



Applied nutritional investigation

Dietary patterns and their effects on postpartum weight retention of lactating women in south central China

Zhi Huang M.S.^a, Neng Li B.S.^b, Yu-Ming Hu^{c,*}^a Human University of Medicine, Huaihua, China^b Huaihua Maternal and Child Health Care Hospital, Huaihua, China^c Department of Toxicology, Hunan Provincial Center for Disease Control and Prevention Changsha, China

ARTICLE INFO

Article History:

Received 21 March 2019

Received in revised form 22 June 2019

Accepted 2 July 2019

Keywords:

Dietary patterns

Lactating women

Postpartum weight retention

Obesity

Principal component analysis.

ABSTRACT

Objectives: Postpartum weight retention is a short- and long-term risk factor for overweight and obesity in women. The aim of this study was to evaluate dietary patterns and their effects on postpartum weight retention among lactating women in south central China.

Methods: The study included 305 lactating women. A 24-h recall method on 3 consecutive d was used to collect dietary information. Furthermore, principal component analysis was performed to explore the main dietary patterns. The association between the postpartum weight retention and dietary patterns was assessed using a general linear regression model.

Results: Two food patterns were obtained. Lactating women with dietary pattern 1 mainly ate red meat, coarse cereals, and fresh vegetables (leafy). Those with dietary pattern 2 mainly ate fresh vegetables (non-leafy), soy milk, and bacteria and algae. The mean energy, protein, fat, and carbohydrate intakes of the highest quartile (Q4) of both patterns exceeded the Chinese Recommended Nutrient Intake, whereas the calcium, selenium, vitamin A, B₁, and C nutrient intakes in the highest quartile (Q4) of both patterns were lower than recommended. Dietary pattern 2 (B = −0.523, 95% confidence interval, −0.948 to −0.099) was negatively associated with postpartum weight retention.

Conclusions: This study identified two dietary patterns among lactating women in south central China. A diet characterized by high intake of fresh vegetables (non-leafy), soy milk, and bacteria and algae was negatively associated with postpartum weight retention.

© 2019 Elsevier Inc. All rights reserved.

Introduction

Overweight and obesity have become a worldwide health problem. Globally, 39% of adults are overweight, and 13% are obese [1]. Postpartum weight retention is a short- and long-term risk factor for overweight and obesity in women [2,3]. An study in the United States reported that nearly 33% of women with normal prepregnancy weight were overweight or obese 1 y after childbirth [4]. In China, the prevalence of postpartum weight retention was 41.5% [5]. Recent studies reported that postpartum weight retention may be associated with the incidence of diabetes, heart disease, and hypertension [6,7].

ZH conceived of the research idea, collected the data, performed the statistical analyses, and drafted the manuscript. YH provided critical review of the manuscript. ZH and NL participated in data acquisition. All authors approved the final version. The authors have no conflicts of interest to declare.

* Corresponding author Tel.: 13973112859

E-mail address: weijianzhige@sina.com (Y.-M. Hu).

Most studies have found that the main reason for postpartum weight retention was gestational weight gain [8,9]. Many studies have confirmed that dietary intake is associated with weight gain [10,11]. Lactation is a critical period for nutritional needs. Nutritional requirements increase not only to support infant growth and development but also to promote maternal postpartum recovery [12,13]. Intake of nutrients during this critical period may have an important effect on maternal weight [8].

However, most nutrition research examining lactating women has focused on individual nutrients or foods [14–16]. The diets of lactating women contain many nutrient sources. An understanding of the potential interactions among many nutrients and foods requires dietary pattern analysis, a method based on the complex source of the diet and the total dietary consumption. It is a popular analytical method for assessing associations between diets and their effect on health [17,18].

Recent studies have shown that the dietary patterns of lactating mothers affects the intake of nutrients and the fatty acid profile of breast milk [19]. However, those studies did not clarify the effect

of dietary patterns on postpartum weight retention in mothers. Therefore, this study evaluated dietary patterns and their effects on postpartum weight retention among lactating women in south central China, which could provide more data to determine the optimal way to reduce overweight and obesity in women.

Methods

Study population

This cross-sectional survey was conducted in Hunan Province, south central China, from July 2011 to July 2012. The study recruited mothers and their children using a multistage sampling technique. We first chose two counties and then randomly chose five residential villages or communities in each county. Next, 30 to 35 lactating women were selected randomly in each village or community through the local maternal and children's health system. The eligibility criteria were as follows: 18 to 40 y of age, lactation period within 1 y, persistent breastfeeding, healthy according to self-evaluation, and no smoking. The study enrolled 305 lactating women. All participants gave informed consent, and the study procedure was approved by the ethics committee of the Hunan Provincial Center for Disease Control and Prevention.

Dietary assessment

Dietary information was collected using a 24-h recall method on 3 consecutive d. Participants were asked to recall their detailed food intake and the estimated portion sizes over the previous 3 consecutive d using local weight units (1 Liang = 50 g). This identified 246 types of food. Subsequently, food intake was subdivided into 23 food groups based on their nutrient similarity and the Chinese Food Composition standards. The 23 food groups were rice, wheat noodles, wheat flour, coarse cereals, cakes, cookies and pastries, starchy roots and tubers, dried legumes, fresh legumes, nuts and seeds, fresh vegetables (non-leafy), fresh vegetables (leafy), dried and pickled vegetables, bacteria and algae, fruit, red meat, organ meats, poultry, eggs, fish and shellfish, soy milk, animal milk, candy and fast foods, and beverages (Table 1). The questionnaires used to collect dietary data were implemented in interviews by trained investigators.

Dietary pattern analysis was used to identify explanatory factors for the 23 food groups using principal component analysis (PCA). The number of dietary patterns was identified based on the eigenvalue (>1) and screen plot, factor interpretability, and variance explained [20]. Factor loadings are equivalent to the correlation between food items and factors. Food with factor loadings $>|0.2|$ were

considered to contribute significantly to the identified factors. The pattern-specific factor scores, which represent the sum of the intakes of the food groups weighted by their factor loadings, were calculated. The factor scores were categorized into four quartiles based on their contribution to each pattern, where the first (Q1) and fourth (Q4) quartiles represented the intake of food weakly and strongly related to the dietary pattern, respectively. Nutrient intakes were analyzed using dietary analysis software (SY2.05) based on the nutrition composition of Chinese food.

Anthropometric measurements

Prepregnancy weight, weight before delivery, and current body weight were recorded in kilograms. The prepregnancy weight and weight before delivery were obtained from the mothers' Maternal Health Handbooks. Current body weight was measured without shoes using an electronic scale. Gestational weight gain was calculated as the weight before delivery minus the prepregnancy weight. Postpartum weight retention was calculated as the current body weight minus the prepregnancy weight.

Other related variables

Information on sociodemographic factors collected included each lactating woman's age, lactation period, delivery mode (normal, forceps delivery, or cesarean delivery), educational level (junior high school and below, senior high school, or college and above), occupation (housework and others), and family economic status (low, middle, or high).

Statistical analysis

EpiData software 3.1 was used to build a database. The analyses were performed using SPSS version 13 (SPSS Inc., Chicago, IL, USA). The variables were categorized according to quartiles of the dietary pattern scores. The mean (SD) across the four quartiles was used to express the values of normally distributed data, and the median (25th and 75th percentiles) to express skewed data. Significant differences between the dietary patterns across the four quartiles were assessed by variance analysis for continuous variables with normal distributions or it will be assessed by the Kruskal–Wallis test, and χ^2 test for categorical variables. The association between the postpartum weight retention and dietary patterns was assessed using a general linear regression model and adjusted for the lactation period in model 1. Model 2 also adjusted for the gestational weight gain. Model 3, the final model, was adjusted for age, occupation, education, family economic level, and delivery mode. $P < 0.05$ was considered statistically significant.

Results

From the 305 lactating women with dietary data, factor analysis obtained two food patterns. Table 2 shows the factor loadings of the two patterns. Lactating women with dietary pattern 1

Table 1
Food grouping used in the dietary pattern analyses

Food groups	Food items
Rice	Rice, rice flour, rice porridge
Wheat noodles	Wheat noodles
Wheat flour	Wheat flour, steamed buns, fried sticks, dumplings, wheat meal, breads
Coarse cereals	Maize, millet
Cakes, cookies, and pastries	Cookies, moon cake, cake
Starchy roots and tubers	Potato, yam, taro, lotus root, cassava
Dried legumes	Soybean flour, dried beans, tofu, tofu products
Fresh legumes	French bean, bean sprouts, sword bean
Nuts and seeds	Sesame, watermelon, pumpkin, sunflower, lotus seeds, peanuts, walnuts, pine nuts
Fresh vegetables, non-leafy	Loofah, cucumber, pumpkin, pepper, white gourd, bitter melon, radish, carrot, tomato, eggplant
Fresh vegetables, leafy	Water spinach, cabbage, day lily, leeks, lettuce
Dried and pickled vegetables	Dried vegetables, salted vegetables, Chinese sauerkraut
Bacteria algae	Kelp, seaweed, mushroom, shiitakes, enoki
Fruits	Apple, banana, grape, watermelon, pear, orange, date, cantaloupe, longan, pomegranate and et al.
Red meat	Beef, lamb, pork and pork products
Organ meats	Liver, kidney, large intestine, blood
Poultry	Chicken, duck, goose
Egg	Duck eggs, chicken eggs
Fish and shellfish	Fish, shrimp, shellfish, crab
Soy milk	Soy milk
Animal milk	Milk, goat's milk, dairy products
Candy and fast foods	Chocolate, honey, sugar, candies, mixed congee, instant noodles, potato chips
Beverages	Coca-Cola, Sprite, fruit and vegetable drinks, fruit juice, tea, grape wine, sweet wine

Table 2
Factor loadings for dietary pattern

Food items	Dietary pattern 1	Dietary pattern 2
Rice	-0.384	0.237
Wheat noodles		
Wheat flour		0.352
Coarse cereals	0.511	
Cake, cookies, and pastries	0.415	
Starchy root and tubers	0.433	
Dried legumes		0.371
Fresh legumes		0.421
Nuts and seed	0.253	-0.207
Fresh vegetable, non-leafy		0.701
Fresh vegetable, leafy	0.441	
Dried and pickle vegetables		
Fruit		0.307
Red meat	0.609	0.203
Organs meat		
Poultry	0.287	-0.260
Egg	0.396	
Fish and shellfish		0.227
Soy milk	-0.414	0.443
Animal milk	0.430	
Bacteria algae	0.314	0.425
Candy and fast food		-0.241
Beverage		

(eigenvalue = 2.23) mainly ate red meat, coarse cereals, fresh vegetables (leafy), starchy roots and tubers, animal milk, cakes, cookies, and pastries, and they consumed less soy milk and rice. Those with dietary pattern 2 (eigenvalue = 1.86) mainly ate fresh vegetables (non-leafy), soymilk, bacteria and algae, and fresh legumes, and they consumed less poultry, candy and fast food, and nuts and seeds. The two factors explained 17.77% of the variance in intake.

Table 3 shows the demographic characteristics of the lactating women according to quartiles for the two dietary patterns. The lactating women had a mean age of 25 y (range 23–28 y) and a lactation period of 96 d (range 30–188 d). More than half had an educational level of junior high school and below (51.15%), reported housework (66.23%) as their occupation, and had a male child (54.75%). Slightly less than half (48.52%) had a cesarean delivery, and 35.41% came from middle-income households. The mothers with higher scores for dietary pattern 1 were had a shorter lactation period, higher level of education, higher family income, and higher rate of delivery by cesarean. By contrast, the mothers with higher scores for dietary pattern 2 had a longer lactation period and lower family income.

Table 4 shows the daily amounts of macronutrients and energy obtained by the lactating mothers with the different dietary patterns. There were significant differences in macronutrients and energy intake among the quartiles of pattern 2; higher nutrient intakes were associated with higher dietary pattern scores. The mean energy, protein, fat, and carbohydrate intakes of the highest quartile (Q4) of both patterns exceeded the recommendations of the Chinese Recommended Nutrient Intake (RNI) [21], especially the energy intake, which was 132.67% and 130.44% of the RNI for patterns 1 and 2, respectively. Figure 1 shows the daily mineral intake by lactating mothers with the different dietary patterns. Pattern 2 was associated with higher intake of calcium, iron, zinc, and selenium as the dietary pattern score increased. However, the mean dietary calcium and selenium intakes of the highest quartile (Q4) in both patterns were lower than recommended, and the calcium level was less than half of RNI in the highest quartiles (Q4) of both patterns. Figure 2 shows the daily vitamin intakes of lactating mothers with different dietary patterns. Those with pattern 1 showed higher intakes of vitamins A, C, B₁, and B₂ with higher

dietary pattern scores. However, the mean dietary vitamin A, C, and B₂ intakes in the highest quartile (Q4) of both patterns were lower than recommended.

Table 5 shows the weight characteristics of the mothers across the quartiles of dietary score. The postpartum weight retention averaged 3.55 kg (range 0.50–7.43 kg). The lactating women in the top quartile (Q4) of pattern 1 had higher current body weights, gestational weight gain, and postpartum weight retention, whereas those with pattern 2 had lower current body weight and lower postpartum weight retention. There were no significant differences in the prepregnancy weight and weight before delivery across the quartiles of the two patterns.

Table 6 presents the multivariate-adjusted association between dietary patterns and postpartum weight retention. After adjusting for lactation period, weight gain during pregnancy, age, occupation, education, family economic level, and delivery mode, scores in the highest quartile of pattern 2 were negatively associated with postpartum weight retention (B = -0.523, 95% confidence interval, -0.948 to -0.099). By contrast, pattern 1 showed no association with postpartum weight retention after adjusting for all confounders.

Discussion

This study evaluated dietary patterns and their effects on postpartum weight retention in lactating women. Two dietary patterns were identified that together explained 17.77% of the total variance in dietary intake. The protein, fat, and carbohydrate intakes of the highest quartiles (Q4) of both patterns markedly exceeded the RNI standards, whereas intake of calcium, selenium, and vitamins A, B₁, and C for both patterns were lower than recommended. Moreover, the results suggest that pattern 2, with a high intake of fresh vegetables (non-leafy), soy milk, bacteria and algae, and fresh legumes, was negatively associated with postpartum weight retention.

In this study, dietary pattern 1 involved high consumption of red meat, coarse cereals, fresh vegetables (leafy), starchy roots and tubers, animal milk, cakes, cookies, and pastries, which is similar to the pattern involving a high intake of meat and marine products for lactating women reported by Tian et al. [19]. Dietary pattern 2 was loaded with fresh vegetables (non-leafy), soy milk, bacteria

Table 3
Demographic characteristics of lactating women according to quartiles of dietary pattern

Characteristics	All (N = 305)	Dietary pattern 1		P-value	Dietary pattern 2		P-value
		Q1 (n = 76)	Q4 (n = 76)		Q1 (n = 76)	Q4 (n = 76)	
Age, y; median (IQR)	25.00 (23.00, 28.00)	26.00 (23.00, 29.00)	25.00 (23.00, 27.75)	0.372	25.00 (22.00, 28.75)	26.00 (23.00, 29.00)	0.132
Lactating period, median (IQR)	96.00 (30.00, 188.00)	144.57 (4.25, 220.50)	81.00 (20.25, 164.75)	0.002	49.00 (13.00, 138.00)	131.00 (65.00, 196.75)	<0.001
Education (%)							
Junior and below	156 (51.15)	58 (76.32)	15 (19.74)	<0.001	33 (43.42)	40 (52.63)	0.527
Senior	95 (31.15)	14 (18.42)	28 (36.84)		27 (35.53)	21 (27.63)	
College and above	54 (17.7)	4 (5.26)	33 (43.42)		16 (21.05)	15 (19.74)	
Occupation (%)							
Housework	202 (66.23)	52 (68.42)	45 (59.21)	0.453	43 (56.58)	54 (71.05)	0.226
Others	103 (33.77)	24 (31.58)	31 (40.79)		33 (43.42)	22 (28.95)	
Family economic level (%)							
Low	92 (30.16)	31 (40.79)	10 (13.16)	<0.001	18 (23.68)	25 (32.89)	0.035
Middle	108 (35.41)	25 (32.89)	30 (39.47)		29 (38.16)	34 (44.74)	
High	105 (34.43)	20 (26.32)	36 (47.37)		29 (38.16)	17 (22.37)	
Delivery mode (%)							
Normal	122 (40.00)	25 (32.89)	32 (42.11)	0.023	31 (40.79)	36 (47.37)	0.452
Forceps delivery	35 (11.48)	17 (22.37)	5 (6.58)		6 (7.89)	8 (10.53)	
Cesarean delivery	148 (48.52)	34 (44.74)	39 (51.32)		39 (51.32)	32 (42.11)	
Infant's sex (%)							
Boy	167 (54.75)	45 (59.21)	40 (52.63)	0.289	43 (56.58)	40 (52.63)	0.12
Girl	138 (45.25)	31 (40.79)	36 (47.37)		33 (43.42)	36 (47.37)	

Values expressed as medians (25th and 75th percentiles) for skewed data (compared by Kruskal–Wallis test)

Values expressed as n (%) for categorical data (compared by χ^2 test)

Table 4
Macronutrients and energy intakes of lactating women by quartile categories of dietary patterns

Dietary pattern and daily intake	RNI for lactating women*	Dietary pattern 1				P-value	Dietary pattern 2				P
		Q1		Q4			Q1		Q4		
		Median	IQR	Median	IQR		Median	IQR	Median	IQR	
Energy (kcal)	2600	2899.00	2510.00, 3479.00	3449.50	3082.00, 3932.75	0.145	2653.50	2120.50, 3142.50	3391.50	2803.75, 3863.25	<0.001
Protein (g)	80	76.35	59.95, 90.43	116.45	100.70, 128.43	0.679	76.90	58.90, 103.65	100.30	79.10, 117.93	<0.001
Fat (g) [†]	57.8–86.7	66.60	55.78, 78.60	118.65	98.58, 140.23	<0.001	87.90	68.88, 112.83	95.25	76.55, 122.55	<0.001
Carbohydrate (g) [‡]	357.5–422.5	487.20	399.80, 598.60	465.55	419.83, 557.78	0.003	371.30	293.60, 454.70	510.30	394.23, 599.35	<0.001

IQR, interquartile range (25th and 75th percentiles); RNI, Recommended Nutrient Intake
 Values expressed as medians (25th and 75th percentiles) for skewed data (compared by Kruskal–Wallis test)
 *RNIs for control women are for a moderate level of physical activity.
[†]Conversion based on the Chinese RNI for fat providing 20% to 30% of the total energy per day.
[‡]Conversion based on the Chinese RNI for carbohydrate providing 55%–65% of the total energy per day.

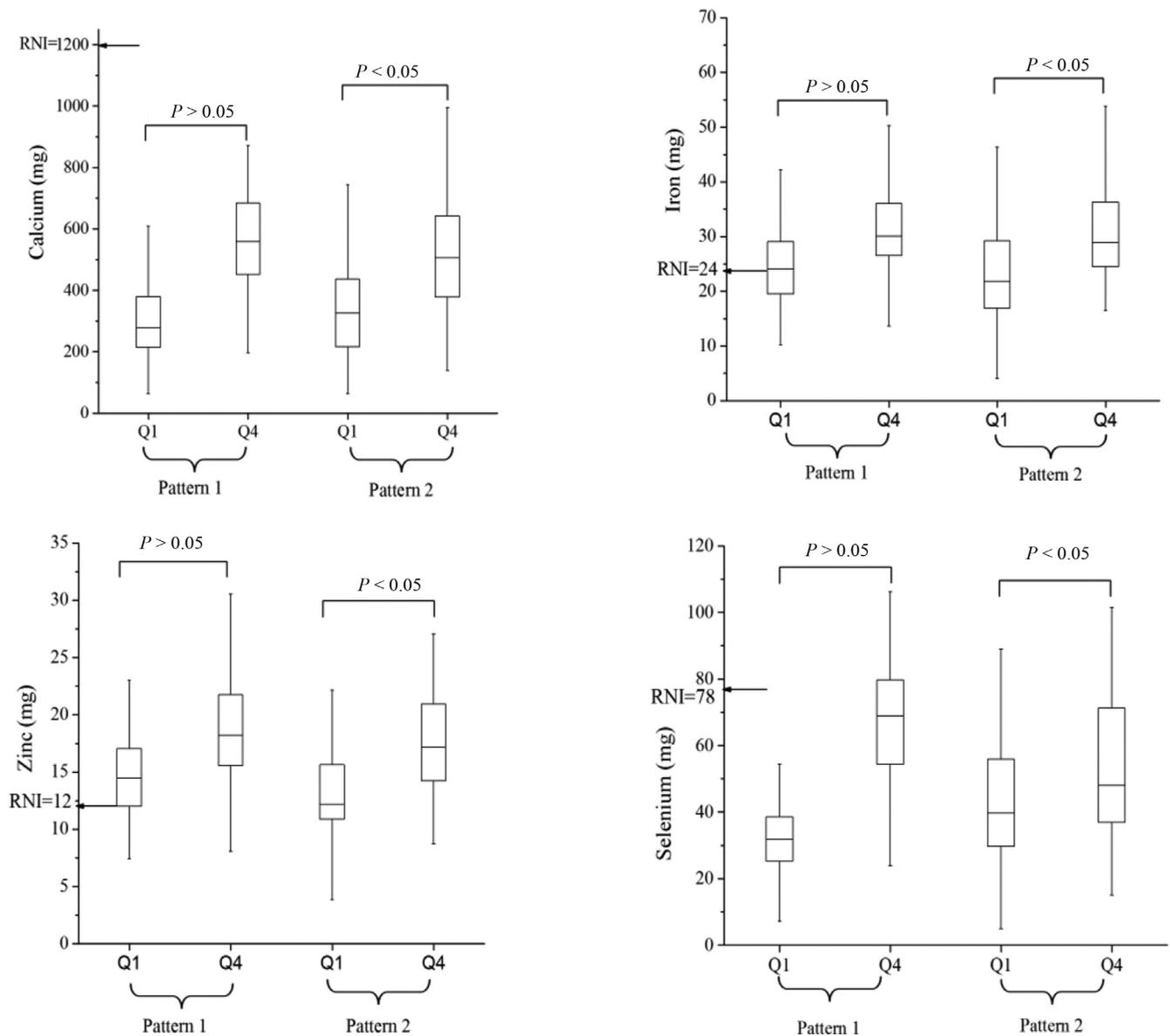


Fig. 1. Intake of calcium, iron, zinc, and selenium by lactating women according to quartile categories of dietary patterns. Box plots indicate interquartile range (IQR). Values compared by Kruskal–Wallis test. RNI, Recommended Nutrition Intake.

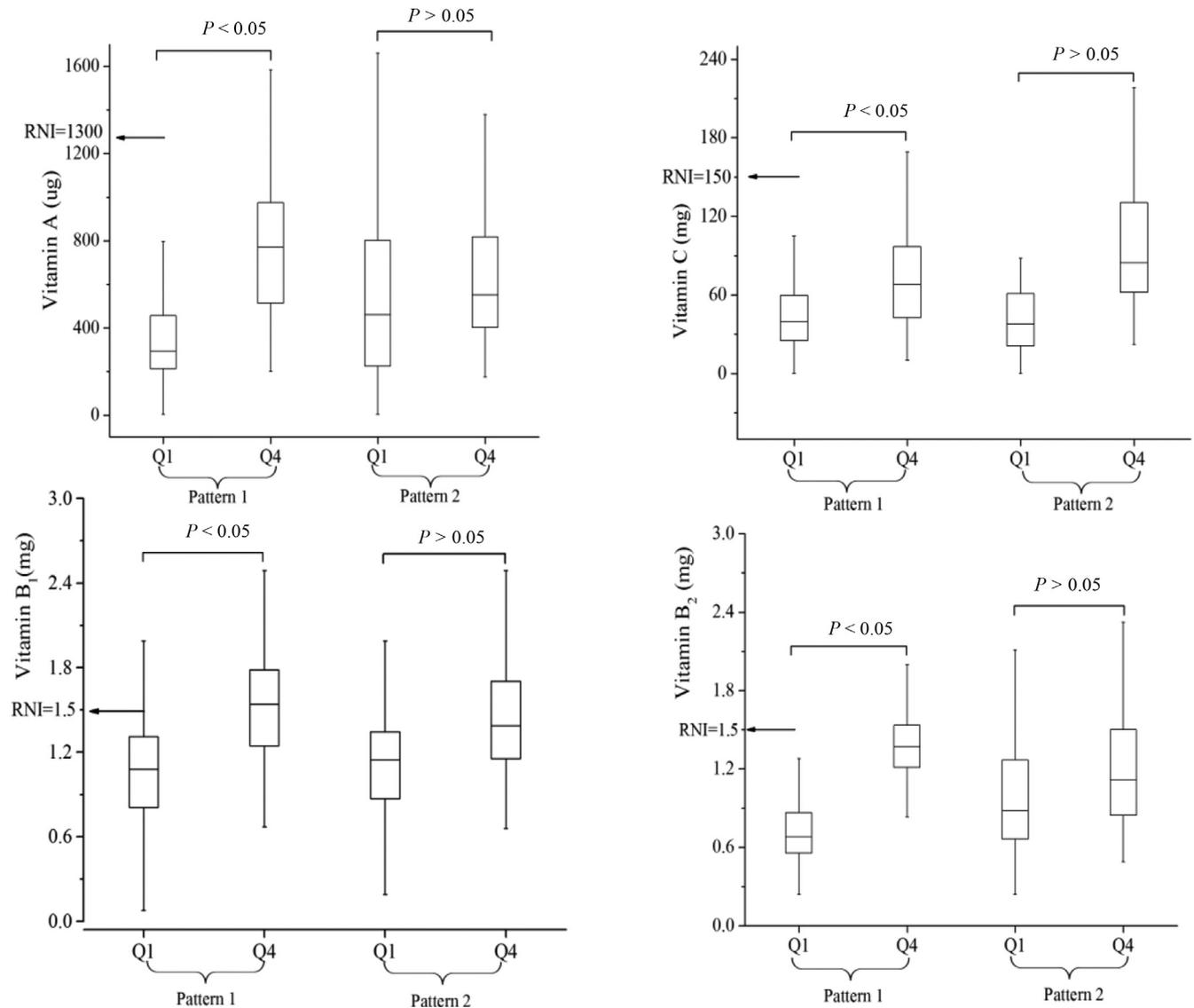


Fig. 2. Intake of vitamins A, C, B₁, and B₂ by lactating women according to quartile categories of dietary patterns. Box plots indicate interquartile range (IQR). Values compared by Kruskal–Wallis test. RNI, Recommended Nutrition Intake.

Table 5
Weight of lactating women by quartile categories of dietary patterns

Weight	Total		Pattern 1				P-value	Pattern 2				P
	Median	IQR	Q1		Q4			Median	IQR	Median	IQR	
			Median	IQR	Median	IQR						
Prepregnancy weight	49.50	46.00, 54.00	49.00	45.25, 54.75	50.00	45.00, 55.00	0.730	50.00	47.50, 55.00	50.00	47.00, 55.00	0.155
Weight before delivery	65.00	60.00, 70.00	63.50	59.25, 70.00	65.00	60.50, 70.75	0.257	66.75	60.00, 71.00	65.00	60.00, 70.00	0.195
Gestational weight gain	15.00	10.25, 19.00	14.00	10.13, 18.38	15.75	11.50, 19.00	0.020	15.25	11.63, 19.75	14.00	10.00, 16.88	0.192
Current body weight	53.75	48.65, 59.93	52.43	45.90, 57.56	55.75	49.85, 63.15	0.041	57.50	50.40, 62.41	53.75	48.76, 58.34	0.011
Postpartum weight retention	3.55	0.50, 7.43	2.50	0.06, 5.63	5.10	2.05, 10.04	0.003	5.73	2.43, 10.24	2.15	0.18, 6.82	0.004

IQR, interquartile range

Values expressed as medians (25th and 75th percentiles) for skewed data (compared by Kruskal–Wallis test)

and algae, and fresh legumes and was consistent with the “varied pattern” of rural Tibetan lactating mothers, which included high intakes of vegetables, fruits, and soy foods [22].

In the present study, the shorter the lactation period was, the stronger the correlation with dietary pattern 1, with its high intake of red meat. This might be attributed to the traditional dietary

custom of Chinese lactating women, which is characterized by a high intake of animal food, such as meat, fish, and eggs, and a low intake of fruit and vegetables within 6 to 8 wk of giving birth [23]. We also found that socioeconomic status had an important effect on dietary patterns. Mothers living in urban areas with higher levels of education and income had higher scores in dietary pattern 1,

Table 6
Association between dietary patterns and postpartum weight retention among lactating women

	Dietary pattern 1		P-value	Dietary pattern 2		P-value
	B	95% CI		B	95% CI	
Crude	0.852	0.412 to 1.292	<0.001	-0.718	-1.223 to -0.339	0.001
Model 1	0.620	0.192 to 1.047	0.005	-0.534	-0.964 to -0.104	0.015
Model 2	0.626	0.199 to 1.054	0.004	-0.514	-0.971 to -0.111	0.014
Model 3	0.361	-0.110 to 0.833	-0.110	-0.523	-0.948 to 0.099	0.016

Model 1: adjusted for lactating period; Model 2: adjusted for lactating period and gestation weight gain; Model 3: adjusted for lactating period, gestation weight gain, age, occupation, education, family economic level, delivery mode

whereas those living in rural areas, with lower incomes had higher scores in dietary pattern 2. Similar associations have been observed in other studies [24,25].

The intake of protein, fat, and carbohydrates in the highest quartiles (Q4) of both patterns markedly exceeded the RNI. In other studies from China, the dietary protein and fat intake of lactating women were sufficient, whereas the carbohydrate intake was below the RNI [26,27]. The energy intake by mothers exceeded that recommended due to the higher intake of energy nutrients such as protein, fat, and carbohydrates, consistent with other results from China [28,29]. These results suggest that Chinese mothers generally consume too much energy during lactation, potentially increasing the risk for obesity and related health problems. In comparison, the intakes of micronutrients such as calcium, selenium, and vitamins A, B₁, and C by the highest quartiles (Q4) of both patterns were lower than recommended, as observed in many studies from China [22,30]. The insufficient intake of micronutrients by lactating women should be a concern, and a health dietary pattern should be established to rectify this problem.

In the present study, the postpartum weight retention averaged 3.55 kg (range 0.50–7.43 kg). Similar to our findings, Wang et al. reported that weight retention by lactating women from 32 provinces in China averaged 3.6 kg (0.2–7.3 kg) [5]. Many studies have reported associations between dietary patterns and obesity [1,10,20,31]. The traditional Chinese high intake of rice, fresh vegetables, fruits, and beans is negatively associated with weight gain [10]. In the present study, after adjusting for confounders, we found that eating habits that placed lactating women in highest quartile of pattern 2 were negatively associated with postpartum weight retention. Dietary pattern 2, with high intakes of fresh vegetables, soy milk, bacteria and algae, and fresh legumes, is similar to the traditional pattern. Food with large amounts of dietary fiber and antioxidants (e.g. vitamins C and E) and water might contribute to reducing the risk for obesity [11].

To our knowledge, this was the first study to evaluate dietary patterns and their effects on postpartum weight retention by lactating women in south central China. Findings from the present study provide valuable information for improving the problem of obesity in women. However, there are several limitations to the study. First, the small sample size (305 participants) may not be representative of the general population of lactating women. Second, we used a 24-h recall method to collect dietary information, which might not represent long-term intake and may be subject to recall bias.

Conclusions

This study identified two dietary patterns among lactating women in south central China. The women following both dietary patterns consumed sufficient amounts of protein, fat, and carbohydrates, but insufficient micronutrients. A diet characterized by

high intakes of fresh vegetables (non-leafy), soy milk, bacteria and algae, and fresh legumes was negatively associated with postpartum weight retention. This dietary pattern should be recommended during lactation to limit obesity in women.

Acknowledgments

The author acknowledge the participants for their assistance and support. The data sets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

References

- [1] Yuan YQ, Li F, Meng P, You J, Wu M, Li SG, et al. Gender difference on the association between dietary patterns and obesity in Chinese middle-aged and elderly populations. *Nutrients* 2016;8. pii: E448.
- [2] Picciano MF. Pregnancy and lactation: physiological adjustments, nutritional requirements and the role of dietary supplements. *J Nutr* 2003;133:1997S–2002S.
- [3] Kirkegaard H, Stovring H, Rasmussen KM, Abrams B, Sorensen TI, Nohr EA. How do pregnancy-related weight changes and breastfeeding relate to maternal weight and BMI-adjusted waist circumference 7 y after delivery? Results from a path analysis. *Am J Clin Nutr* 2014;99:312–9.
- [4] Endres LK, Straub H, McKinney C, Plunkett B, Minkovitz CS, Schetter CD, et al. Postpartum weight retention risk factors and relationship to obesity at 1 year. *Obstet Gynecol* 2015;125:144–52.
- [5] Wang J, Yang ZY, Pang XH, Duan YF, Jiang S, Zhao LY, et al. The status of postpartum weight retention and its associated factors among Chinese lactating women in 2013. *Chin J Prev Med* 2016;50:1067–73.
- [6] Huang T, Brown FM, Curran A, James-Todd T. Association of pre-pregnancy BMI and postpartum weight retention with postpartum HbA1c among women with type 1 diabetes. *Diabet Med* 2015;32:181–8.
- [7] Rooney BL, Schauburger CW, Mathiason MA. Impact of perinatal weight change on long-term obesity and obesity-related illnesses. *Obstet Gynecol* 2005;106:1349–56.
- [8] Jaakkola J, Hakala P, Isolaure E, Poussa T, Laitinen K. Eating behavior influences diet, weight, and central obesity in women after pregnancy. *Nutrition* 2013;29:1209–13.
- [9] Shao HH, Hwang LC, Huang JP, Hsu HY. Postpartum weight retention risk factors in a Taiwanese cohort study. *Obes Facts* 2018;11:37–45.
- [10] Shu L, Zheng PF, Zhang XY, Si CJ, Yu XL, Gao W, et al. Association between dietary patterns and the indicators of obesity among Chinese: a cross-sectional study. *Nutrients* 2015;7:7995–8009.
- [11] Zhen S, Ma Y, Zhao Z, Yang X, Wen D. Dietary pattern is associated with obesity in Chinese children and adolescents: data from China Health and Nutrition Survey (CHNS). *Nutr J* 2018;17:68.
- [12] Barrera C, Valenzuela R, Chamorro R, Bascunan K, Sandoval J, Sabag N, et al. The impact of maternal diet during pregnancy and lactation on the fatty acid composition of erythrocytes and breast milk of Chilean women. *Nutrients* 2018;10:1–14.
- [13] Vonnahme KA, Lemley CO, Caton JS, Meyer AM. Impacts of maternal nutrition on vascularity of nutrient transferring tissues during gestation and lactation. *Nutrients* 2015;7:3497–523.
- [14] Zhou X, Chen R, Zhong C, Wu J, Li X, Li Q, et al. Maternal dietary pattern characterised by high protein and low carbohydrate intake in pregnancy is associated with a higher risk of gestational diabetes mellitus in Chinese women: a prospective cohort study. *Br J Nutr* 2018;120:1045–55.
- [15] Ros P, Diaz F, Freire-Regatillo A, Argente-Arizon P, Barrios V, Argente J, et al. Resveratrol intake during pregnancy and lactation modulates the early metabolic effects of maternal nutrition differently in male and female offspring. *Endocrinology* 2018;159:810–25.

- [16] Leung AM, Pearce EN, Braverman LE. Iodine nutrition in pregnancy and lactation. *Endocrin Metab Clin North Am* 2011;40:765–77.
- [17] Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipid* 2002;13:3–9.
- [18] Zhang JG, Zhang B. The methods of dietary pattern: a system review. *Wei Sheng Yan Jiu* 2013;42:698–9.
- [19] Tian HM, Wu YX, Lin YQ, Chen XY, Yu M, Tong L, et al. Dietary patterns affect maternal macronutrient intake levels and the fatty acid profile of breast milk in lactating Chinese mothers. *Nutrition* 2019;58:83–8.
- [20] Xu X, Hall J, Byles J, Shi Z. Dietary pattern is associated with obesity in older people in China: data from China Health and Nutrition Survey (CHNS). *Nutrients* 2015;7:8170–88.
- [21] Shu XY. The recommended intake of food for pregnant women and lactating mothers. *J Clin Pediatr* 2018;36:645–8.
- [22] Wang Z, Dang S, Xing Y, Li Q. Dietary patterns and their associations with energy, nutrient intake and socioeconomic factors in rural lactating mothers in Tibet. *Asia Pac J Clin Nutr* 2017;26:1–8.
- [23] Society CN. Dietary guidelines for lactating women. *J Clin Pediatr* 2016;34:958–60.
- [24] Tseng M, Devellis Robert F. Fundamental dietary patterns and their correlates among US whites. *J AM Diet Assoc* 2001;101:929–32.
- [25] Schulze MB, Hoffmann K, Kroke A, Boeing H. Dietary patterns and their association with food and nutrient intake in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam study. *Br J Nutr* 2001;85:363–73.
- [26] Li X, Ding Z, Liu GL, He CC. Analysis and evaluation of dietary nutrition of 251 lactating mothers in Changchun. *Chin J Matern Child Health* 2014;29:4473–5.
- [27] Feng L, Liu YJ, Guo HP, Liu XF. Analysis on dietary nutrition of foster - nurses at 4-12 months after delivery in Shunyi district of Beijing city. *Chin J Matern Child Health* 2012;27:3784–6.
- [28] Hai YL, Geng CM, Li GQ. Nutrition survey of 348 lactating women in the mid-west of Inner Mongolia. *Ying Yang Xue Bao* 2018;40:90–4.
- [29] YANG TT, Zhang YM, Ma DF, Li WJ. Survey on the nutrients intakes of lactating women in three cities of China. *Ying Yang Xue Bao* 2014;36:84–7.
- [30] Chen HJ, Wang P, Han YF, Ma J. Evaluation of dietary intake of lactating women in China and its potential impact on the health of mothers and infants. *BMC Womens Health* 2012;12.
- [31] Xu X, Byles J, Shi Z, McElduff P, Hall J. Dietary pattern transitions, and the associations with BMI, waist circumference, weight and hypertension in a 7-year follow-up among the older Chinese population: a longitudinal study. *BMC Public Health* 2016;16:743.