other fermented foods is not associated with lower prevalence of a K6 score of ≥ 13 in pregnant women. This finding differed from our expectations, based on previous research by Miyake et al. (2015), who reported that a higher intake of yogurt was associated with lower prevalence of depressive symptoms during pregnancy. The difference between our results and those

reported by Miyake et al. (2015) may be attributable to several factors. The study by Miyake et al. (2015) used the Japanese version of the Center for Epidemiologic Studies Depression Scale (Radloff 1977; Shima et al. 1985) to measure the presence of depressive symptoms. Miyake et al. (2015) also recruited participants from Fukuoka City and Okinawa Prefecture on Kyushu, in Japan. Furthermore, data collected during the first trimester, a period corresponding to the peak occurrence of hyperemesis gravidarum (Lacroix et al. 2000), were included in their study, and approximately 34% of the study population was evaluated during this period. Finally, in their study, subjects were categorized into quartile groups, and the prevalence of depressive symptoms among groups was evaluated. By contrast, our study used the Japanese version of K6, which is the

Table 8. Multivariate regression analysis for fermented related foods (Total = 9,030).

		AOR*	95%CI	P
<i>Exposures</i>				
Yogurt (g/day)	< 60	0.997	0.992-1.003	0.41
	≥ 60	1.001	0.999-1.002	0.36
Cheese (g/day)	0	1		
	0 <= 2.5	0.948	0.674-1.334	0.76
	2.5 <= 5	0.706	0.477-1.047	0.08
	> 5	0.989	0.668-1.465	0.96
Miso soup (cup/week)	≤ 2	1		
	3-4	0.817	0.574-1.163	0.26
	5-6	0.743	0.526-1.049	0.09
	≥ 7	0.771	0.542-1.097	0.15
Beans (g/day)	≤ 15	1		
	15 <= 30	0.953	0.662-1.372	0.80
	30 <= 60	0.714	0.485-1.049	0.09
	> 60	0.934	0.637-1.370	0.73
<i>Covariates</i>				
<i>Information from the baseline questionnaire</i>				
Parity	Primipara	1		
	Multipara	1.407	0.660-3.001	0.38
	no answer	1.123	0.594-2.121	0.72
BMI (kg/m ²)	<18.0	0.975	0.687-1.384	0.89
	18.0-25.0	1		
	≥ 25.0	1.263	0.868-1.837	0.22
Marital status	no answer	0.630	0.239-1.662	0.35
	married, common-law marriage (live together)	1		
	married, common-law marriage (live apart)	0.700	0.328-1.496	0.36
	unmarried, divorce, lost	0.978	0.553-1.731	0.94
Number of children	no answer	3.688	1.336-10.179	0.01
	0	1		
	1	0.887	0.424-1.854	0.75
	≥ 2	1.013	0.476-2.155	0.97
Mood after pregnancy is confirmed	no answer	8.578	0.834-88.263	0.07
	happy	1		
	unplanned but happy	1.100	0.814-1.488	0.54
	unplanned and puzzled, troubled, nothing	1.794	1.249-2.576	0.002
History of a mental disorder	no answer	2.688	0.400-18.075	0.31
	no	1		
	yes	3.773	2.729-5.215	<.0001
	no answer	>999.999	<.0001->999.999	0.99

AOR (adjusted odds ratio), CI (confidence interval).

*Adjusted for all the items listed in Table 8, Table 8 (continued-1), and Table 8 (continued-2).

preferred survey for DSM-IV mood or anxiety disorder screening, and we recruited Japanese participants nationwide. Furthermore, we limited the target period of the dietary survey to the second and third trimesters, to eliminate overlap with the period of hyperemesis gravidarum. Finally, the study subjects in our analysis were not categorized.

Nausea and vomiting during pregnancy are reported by 75% of pregnant women and last an average of 35 days. Half of these women experienced relief of these symptoms by 14 weeks, and 90% do so by 22 weeks (Lacroix et al. 2000). The subjects of the study by Miyake et al. (2015)

could not deny the influence of nausea and vomiting on their answers to a comprehensive diet history questionnaire, administered to assess dietary habits during the first trimester of pregnancy. With this in mind, our study used the M-T2 questionnaire to avoid the influence of nausea and vomiting during pregnancy on questionnaire responses, for more accurate accounting of daily food intake.

The findings of the present study may also conflict with expectations based on previous research by Tillisch et al. (2013). The discrepancies between our findings are likely due to the fact that Tillisch et al. (2013) limited their evaluation to fermented milk products and yogurt produced

Table 8. (continued-1) (Total = 9,030).

		AOR*	95%CI	P
<i>Information from the follow-up questionnaire</i>				
Age (years)	≤ 24	1.980	1.308-2.997	0.001
	25-29	1.313	0.948-1.817	0.10
	30-34	1		
	35-39	0.657	0.437-0.989	0.04
	≥ 40	0.860	0.429-1.724	0.67
Academic history	no answer	3.490	0.743-16.392	0.11
	college, university	1		
	senior high school	0.895	0.665-1.205	0.47
	junior high school	0.688	0.412-1.148	0.15
Job type	no answer	1.352	0.331-5.528	0.67
	no	1		
	yes (full time)	0.558	0.394-0.789	0.001
	yes (part time)	0.656	0.465-0.926	0.02
Household income (10 ³ yen/year)	no answer	1.274	0.399-4.072	0.68
	< 4,000	1.016	0.742-1.391	0.92
	4,000 ≤ < 6,000	1		
	≥ 6,000	1.062	0.714-1.580	0.77
IPAQ (mets·min/week)	no answer	0.930	0.517-1.671	0.81
	0	1.535	0.980-2.404	0.06
	0 < <= 350	1.188	0.739-1.911	0.48
	350 < <= 700	1		
	700 < <= 1750	1.107	0.680-1.801	0.68
	> 1750	1.712	1.103-2.658	0.02
Present smoking status	no answer	1.958	1.064-3.601	0.03
	never	1		
	ever	1.082	0.813-1.438	0.59
	smoking	1.088	0.668-1.772	0.73
Present smoking status of husband	no answer	0.567	0.121-2.654	0.47
	never	1		
	ever	0.670	0.449-0.999	0.0496
	smoking	0.932	0.661-1.316	0.69
Secondhand smoking status	no answer	0.912	0.379-2.196	0.84
	no	1		
	yes	1.191	0.894-1.585	0.23
	no answer	1.527	0.192-12.150	0.69

using five *Lactobacillus* strains and our study population was restricted to pregnant women. Different yogurt products contain different strains of *Lactobacillus* and may have differential effects (Bravo et al. 2011; McNulty et al. 2011; Neufeld et al. 2011; Cryan and Dinan 2012; Mohammadi et al. 2016), which could explain the discrepancy in the results. The trade names of the fermented milk and yogurt products consumed by our study participants were not recorded in our survey.

The prevalence of psychological distress during the second or third trimester of pregnancy was 3.1%. This value was lower than precedent studies (Marcus et al. 2003; Andersson et al. 2003; Sutter-Dallay et al. 2004; Bowen and Muhajarine 2006a; Faisal-Cury and Rossi Menezes 2007). The subjects of this survey were limited to only pregnant women that participated in J ECS voluntarily. Thus, a number of cooperative and health conscious pregnant women likely participated in the survey. Therefore, there was some selection bias here.

The limitations of our study include the non-uniformity of food products and brands, the wide variation in bacterial species and strains among the consumed products, even within those of the same type, and the potential inhomogeneity of the study population due to regional variations in dietary culture.

In conclusion, we show no association between psychological distress during the second and third trimester of pregnancy, and the consumption of yogurt, lactic acid beverages, cheese, fermented milk, Japanese pickles, miso soup, fermented soybeans, or beans. However, in light of the study limitations, further studies are needed to confirm our findings.

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Table 8. (continued-2) (Total = 9,030).

		AOR*	95%CI	P
Total energy (kcal/day)	500 ≤ <1200	1.050	0.692-1.595	0.82
	1200 ≤ <1600	0.925	0.643-1.330	0.67
	1600 ≤ < 2000	1		
	2000 < < 5000	1.592	1.119-2.264	0.01
Black tea (cup/day)**	0	1		
	< 1	1.193	0.909-1.566	0.20
	≥ 1	1.486	0.932-2.369	0.10
<i>Occurrence of complications or disease</i>				
Mental health disorder	no	1		
	yes	1.244	0.539-2.871	0.61
Other obstetric labor complication	no	1		
	yes	1.341	1.040-1.728	0.02
<i>Intimate partner violence (IPV)</i>				
Have you ever been insulted or reviled by your partner during the present pregnancy?	no	1		
	yes	2.243	1.646-3.057	<.0001
	no answer	5.745	0.945-34.923	0.06
Have you ever been hit or beaten by your partner due to a fight during pregnancy, resulting in injury?	no	1		
	yes	1.876	1.132-3.107	0.01
	no answer	<.001	<.001->999.999	0.99
<i>Social Capital (SC)</i>				
Are there any contactable people who show love and affection to you?	yes	1		
	no	1.214	0.822-1.769	0.31
	no answer	0.161	0.017-1.487	0.11
Are there any people who mentally support you, such as providing consultation to resolve problems and helping with difficult decision-making?	yes	1		
	no	1.275	0.855-1.902	0.23
	no answer	8.308	1.427-48.364	0.02
Do you contact persons who are familiar to you and trustworthy as frequently as you desire?	yes	1		
	no	1.516	1.094-2.102	0.01
	no answer	<.001	<.001->999.999	0.98
How many relatives or friends do you have with whom you can freely consult do you have?	≥ 3	1		
	0-2	1.814	1.380-2.384	<.0001
	no answer	<.001	<.001->999.999	0.99

**A cup of tea is approximately 120 mL.

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Conflict of Interest

The authors declare no conflict of interest.

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