Dietary patterns during pregnancy and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study

Hitomi Okubo[1,2]*, Yoshihiro Miyake[3], Satoshi Sasaki[1,4], Keiko Tanaka[3], Kentaro Murakami[4], Yoshio Hirota[5] and the Osaka Maternal and Child Health Study Group†

[1]*Department of Social and Preventive Epidemiology, Graduate School of Medicine, The University of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113-0033, Japan*
[2]*Japan Society for the Promotion of Science, Tokyo, Japan*
[3]*Department of Public Health, Faculty of Medicine, Fukuoka University, Fukuoka, Japan*
[4]*Department of Social and Preventive Epidemiology, School of Public Health, The University of Tokyo, Tokyo, Japan*
[5]*Department of Public Health, Osaka City University Graduate School of Medicine, Osaka, Japan*

Abstract

Although several nutrients and foods are suggested to be preventive against postpartum depression, all previous studies have primarily focused on single nutrients or foods. In contrast, studies on dietary patterns, namely the measurement of overall diet by considering the cumulative effects of nutrient, may provide new insights into the influence of diet on postpartum depression. We prospectively examined the association between dietary patterns during pregnancy and the risk of postpartum depression among 865 Japanese women. Diet was assessed with a validated, self-administered diet history questionnaire. Dietary patterns from thirty-three predefined food groups (energy-adjusted food (g/d)) were extracted by factor analysis. Postpartum depression was defined as present when the subjects had an Edinburgh Postnatal Depression Scale score of ≥9 at 2–9 months postpartum. A total of 121 women (14·0 %) were classified as having postpartum depression. Three dietary patterns were identified: 'Healthy', 'Western' and 'Japanese' patterns. After adjustment for potential confounders, neither the 'Healthy' nor the 'Japanese' pattern was related to the risk of postpartum depression. Compared with the first quartile of the 'Western' pattern, only the second quartile was independently related to a decreased risk of postpartum depression (multivariate OR 0·52, 95 % CI 0·30, 0·93), although no evident exposure–response associations were observed (P for trend=0·36). The present study failed to substantiate clear associations between dietary patterns and the risk of postpartum depression. Further studies with more accurate measurements are warranted to confirm the relationship between dietary patterns and the risk of postpartum depression.

Key words: Cohort studies: Dietary patterns: Postpartum depression: Japanese pregnant women

Postpartum depression, a mental and emotional condition that emerges within several weeks after delivery, can exert detrimental effects on maternal, infant and family well-being[1]. Investigation of risk factors for and the treatment of postpartum depression is thus warranted in community health.

As one modifiable risk factor, nutrition has been suggested to play a role in postpartum depression[2,3]. Epidemiological studies have focused primarily on B vitamins (folate, vitamins B_2, B_6 and B_{12})[3–5] and long-chain n-3 PUFA[6–9] on the basis of their role in the biosynthesis, metabolism and function of various hormones and neurotransmitters, but results have not been consistent. One reason for this inconsistency may be the traditional single nutrient- or food-based approach. This dominant approach examines single nutrients or foods but might not adequately account for complicated interactions and cumulative effects and might result in the drawing of erroneous associations between dietary factors and disease.

Recently, the dietary pattern approach, which measures overall diet, has been widely used to elucidate the relationship between diet and several health outcomes[10,11]. Results have suggested the usefulness of this analysis in capturing some of the complexity of diet[12]. To our knowledge, however, the relationship between dietary

patterns and the risk of postpartum depression has not been investigated.

In the present study, we examined the association between dietary patterns during pregnancy and the risk of postpartum depression among 865 Japanese women using data from the Osaka Maternal and Child Health Study (OMCHS). We hypothesised that a dietary pattern high in the main food sources of nutrients, such as B vitamins including folate (from vegetables and fruits) and *n*-3 PUFA (from fish and shellfish), potentially protective against postpartum-depressive symptoms would be associated with a decreased risk of postpartum depression.

Subjects and methods

Study population

Subjects were pregnant women who participated in the OMCHS, a prospective cohort study investigating the preventive and risk factors for maternal and child health problems. The principal objective of the OMCHS is to clarify risk factors for childhood allergic disorders. Details of the OMCHS have been published elsewhere[5,7]. Briefly, a total of 1002 pregnant women in Osaka Prefecture took part in a baseline survey conducted between November 2001 and March 2003, of whom 867 participated in the second survey at 2–9 months postpartum. After excluding two women with missing information on baby's birth weight, the final analysis comprised 865 women. The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects/patients were approved by the ethics committee of the Osaka City University School of Medicine. Written informed consent was obtained from all subjects/patients.

Measurements

At the baseline survey, each participant filled out a set of two self-administered questionnaires. A third self-administered questionnaire was additionally answered in the second survey. Participants mailed these completed questionnaires to the data management centre at the time of each survey. Research technicians completed missing or illogical data by telephone interview.

In the baseline survey, we collected information on dietary habits during the preceding month using a validated, self-administered, comprehensive, dietary history questionnaire (DHQ)[13,14]. Estimates of daily intake for 150 food and beverage items, energy and nutrients were calculated using an *ad hoc* computer algorithm for the DHQ, which was based on the Standard Tables of Food Composition in Japan[15,16]. According to similar nutrient profiles and culinary usage of the food items, 145 food items of the DHQ, excluding five

items (cornflakes, nutritional supplement bars, Japanese-style pancakes, noodle soup and drinking-water), were grouped into thirty-three predefined food groups by adding food items within each group to extract dietary patterns[17]. Information on dietary supplements was not used in the calculation of dietary intake because of a lack of a reliable composition table in Japan. A more detailed description of the methods used to calculate dietary intake and the validity of the DHQ has been published elsewhere[13,14].

Another self-administered questionnaire at the baseline survey inquired about age, gestation, parity, smoking habits, family structure, occupation, family income, education, weight, height and changes in diet in the previous 1 month. BMI was calculated by dividing self-reported body weight (kg) by the square of self-reported height (m²).

The self-administered questionnaire in the second survey included the Japanese version[18] of the Edinburgh Postnatal Depression Scale[19,20], a ten-item self-reported scale designed to screen for postpartum depression in community samples. Each item is scored on a four-point scale (from 0 to 3), giving a total score range of 0–30. The scale rates the intensity of depressive symptoms present within the preceding 7 d. Although a cut-off of 9/10 has been proposed to identify postpartum-depressive symptoms[19], a cut-off of 8/9 was found to detect depression among Japanese women with a specificity of 93 % and a sensitivity of 75 %[18]. Postpartum depression in the present study was therefore defined as present when the Edinburgh Postnatal Depression Scale score was ≥9. The questionnaire also elicited information on medical problems in pregnancy as well as on the sex, birth weight and date of birth of the infant born after the baseline survey.

Statistical analysis

All statistical analyses were performed using Statistical Analysis Systems statistical software version 9.1 (SAS Institute, Inc., Cary, NC, USA).

Factor analysis to derive dietary patterns based on the thirty-three predefined food groups from the DHQ was conducted using the FACTOR PROCEDURE of the SAS software. Intakes of these food groups (g food/d) were adjusted for total energy intake using the residual method[21]. The number of factors was determined by scree plots and the combination of foods on the factors. A factor solution with three factors was found to be reasonable and meaningful. The proportion of variance explained by each factor was calculated by dividing the sum of the squares of the respective factor loadings by the number of variables. The factor score for each dietary pattern was calculated by summing the intakes of food groups weighted by their factor loadings[22], with each subject receiving a factor score for each identified pattern. We used these scores to rank the subjects according to the

degree to which they conformed to the dietary pattern. All data presented in the present study are from the Varimax rotation. The validity of dietary patterns derived from the DHQ has been reported previously[17].

Pearson's correlation coefficients were calculated between each score for dietary pattern and energy-adjusted nutrients such as B vitamins (vitamins B_2, B_6, B_{12} and folate) and n-3 PUFA (total n-3 PUFA, EPA and DHA). To compare the risk of postpartum depression, scores for each dietary pattern were categorised into quartiles based on the distribution of the study participants. The first quartile of each dietary pattern was used as a reference category. Logistic regression analysis was used to estimate both crude and multivariate ratios (OR) and 95 % CI of postpartum depression (the dependent variable) for each quartile category of dietary pattern (independent variables). Multivariate OR were calculated by adjusting for potential confounding factors[5,7], including age (years, continuous), gestation (weeks, continuous), parity (0 and ≥1), cigarette smoking (never, former and current), change in diet in the preceding 1 month (none or seldom, slight and substantial), family structure (nuclear and expanded), occupation (outside work and housewife), family income (<4 000 000, 4 000 000–5 999 999 and ≥6 000 000 ¥/year), education (<13, 13–14 and ≥15 years), season when data at the baseline survey were collected (spring, summer, autumn and winter), BMI (kg/m², continuous), time of delivery before the second survey (<4 and ≥4 months), medical problems in pregnancy (yes and no), baby's sex (male and female) and baby's birth weight (g, continuous). Trends of association were assessed by a logistic regression model assigning consecutive integers (1–4) to the levels of the independent variables. Possible interactions between dietary patterns and several characteristics were also examined in the multivariate model. All reported P values were two-tailed, and a P value of <0·05 was considered to be statistically significant.

Results

The subjects' characteristics are listed in Table 1. Of the 865 women, 591 (68·4 %) took part in the baseline survey by the 20th week of gestation. A total of 121 subjects (14·0 %) were classified as having postpartum depression.

Three dietary patterns were identified. The factor-loading matrices for each dietary pattern are shown in Table 2. Factor 1, which loaded heavily on green and yellow vegetables, seaweeds, white vegetables, potatoes, fish, fruits, shellfish and sea products, was labelled the 'Healthy' pattern. Factor 2, with high loadings for vegetable oil, beef and pork, salt-containing seasonings, processed meat, chicken and eggs, was labelled the 'Western' pattern. Factor 3, with high loadings for rice, miso soup, sea products, fish and pickled vegetables, was labelled the 'Japanese' pattern. Overall, the three dietary patterns

accounted for 22·1 % of the overall variance in food intake. The Pearson correlation coefficients between each dietary pattern and nutrients, such as B vitamins (vitamins B_2, B_6, B_{12} and folate) and n-3 PUFA (total n-3 PUFA, EPA and DHA), potentially protective against postpartum-depressive symptoms were examined. The 'Healthy' pattern was significantly correlated with the intake of vitamin B_2 (r 0·42), vitamin B_6 (r 0·71), vitamin B_{12} (r 0·48), folate (r 0·69), total n-3 PUFA (r 0·26), DHA (r 0·40) and EPA (r 0·42). The 'Western' pattern was significantly correlated with the intake of total n-3 PUFA (r 0·51). In contrast, the 'Japanese' pattern was significantly correlated with the intake of total n-3 PUFA (r 0·33), DHA (r 0·46) and EPA (r 0·48).

Crude and multivariate OR (95 % CI) for postpartum depression across quartiles of all three dietary patterns are shown in Table 3. No association was observed

Table 1. Characteristics of 865 Japanese women who participated in the Osaka Maternal and Child Health Study, Japan

(Mean values and standard deviations or percentages)

Variable	All (n 865)	
	Mean	SD
Baseline characteristics		
Age (years)	29·9	4·0
BMI (kg/m²)	21·5	2·8
Gestation (weeks)	18·0	6·8
Parity of 1 or more (%)	50·9	
Cigarette smoking (%)		
Never	71·6	
Former	11·8	
Current	16·7	
Changes in diet in the previous 1 month (%)		
None or seldom	28·8	
Slight	44·3	
Substantial	26·9	
Nuclear family structure (%)	87·3	
Occupation (%)		
Outside work	29·0	
Housewife	71·0	
Family income (¥/year, %)		
< 4 000 000	28·9	
4 000 000–5 999 999	39·9	
≥ 6 000 000	31·2	
Education (years, %)		
< 13	29·7	
13–14	42·4	
≥ 15	27·9	
Season when data were collected (%)		
Spring	32·1	
Summer	16·4	
Autumn	22·0	
Winter	29·5	
Characteristics at the postnatal assessment		
Postpartum depression (%)*	14·0	
Time of delivery before the assessment (months, %)		
< 4	50·4	
≥ 4	49·6	
Medical problems in pregnancy (%)†	7·9	
Baby's sex (male, %)	52·3	
Baby's birth wt (g)	3069	414

* Defined according to the Edinburgh Postnatal Depression Scale score of ≥9[18].
† Hyperemesis, hydramnios, oligoamnios, gestosis, abruptio placenta, placenta previa or incompetent cervical os.

Table 2. Factor-loading matrix for the major dietary patterns identified from a self-administered diet history questionnaire among 865 Japanese women who participated in the Osaka Maternal and Child Health Study, Japan

	Factor 1 (Healthy)	Factor 2 (Western)	Factor 3 (Japanese)
Food group			
Green and yellow vegetables	0·70*	0·15	0·00
Seaweeds	0·62*	0·01	0·15
White vegetables	0·61*	0·33*	0·01
Mushrooms	0·61*	0·03	0·07
Pulses	0·58*	0·09	0·19
Potatoes	0·46*	−0·02	0·12
Fish	0·39*	−0·05	0·36*
Fruits	0·37*	−0·33*	−0·05
Shellfish	0·27*	−0·01	0·21
Sugar	0·10	0·06	0·01
Alcoholic beverages	−0·11	0·11	0·05
Noodles	−0·17	−0·07	0·12
Soft drinks	−0·34*	−0·29*	0·02
Vegetable oil	−0·10	0·57*	0·03
Beef and pork	0·03	0·55*	0·05
Salt-containing seasonings	0·21	0·53*	0·11
Processed meat	−0·08	0·42*	−0·01
Chicken	0·15	0·42*	0·07
Eggs	0·04	0·39*	0·03
Butter	0·04	0·21	−0·12
Japanese and Chinese tea	0·03	0·15	0·12
Tea	−0·04	−0·06	−0·01
Nuts	0·20	−0·21	−0·13
Fruit and vegetable juice	−0·04	−0·24	0·03
Rice	−0·12	−0·05	0·68*
Miso soup	0·12	−0·10	0·55*
Sea products	0·32*	0·02	0·42*
Pickled vegetables	0·13	0·03	0·27*
Other soup	0·02	0·07	0·11
Coffee and cocoa	0·00	0·10	−0·11
Dairy products	0·23	−0·06	−0·32*
Confectioneries	−0·28*	−0·34*	−0·45*
Bread	−0·06	−0·15	−0·65*
Variation explained (%)	9·4	6·4	6·3

* Absolute values < −0·25 or >0·25.

between the 'Healthy' pattern and the risk of postpartum depression. Compared with the first quartile of the 'Western' pattern, only the second quartile of this pattern was significantly associated with a decreased risk of postpartum depression. This association remained significant after adjustment for possible confounding factors, albeit with slight attenuation (multivariate OR 0·52, 95 % CI 0·30, 0·93). Compared with the first quartile of the 'Japanese' pattern, only the second quartile of this pattern was associated with a lower risk of postpartum depression, but the association disappeared after adjustment for possible confounding factors (multivariate OR 0·56, 95 % CI 0·30, 1·02).

Discussion

The primary aim of the present study was to investigate the relationship between dietary patterns during pregnancy and the risk of postpartum depression. We hypothesised that a dietary pattern high in the main food sources of nutrients, such as B vitamins including folate (from vegetables and fruits) and marine-originated *n*-3 PUFA (from fish and shellfish), potentially protective against postpartum-depressive symptoms would be related to a decreased risk of postpartum depression[23,24]. In the present study, we found the fact that the 'Healthy' pattern, characterised by a high intake of green and yellow vegetables, seaweeds, white vegetables, potatoes, fish, fruits, shellfish and sea products, was significantly correlated with the intake of vitamins B_2, B_6, B_{12}, folate, total *n*-3 PUFA, DHA and EPA. However, no evident association was observed between the 'Healthy' pattern and the risk of postpartum depression in the present study. Furthermore, our previous examination of the relationship between postpartum depression and dietary intake at the food[7] and nutrient levels[5] among the same subjects also showed no clear inverse relationships between the intake of fish, *n*-3 PUFA, folate and B vitamins and the risk of postpartum depression[5,7]. In the present study of Japanese women, we could not substantiate evident exposure–response associations between dietary patterns and the risk of postpartum depression regardless of the consideration of the cumulative effects of possibly protective nutrients, although only the second quartile of the 'Western' pattern was associated with the lower risk of postpartum depression.

To our knowledge, this is the first study to examine the relationship between dietary patterns and the risk of postpartum depression. To date, however, only three studies have examined the relationship of dietary pattern with depression among general populations[25–27]. In a large British middle-aged population[25], a 'whole food' pattern (vegetables, fruits and fish) was associated with a lower risk of 5 years latter depressive symptoms, whereas a 'processed food' pattern (sweetened desserts, fried food, processed meat, refined grains and high-fat dairy products) was associated with a higher risk. Similar findings were also observed in the Traditional dietary pattern and the Western pattern among Australian women[26]. In a study of participants in the SUN Project[27], higher adherence to the Mediterranean dietary pattern, characterised by high intakes of vegetables, fruit and nuts, cereal, legumes and fish, a high ratio of MUFA:SFA, moderate alcohol, a low intake of meat products and whole-fat dairy products, was associated with a lower risk of the incidence of clinical depression. The present findings are at variance with these previous studies. The reason for this inconsistency is unknown, but pathophysiological differences such as the drastic change in hormonal level throughout pregnancy and increasing overall nutrient requirements of pregnant women might be related[3,28].

Several limitations of the present study warrant mention. First, the diagnosis of postpartum depression was established by a self-report rating scale (i.e. Edinburgh Postnatal Depression Scale) rather than by

Table 3. Crude and multivariate odds ratios (95 % CI) for postpartum depression according to the quartile of dietary pattern scores among 865 Japanese women who participated in the Osaka Maternal and Child Health Study, Japan

(Odds ratios and 95 % confidence intervals)

| | Quartile of dietary pattern | | | | | | | | |
| | 1 (n 216) | 2 (n 216) | | 3 (n 217) | | 4 (n 216) | | |
Variable	OR	OR	95 % CI	OR	95 % CI	OR	95 % CI	P for trend
Factor 1 (Healthy)								
n with postpartum depression	30	25		38		28		
Crude	1·00	0·81	0·46, 1·43	1·32	0·78, 2·22	0·92	0·53, 1·61	0·76
Multivariate*	1·00	0·82	0·46, 1·47	1·49	0·86, 2·60	0·94	0·52, 1·69	0·72
Factor 2 (Western)								
n with postpartum depression	40	22		29		30		
Crude	1·00	0·50	0·29, 0·87	0·68	0·40, 1·14	0·71	0·42, 1·19	0·31
Multivariate*	1·00	0·52	0·30, 0·93	0·71	0·41, 1·20	0·73	0·42, 1·24	0·36
Factor 3 (Japanese)								
n with postpartum depression	34	20		35		32		
Crude	1·00	0·55	0·30, 0·98	1·03	0·62, 1·72	0·93	0·55, 1·57	0·70
Multivariate*	1·00	0·56	0·30, 1·02	1·14	0·66, 1·96	0·96	0·56, 1·64	0·59

* The multivariate models included the following: age (years, continuous), gestation (weeks, continuous), parity (0 and ≥1), cigarette smoking (never, former and current), change in diet in the preceding 1 month (none or seldom, slight and substantial), family structure (nuclear and expanded), occupation (outside work and housewife), family income (<4 000 000, 4 000 000–5 999 999 and ≥6 000 000 ¥/year), education (<13, 13–14 and ≥15 years), season in which data at baseline survey were collected (spring, summer, autumn and winter), BMI (kg/m², continuous), time of delivery before the second survey (<4 and ≥4 months), medical problems in pregnancy (yes and no), baby's sex (male and female) and baby's birth weight (g, continuous).

a clinician-administered structured diagnostic interview. The Edinburgh Postnatal Depression Scale was originally designed as a screening test for depressive symptoms within the previous 7 d. Moreover, the second survey for the assessment of postpartum-depressive symptoms was conducted at 2–9 months postpartum. However, almost all subjects (89·2 %) took part in the second survey at 3–4 months postpartum. Therefore, accurate estimation of the incidence and prevalence of post-partum depression might not be obtained due to the limited assessment period.

Second, dietary data were obtained using a self-administered diet history questionnaire. Although the validity and reliability of our dietary questionnaire have been evaluated[13,14,17], non-differential misclassification might also exist in dietary exposures, and this may bias the magnitude of the observed effects towards null. More-over, our dietary questionnaire was designed to assess the recent diet, namely the preceding 1 month before complet-ing the questionnaire, rather than throughout pregnancy. However, previous longitudinal studies have reported that dietary patterns do not vary significantly through-out pregnancy[29,30]. We also assessed a change in diet during the assessment period to account for the possibility that the diet was changed due to reasons such as hyper-emesis gravidarum. We found no significant interaction between changes in diet in the past month and the dietary patterns under investigation in relation to postpartum depression (data not shown). Potential misclassification associated with variability across subjects with regard to the stability of diet during pregnancy is thus likely to be negligible. The negative findings of the present study are therefore unlikely to be ascribable to dietary assessment during pregnancy.

Third, because of a lack of information on taking anti-depressant medication, we could not control for taking anti-depressant medication. In addition, although we attempted to adjust for a number of potential confounding variables, unknown or poorly measured confounders could not be controlled. In particular, we could not control for personal and family psychiatric history, sociocultural factors or personal and family relationships because of a lack of information.

Fourth, the study subjects were not a representative sample of Japanese women in the general population, and the present findings might not be generalised, although the relatively high follow-up rate (86·3 %) mini-mised the possibility of bias by loss of follow-up. Finally, because our sample size was relatively small, statistical power may have been insufficient to allow detection of the association between dietary patterns and postpartum depression.

In conclusion, this prospective study in Japanese women failed to substantiate clear exposure–response relationships of dietary patterns with the subsequent risk of postpartum depression, although the second quartile of the 'Western' pattern was associated with a lower risk of postpartum depression. Further large-scale pro-spective studies are needed to confirm the relationship between dietary patterns and the risk of postpartum depression, given the paucity of evidence on this issue.

Acknowledgements

References

1. Horowitz JA & Goodman JH (2005) Identifying and treating postpartum depression. *J Obstet Gynecol Neonatal Nurs* **34**, 264–273.

2. Bodnar LM & Wisner KL (2005) Nutrition and depression: implications for improving mental health among child-bearing-aged women. *Biol Psychiatry* **58**, 679–685.

3. Leung BM & Kaplan BJ (2009) Perinatal depression: prevalence, risks, and the nutrition link – a review of the literature. *J Am Diet Assoc* **109**, 1566–1575.

4. Livingston JE, MacLeod PM & Applegarth DA (1978) Vitamin B$_6$ status in women with postpartum depression. *Am J Clin Nutr* **31**, 886–891.

5. Miyake Y, Sasaki S, Tanaka K, *et al.* (2006) Dietary folate and vitamins B$_{12}$, B$_6$, and B$_2$ intake and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. *J Affect Disord* **96**, 133–138.

6. Doornbos B, van Goor SA, Dijck-Brouwer DA, *et al.* (2009) Supplementation of a low dose of DHA or DHA + AA does not prevent peripartum depressive symptoms in a small population based sample. *Prog Neuropsychopharmacol Biol Psychiatry* **33**, 49–52.

7. Miyake Y, Sasaki S, Yokoyama T, *et al.* (2006) Risk of postpartum depression in relation to dietary fish and fat intake in Japan: the Osaka Maternal and Child Health Study. *Psychol Med* **36**, 1727–1735.

8. Otto SJ, de Groot RH & Hornstra G (2003) Increased risk of postpartum depressive symptoms is associated with slower normalization after pregnancy of the functional docosahexaenoic acid status. *Prostaglandins Leukot Essent Fatty Acids* **69**, 237–243.

9. Strom M, Mortensen EL, Halldorsson TI, *et al.* (2009) Fish and long-chain *n*-3 polyunsaturated fatty acid intakes during pregnancy and risk of postpartum depression: a prospective study based on a large national birth cohort. *Am J Clin Nutr* **90**, 149–155.

10. Kant AK (2004) Dietary patterns and health outcomes. *J Am Diet Assoc* **104**, 615–635.

11. Newby PK & Tucker KL (2004) Empirically derived eating patterns using factor or cluster analysis: a review. *Nutr Rev* **62**, 177–203.

12. Moeller SM, Reedy J, Millen AE, *et al.* (2007) Dietary patterns: challenges and opportunities in dietary patterns research an Experimental Biology workshop, April 1, 2006. *J Am Diet Assoc* **107**, 1233–1239.

13. Sasaki S, Ushio F, Amano K, *et al.* (2000) Serum biomarker-based validation of a self-administered diet history questionnaire for Japanese subjects. *J Nutr Sci Vitaminol* **46**, 285–296.

14. Sasaki S, Yanagibori R & Amano K (1998) Self-administered diet history questionnaire developed for health education: a relative validation of the test-version by comparison with 3-day diet record in women. *J Epidemiol* **8**, 203–215.

15. Science and Technology Agency (2005) *Standard Tables of Food Composition in Japan (in Japanese)*, 5th rev ed. Tokyo: Printing Bureau of the Ministry of Finance.

16. Science and Technology Agency (2005) *Standard Tables of Food Composition in Japan: Fatty Acid Section (in Japanese)*, 5th rev and enlarged ed. Tokyo: Printing Bureau of the Ministry of Finance.

17. Okubo H, Murakami K, Sasaki S, *et al.* (2010) Relative validity of dietary patterns derived from a self-administered diet history questionnaire using factor analysis among Japanese adults. *Public Health Nutr* **13**, 1080–1089.

18. Okano T, Murata M, Masuji F, *et al.* (1996) Validation and reliability of Japanese version of the EPDS. *Arch Psychiatr Diag Clin Eval* **7**, 525–533 (in Japanese).

19. Cox J (1987) Origins and development of the 10 item Edinburgh Depression Scale. In *Perinatal Psychiatry: Use and Misuse of the Edinburgh Postnatal Depression Scale*, pp. 115–124 [J Cox and J Holden, editors]. London: Gaskell.

20. Cox JL, Holden JM & Sagovsky R (1987) Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* **150**, 782–786.

21. Willett W & Stampfer MJ (1986) Total energy intake: implications for epidemiologic analyses. *Am J Epidemiol* **124**, 17–27.

22. Kim JO & Mueller CW (1978) *Factor Analysis: Statistical Methods and Practical Issues*. Thousand Oaks, CA: Sage Publications, Inc.

23. Hibbeln JR (1998) Fish consumption and major depression. *Lancet* **351**, 1213.

24. Hibbeln JR (2002) Seafood consumption, the DHA content of mothers' milk and prevalence rates of postpartum depression: a cross-national, ecological analysis. *J Affect Disord* **69**, 15–29.

25. Akbaraly TN, Brunner EJ, Ferrie JE, *et al.* (2009) Dietary pattern and depressive symptoms in middle age. *Br J Psychiatry* **195**, 408–413.

26. Jacka FN, Pasco JA, Mykletun A, *et al.* (2010) Association of Western and traditional diets with depression and anxiety in women. *Am J Psychiatry* **167**, 305–311.

27. Sanchez-Villegas A, Bes-Rastrollo M, Martinez-Gonzalez MA, *et al.* (2006) Adherence to a Mediterranean dietary pattern and weight gain in a follow-up study: the SUN cohort. *Int J Obes (Lond)* **30**, 350–358.

28. Jenkins DJA, Wolever TMS, Taylor RH, *et al.* (2003) Endocrine factors and postpartum depression. A selected review. *J Reprod Med* **48**, 402–408.

29. Crozier SR, Robinson SM, Godfrey KM, *et al.* (2009) Women's dietary patterns change little from before to during pregnancy. *J Nutr* **139**, 1956–1963.

30. Cuco G, Fernandez-Ballart J, Sala J, *et al.* (2006) Dietary patterns and associated lifestyles in preconception, pregnancy and postpartum. *Eur J Clin Nutr* **60**, 364–371.

Appendix

Space limitations preclude the inclusion as authors of the following members of the OMCHS Group: Hideharu Kanzaki, Mitsuyoshi Kitada (Department of Obstetrics and Gynecology, Kansai Medical University); Yorihiko Horikoshi (Department of Obstetrics and Gynecology, Kansai Medical University Kori); Osamu Ishiko, Yuichiro Nakai, Junko Nishio, Seiichi Yamamasu (Department of Obstetrics and Gynecology, Osaka City University Graduate School of Medicine); Jinsuke Yasuda (Department of Obstetrics and Gynecology, Matsushita Memorial Hospital); Seigo Kawai (Department of Obstetrics and Gynecology, Hoshigaoka Koseinenkin Hospital); Kazumi Yanagihara (Yanagihara Clinic); Koji Wakuda (Department of Obstetrics and Gynecology, Fujimoto Hospital); Tokio Kawashima (Kyohritsu Women's Clinic); Katsuhiko Narimoto (Ishida Hospital Obstetrics, Gynecology); Yoshihiko Iwasa (Iwasa Women's Clinic); Katsuhiko Orino (Orino Lady's Clinic); Itsuo Tsunetoh (Tsunetoh Obstetrics and Gynecology); Junichi Yoshida (Yoshida Clinic); Junichi Iito (Iito Obstetrics and Gynecology Clinic); Takuzi Kaneko (Kaneko Sanfujinka); Takao Kamiya (Kamiya Ladies Clinic); Hiroyuki Kuribayashi (Kuribayashi Clinic); Takeshi Taniguchi (Taniguchi Hospital); Hideo Takemura (Kosaka Women's Hospital); Yasuhiko Morimoto (Aizenbashi Hospital); Ichiro Matsunaga, Hajime Oda (Osaka Prefectural Institute of Public Health); Yukihiro Ohya (Division of Allergy, Department of Medical Specialties, National Center for Child Health and Development).