"Zuòyuèzi" dietary and behavioural associations with maternal health among puerperal women in South China

Running title: "zuòyuèzi" practices and postpartum health

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ABSTRACT

Background and Objectives: This study aimed to explore the associations of postpartum dietary quality and behavioral practices with maternal health in Guangzhou China. **Methods and Study Design:** We conducted a cross-sectional study among puerperal women in urban and suburban areas in Guangzhou, China (n=2013). Data for postpartum dietary and behavioral practices and health conditions were collected by a standardized questionnaire. Dietary balance index (DBI) was calculated to assess an individual's dietary quality. Logistic regression analysis was used to identify the factors related to women's health. **Results:** 75.5% of women reported at least one postpartum disease, and the most common problems were prolonged duration of lochia (70.0%) and backache (43.0%), followed by constipation (23.6%), insufficient milk secretion (19.2%), breast swelling (18.5%) and hemorrhoids (13.8%). Average postpartum weight retention was 3.5 kg. Logistic regression analysis revealed that 12-18 h/d of bed rest time, breastfeeding, doing postpartum exercise, basking, getting out of bed within 2 days after delivery, higher intake of fish and shrimp, fruits, vegetable, milk were protective factors for at least one out of these health problems or weight retention ($p<0.05$). Bed rest time for more than 18 h/d or less than 12 h/d, ginger vinegar intake, doing housework, cesarean section, and excessive and inadequate intake of cereals had an adverse association ($p<0.05$). **Conclusions:** Some features of a traditional Chinese postpartum diet and behaviour are related to maternal morbidity during the puerperium. Further studies are needed to assess whether postpartum diet and behavioral intervention improve maternal health during the postpartum period.

Key Words: Zuòyuèzi, postpartum diet, women's health, lactation, postpartum weight retention

INTRODUCTION

The postpartum period is a critical transitional time for the mother, her newborn, and the family, which begins with childbirth to reproductive organs returning to their normal non-pregnant state, and covers 6 weeks.[1] In China, the first month after childbirth is called "zuòyuèzi", also known as "sitting with the month" or "doing the month". Some newborn and maternal health problems such as bleeding, venous thromboembolism, pain, breast problems, depression, infection, postpartum weight retention and malnutrition are caused by inappropriate care during the postpartum period.[1-3] A previous study illustrated that at least one such problem was reported by about 60% of women in China.[3]

The American College of Obstetricians Gynecologists suggested that postpartum care should be an ongoing process, with services and support tailored to each woman's needs.[4] However, in western countries, women have noted that there is an intense focus on women's health prenatally but care during the postpartum period is infrequent and late.[5] "Zuòyuèzi", as a postpartum tradition with the woman and her newborn surrounded and supported by family and community members, has a history of more than 2000 years in China.[6,7] Women usually follow traditional customs or taboos, which is characterized by the room confinement, the avoidance of shampoo and bath, as well as the changes in diet (encouraging warm or yang food, such as animal food and limiting cold or yin food, such as vegetables and fruits) during this period.[8,9] Even enormous development has been achieved in China, most postpartum women still follow these kinds of traditional customs.[10] Those practices are believed to promote healing of wounds, prevent long-term diseases and increase lactation in the traditional view. But some researchers disputed controversial claims of adherence to the "zuòyuèzi" practices, which may be due to the complexity of the whole ritual. Some studies indicated that traditional health care practices were beneficial to postpartum women, since the women will receive more care, support and reassurance from family and friends during this period.[11-13] Others believe that a monotonous diet, excessive intake of meat and poultry and inadequate intake of vegetable may be associated with malnutrition, breast problems and postpartum complications including constipation.[3,14] Additionally, activity restriction, particularly the long period of bed rest, commonly causes cardiovascular and musculoskeletal deconditioning, and leads to reduced aerobic endurance and lower-body muscle strength.[15] Thus, the validity association of traditional diet and behavioral practices with maternal health still remains a far reached question.

Despite the complexity and common use of "zuòyuèzi" among China, only a limited number of studies with limited sample size (<400) in north china (Wuhan, Shanghai and Beijing) have been performed to quantitatively assess the association between women's health and "zuòyuèzi" practices of women during this period.[6,15-17] Beyond that, postpartum diet, behavioral practice and other domestic traditions and obligations vary greatly among different countries and regions.[18-20] Thus, it is important to explore the information about health status and postpartum dietary and behavioral practice during postpartum period in southern China for the first time, and to figure out the factors related to health status in South China. In order to quantitative assess the overall quality of individual's diet, Dietary Balance Index (DBI) for lactation women was developed based on Chinese Dietary Guidelines and

Food Guide Pagoda for lactating women (2016).[21] In this study, we would use DBI to assess diet quality of postpartum women.

The objectives of this study were: (1) to collect the data of diet and behavioral practices Guangzhou, China; (2) and to examine the association between postpartum dietary quality, behavioral practices and health status.

MATERIALS AND METHODS

Study population

A cross-sectional retrospective survey was conducted in two districts of Guangzhou, including Yuexiu District as an urban area and Baiyun District as a suburban area. This study included those women with a healthy singleton baby, of age 42 days to 1 year, and were eligible for midwifery care in Maternal and Child Health Hospital in two districts. Those were excluded if they were younger than 17 years old, suffered from gestational complications, including gestational diabetes, pregnant with heart disease or delivered an unhealthy baby. A total of 2040 women were recruited, 2013 of which complete the questionnaire, including 1007 from urban area and 1006 from suburban area.

Ethics approval

The study was approved by the Ethics Committees of the local Health Department and the research ethics boards of Tongji Medical College, China (trial registration: clinicaltrials.gov ID: NCT01039051), and all participants provided written informed consent.

Dietary assessment

Information about specific food consumed regularly including ginger vinegar and brown sugar during the postpartum period was collected by face-to-face questionnaire. A short food frequency questionnaire (FFQ) composed of 19 items was used to collect the information about food intake, by asking the participants to recall the frequency and approximate amount of food consumed during the period of "zuòyuèzi". The categories of foods included cereals (such as rice, noodles, coarse grains), tuber (such as sweet potato, Chinese yam, taro, potato), eggs, dairy (such as milk, dried milk, yoghurt), red meat (such as pork, beef, mutton,)), fish, poultry (such as chicken, duck, goose), shrimps and crabs, animal visceral, animal blood, soy, soy-based products (such as soybean milk, tofu curb, tofu, dried bean curd pieces), green leafy vegetables and other vegetables (such as eggplant, wax gourd), fruits, seed (sunflower, pumpkin) or nut (such as walnut, hazelnut), brown sugar and beverages. Measures (such as

cups, bowls and spoons) and photos of food were used to assist food recall and measurement. The total consumption for each type of food was calculated and converted to mean daily intake. In addition, foods used in each category such as Yin and Yang are presented in Supplementary Table 1.

Dietary Balance Index (DBI) for postpartum women

DBI was developed according to Chinese Dietary Guidelines and Food Guide Pagoda (2016) and revised according to the recommendation of Dietary Guidelines for Lactating Women (2016).[21] The revised DBI comprises 9 components, and the details and scoring rule are present in Table 1. For each component, the score of "0" indicates an excellent dietary intake, a higher positive score indicates a larger excessive food intake, whereas a higher absolute value of a negative score indicates a more insufficient food intake. Negative scores were used to estimate inadequate food intake for vegetables, fruits, dairy, soybean and fish and shrimp, in accordance with the dietary guidelines for lactating women as "sufficient" or "plenty". Both positive and negative scores were used to assess cereals, meat and poultry and egg intakes, where the dietary guidelines recommend "appropriate" amounts.

Higher Bound Score (HBS), Lower Bound Score (LBS) and Diet Quality Distance (DQD) were calculated to evaluate overall dietary quality for each participant. HBS is the sum of all positive score, which indicates excessive food intake, ranges from 0 to 20. LBS is the sum of all negative score, which indicates inadequate food intake, ranges from -60 to 0. DQD is the sum of all positive score and absolute value of a negative score, which indicates imbalance diet, ranges from 0 to 60. Each indicator is further divided into 5 level: "0" indicate "excellent"; less than 20% of total score indicate "good"; less than 20~40% of total score indicate "mild poor"; less than 40~60% of total score means "moderate poor"; more than 60% of total score indicate "severe poor".

Lifestyle investigation

This face-to-faced questionnaire also collected detailed information about frequency of behavioral practices in four degrees (never, occasionally, every week, every day) during the period of "zuòyuèzi", including bedroom ventilation, doing postpartum exercise, doing housework, outdoor sunbathe and personal hygiene, and hours of sleep and bed rest.

Physical health status

Information about women's health status during postpartum period included self-reported body weight from pre-pregnancy to postpartum, lactation, bloody lochia duration and the prevalence of various postpartum diseases including back pain, constipation, breast swelling, hemorrhoids, leg cramps, dizziness. Morbidity was based on self-report of doctor diagnosis and verified during the face-to-face interview. In this study, "sufficient lactation" was defined as exclusive breastfeeding within 6 weeks along with normal growth and development of infant; and "moderate lactation" was defined as breastfeeding cannot meet the physical needs of infants, but the added dairy products did not exceed half of the baby physiological needs; that the women secreted little breast milk and the infant feeding mainly depended on dairy products was considered as "insufficient lactation"; "none" was milk free secretion, all of which were artificially fed. Lochia was divided into bloody lochia, serous lochia and white lochia, which generally lasted about 3~4 days, 10 days and 3 weeks, respectively. The prolonged duration of lochia was defined as bloody lochia lasting for more than 14 days.[22] And postpartum weight retention (PPWR) was calculated by subtracting the pre-pregnancy body weight from the current self-reported body weight.

This questionnaire survey was conducted by face-to-face interview. And all interviewers were health professionals from maternal and child health clinic, and trained uniformly before investigation.

Statistical analysis

The operation of data input was carried out by two people performed in Epidata 3.1, then data and logicality were checked, and the unqualified data were corrected. Data analysis was performed using IBM SPSS 23.0. Normality for continuous data was tested before analysis. Women's characteristics and food intake were expressed as mean and standard deviation (SD) or median (P_{25}, P_{75}) for continuous variables, and absolute and relative frequencies for categorical variables. The student t test, nonparametric test and χ^2 tests were used to compare the characteristics, food intake and prevalence of health problems between women residence in urban and suburban area.

A series of multivariate logistic regression analyses (Forward: LD) were performed to estimate the effects of food consumption, health behaviour and other factors on the maternal morbidity. The variables that showed difference between case and control at the $p<0.10$ level in the univariate analysis, were identified as independent variables and input into the logistic regression analysis. Then those variables, which had a significant relationship with response

variables at $p<0.05$ level were considered as independent variables in the final regression models, and the odds ratio (OR) corresponding with 95% confidence interval (CI) was computed. The following variables were considered as potential independent variables: place of residence (0 = urban resident, 1 = suburban resident), parity (0 = primipara, 1 = multipara), way of delivery (0 = vaginal delivery, 1 = cesarean), started to work during postpartum period (0 = no, 1 = yes), education level (continuous), annual household income (continuous), age (continuous), pre-pregnancy BMI (continuous), gestational weight gain (continuous), anemia during pregnancy (0 = no, 1 = yes), had leg cramps during pregnancy (0 = no, 1 = yes), time interval between the date of investigation and delivery (continuous), DBI score for each component include cereals (positive score and absolute value of negative score), vegetables, fruits, dairy, soybean, meat and poultry products (positive score and absolute value of negative score), fish and shrimp, eggs (positive score and absolute value of negative score), as well as food variety (continuous), ginger vinegar intake (0 = no, 1 = yes), brown sugar intake (0 = no, 1 = yes), basking (0 = never, 1 = occasionally, 2 = every week/day), doing postpartum excise (0 = never, 1 = occasionally, 2 = every week/day), shampoo (0 = never, 1 = occasionally, 2 = every week/day), shower (0 = never, 1 = occasionally, 2 = every week/day), tooth brushing (0 = never, 1 = occasionally, 2 = every week/day), lower body washing (0 = never, 1 = occasionally, 2 = every week/day), bedroom ventilation (0 = never, 1 = occasionally, 2 = every week/day), doing house work (0 = never, 1 = occasionally, 2 = every week/day), bed rest time for less than 12 h/d (0 = no, 1 = yes), bed rest for more than 12 h/d and less than 18 h/d (0 = no, 1 = yes), bed rest time for more than 18 h/d(0 = no, 1 = yes), mean sleep duration (0 = less than 8 h/d, 1 =more than 8h/d), breastfeeding (0 = no, 1 = yes), breast feeding started within 0.5 h after giving birth (0 = no, 1 = yes), and getting out of bed within 2 days after delivery (0 = no, 1 = yes). The response variables were prolonged duration of lochia (0= bloody lochia duration ≤14 days, 1 = bloody lochia duration >14 days), backache (0 = no, 1 = yes), insufficient milk secretion, (0 = "sufficient" and "moderate", 1 = "lack" and "none"), and diseases, such as constipation (0 = no, 1 = yes), breast swelling (0 = no, 1 = yes), hemorrhoids (0 = no, 1 = yes), leg cramps (0 = no, 1 = yes) and dizziness (0 = no, 1 = yes). A logistic regression model (Forward:LD) was performed, and the median of body postpartum weight retention (PPWR) was set as the boundary value (1 = PPWR > Median; 0 = PPWR ≤ Median), to assess the relationship between postpartum weight retention and key variables, which showed differences at the $p<0.10$ level in univariate analysis. Multicollinearity of independent variables were assessed in order to rule out the possibility of

multicolliearity issue. The significant level for inclusion of a variable was 0.05, and 0.1 for exclusion of a variable.

RESULTS

Characteristics of the participants

The mean age of participants was 27.81±4.04 years. Urban participants were older, and had a higher educational level and annual household income. Nearly 90% of participants were primiparas (86.0%), accounting for 93.9% and 78.1% in urban and suburban areas, respectively. About 60% of women were for vaginal delivery. Further details are presented in Table 2.

Dietary information

Maternal dietary intakes during postpartum period are presented in Table 3. The consumption of food during postpartum period was compared with the dietary guidelines for Chinese lactating women.[23] The average consumption of total fish, poultry, eggs and red meat was nearly triple the recommendation defined as 250 g/day during postpartum period, especially in suburban area ($p<0.05$). But the mean consumption of cereals was closed to the lower limit of recommendation. And there was about half of the recommended consumption of vegetables, soybeans, and soybean products, and less than half of the recommended intake of dairy and fruits among participants during postpartum period. Suburban participants had higher poultry and eggs intake compared to urban participants ($p<0.05$), while the consumption of dairy, soybeans and soybean products, green leafy vegetables and fruits among urban participants was significantly higher than suburban participants ($p<0.05$). In addition, 63.1% of women consumed ginger vinegar soup regularly.

Scores for the DBI components and the percentage of participants with each score (estimated energy intake of 2400 kcal per day) are presented in Table 4. Overall, the percentage of participants meeting the recommended dietary intakes was ranged from 5.2% for cereals and fruit intake to 54.5% for fish and shrimp intake (score=0). A total of 39.1%, 90.2% and 72.2% of participants have excessive intake of cereals, meat and poultry products and eggs, and 81.2%, 94.9%, 88.4% and 77.5% of participants have inadequate intake of vegetables, fruits, dairy, and soybean. Only 25.7% of participants meet the recommendation of food variety. The median of HBS, LBS and DQD were 4 (2, 8), 23 (16, 28) and 28 (21, 34), respectively. As showed in Figure 1, the total proportion of HBS, LBS and DQD in the level

of "excellent" and "good" is 67.0%, 15.4% and 4.5%, respectively. The total proportion of HBS, LBS and QDQ in the level of "poor" is 33%, 84.6% and 95.5%, respectively.

Behavioral practices

The information of behavioral practice is shown in Table 5. The average daily sleep time of women during postpartum period was 9.04 ± 2.13 h, and the bed rest time was 13.39 ± 3.40 h. More than 90% of the women rarely or never did postpartum exercises (91.7%). Almost all women (99.2%) ventilated, 64.6% got out of bed within 2 days after delivery, 15.2% never basked, and 58.3% pay slightly more attention to keeping warm than usual.

The prevalence of no-bathing (4.4%), no-washing feet (1.6%), no-brushing teeth (1.0%) and no-washing low private part (0.1%) was low. But the behavior of never shampoo (14%) had a high incidence (the data were not shown).

Maternal health problems during postpartum period

75.5% of postpartum women reported one or more puerperal diseases. Table 6 shows the prevalence of health problems reported during postpartum period. The most common problem was prolonged duration of lochia (70.3%), back pain (43.0%), followed by constipation (23.6%), insufficient milk secretion (19.2%), breast swelling (18.5%) and hemorrhoids (13.8%). And the median ($P_{25} \sim P_{75}$) of PPWR was 3.5 (1.0~6.3) kg.

Factors associated with postpartum health problems

The logistic regression analysis showed that basking was associated with less back pain, breast swelling, hemorrhoids, and insufficient milk secretion. Doing postpartum exercise was likely to decrease the risk of prolonged duration of lochia and PPWR. Women residence in suburban area reported fewer occurrences of prolonged duration of lochia and insufficient milk secretion, and more occurrences of constipation and dizziness. Getting out of bed within two days after delivery was associated with less dizziness and leg cramp. Bed rest time for 12-18 h/d was a protective factor for backache and breast swelling, and bed rest time for less than 12 h/d was a risk factor for prolonged duration of lochia and insufficient milk secretion. Doing housework and cesarean birth were related with high risk of back pain. Breastfeeding within 4 months resulted in less back pain and constipation. Higher intake of vegetable and milk had protective effects on the prolonged duration of lochia, whereas ginger vinegar intake had an adverse association with prolonged duration of lochia and insufficient milk secretion. Dizziness is associated with both higher positive and negative score (absolute value) of

cereals intake. Women with higher score of fish and shrimp, fruits and milk intake reported less breast swelling, insufficient milk secretion and PPWR respectively. The details are presented in Table 7 to 9.

DISCUSSION

Our study indicated that most women in this study have an imbalanced diet, the inadequate intake of vegetables, fruits, dairy (defined as yin or cold food) and excessive intake of egg, meat and poultry products (defined as yang or warm food) were widespread, similar to the result in other city of China.[21] Traditional practices of "zuòyuèzi", such as reduced physical activities and regular intake of ginger vinegar soup are used universally. Besides, our study found that health problems in women during postpartum period were highly prevalent, and the dietary and behavioral factors were related to health.

Our study revealed that nearly 80% of the women reported at least one problem during postpartum period. Reported health problems included prolonged duration of lochia, backache (43.0%), constipation (23.6%), breast swelling (18.5%) and hemorrhoids (13.8%), postpartum weight retention (3.5 kg). Other studies have found a similar result. In a India study, nearly three-fourths of women had reported illness during the early postpartum period, the common morbidity was anaemia (53.4%) fever (4%), breast conditions (4.9%), and perineal conditions (4.5%).[24] In a cohort study in Bangladesh, nearly half (42%) of all women suffered from at least one morbidity, at 6-9 weeks after delivery, included genital infection (19%) and urinary tract infections (12.3%).[25] The high incidence of health problems, will not only affect physical health of both women and infants, but also cause social consequences, such as decline in the life quality during postpartum period.[26] And the logistic regression analysis in this study showed that certain postpartum dietary and behavioral practices were thought to be associated with health status.

In traditional Chineses belief, postpartum women are believed to need special dietary and behavioral approaches in the first month after childbirth to help physical recovery, which is known as "zuòyuèzi". Those customs are associated with food taboo and confinement of practice, and vary considerably around cultures, but all focus on avoidance of yin food and placement of restrictions on movement after giving birth.[27] In this study, regular intake of ginger vinegar during puerperium was popular in Guangzhou. Previous studies supported that ginger vinegar consumption is beneficial to recovery after childbirth and stimulating milk secretion, which is also popular in Hong Kong, China.[28] But, the present study demonstrated that regular intake of ginger vinegar is a risk factor for insufficient milk secretion and

prolonged duration of lochia. Ginger was reported to improve breast milk volume in early postpartum period.[29] While another study found that cows fed with high level of vinegar yielded less milk.30 Excessive intake of ginger may lead to hypertension, and contributed to the risk of prolonged uterine bleeding.[31] Hence, those reported differences may be ascribed to the different consumption and proportions of ginger and vinegar.

Our logistic regression analysis showed that intake of vegetable and fruit was associated with less prolonged duration of lochia. Fruit consumption was associated with less insufficient milk secretion, theses result challenge the traditional view that yin food consumption will cause postpartum health problem. Women who have adequate intake of fish and shrimp and dairy reported less breast swelling and PPWR, respectively. In accordance to our study, a clinical trial found that increasing dairy food to 4~5 servings per day may be beneficial to weight loss.[32] Studies found that high fish consumption was associated with reduced risk of breast cancer, which indicated that fish intake may be beneficial to breast health.[33] In the present study, a higher absolute negative score for cereal intake suggested that a more inadequate intake might increase the risk of dizziness, while excessive cereal intake might also have an adverse effect on both dizziness and breast swelling. Thus, both excessive and inadequate cereal intakes may be unfavourable. But the mechanisms for these putative associations are by no means clear and must be regarded as personal observations, interpretations, or beliefs until more robust intervention studies of diet and postpartum outcomes are available.

It was found that a range of behavioral practices are associated with health status. Logistic regression suggested that breastfeeding may reduce back pain and constipation, potentially adding to recognised benefits of breastfeeding for mother and baby. A follow-up study found that breastfeeding had a beneficial effect on the recovery process of pelvic girdle pain after childbirth.[34] Basking is associated with fewer hemorrhoids, breast swelling, lactation insufficiency and back pain. Outdoor sunlight and accompanying outdoor activities during postpartum period may be good to health. And sunlight spurs the body to produce vitamin D in skin, giving them important protection from a range of diseases and enhancing skeletal health.[35] Studies supported moderate physical exercise or gymnastics after childbirth to accelerate reproductive recovery, help weight management, and enhance psychological well-being and physical fitness.[36,37] According to the logistic regression analysis, it was found that doing postpartum exercise was related to less prolonged duration of lochia and postpartum weight retention. Yet, resting in bed for 12~18 h/day was positively associated with back pain and breast swelling, but bed rest time for greater than 18 h/d or less than 12 h/d is the risk

factor for prolonged duration of lochia, and lactation insufficiency, respectively. In addition, getting out of bed within two days after delivery was associated with less dizziness and leg cramp. And doing housework regularly during postpartum period will result in a high incidence of back pain. That is to say, regular exercise and adequate rest are equally important. A survey in the United States showed that career women were in poorer health status during postpartum period than other women, thus it is recommended to rest properly.[38] Above all, it is advisable to stay in bed for 12-18 hours a day, get out of bed within 2 days after delivery and do postnatal exercises regularly on the basis of adequate rest. However, this survey did not find any adverse effects on bathing, shampooing, brushing teeth, basking; on the contrary, basking is still promoting factors for women's puerperal health, which showed that these traditional behavior taboos are not reasonable. In summary, the above results suggested that women should pay attention to regular outdoor sunbath, postpartum excise, good hygiene status and breastfeeding during postpartum period to promote physical recovery and stay away from health problems.

Strengths and limitations

The first strength of this study was to recruit women from urban and suburban areas with a large sample size as well, allowing a comparison between those with their various degrees of adherence to traditional Chinese belief and practices during the postpartum period. The second strength was that trained interviewers conducted the face-to-face surveys and used the validated food frequency questionnaire to get quantitatively and comprehensive assessment of dietary and behavioral practices.

Two limitations of this study warrant mention. First, health problems and body weight from pre-pregnancy to postpartum were self-reported. For health problems including backaches, breast swelling, constipation, cramp, haemorrhoids, reportability is probably reliable, since all the interviewers were health professionals from maternal and child health clinics, and had trained uniformly before investigation, but self-reported maternal weight is error-prone, and the context of investigation may impact error distributions. Although measured weight is preferable, self-report is a cost-effective and practical measurement approach for calculating pre-pregnancy BMI, and self-reported weight during pregnancy is generally considered more accurate than weight reported during other life stages.[39] Furthermore, our study converted postpartum weight retention into a binary variable, and reduced the possibility of interpretive errors. Secondly, this cross-sectional study cannot imply causality between puerperal risk

factors and concurrent health problems. A prospective study is required for greater sociobiological clarity.

Conclusion

Postpartum dietary quality and behavioral practices and associated prevalences of maternal health problems have been detailed in Guangzhou, China. Multivariate analysis confirms that some traditional postpartum dietary and behavioral practices in China are related to the maternal morbidity, but of uncertain causality. Nutritional and healthcare practitioners may thus be able to identify, implement and evaluate measures to improve the puerperal health of Chinese women.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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Table 1. The characteristics of participating restaurants (n=90)

Components	Score	Scoring rule
Cereals[†]	-12~12	0 g = -12; 275~325 g = 0; >600 g = 12; (Score decreased by 2 with intake amount decreased by 50 g)
Vegetables	-6~0	0 g = -6; ≥500 g = 0; (Score decreased by 1 with intake amount decreases by 100g)
Fruits	-6~0	0 g = -6; ≥350 g = 0; (Score decreased by 1 with intake amount decreases by 70g)
Dairy	-6~0	0 g = -6; ≥400 g = 0; (Score decreased by 1 with intake amount decreases by 80g)
Soybean	-6~0	0 g = -6; ≥25 g = 0 (Score decreased by 1 with intake amount decreases by 5g)
Meat and poultry products	-4~4	0 g = -4; 1~25 g = -3; 26~50 = -2; 51~75 = -1 76~95 g = 0; 96~120 g = 1; 121~145 g = 2;46~170 g = 3; >170 g = 4
Fish and shrimp	-4~0	0 g = -4; 1~1 g = -3; 31~60 g = -2; 61~85 g = -1; >85 g = 0
Eggs	-4~4	0 g = -4; 1~15 g = -3; 16~30 g = -2; 31~45 g = -1 46~55 g = 0; 56~70 g = 1; 71~85 g = 2; 86~100 g = 3; >100 g = 4
Food variety[‡]	-12~0	≥12 kinds of food (soybean is 5g) = 0; (Score decreased by 1 with food variety decreased by 1)

[†]Cereals include rice, noodles, coarse grains, sweet potato, Chinese yam, taro, potato
[‡]Food variety: 1) grains, 2) tuber (such as sweet potato, Chinese yam, taro, potato.), 3) eggs, 4) red meat (such as pork, beef, mutton), 5) fishes, 6) poultry (such as chicken, duck, goose.), 7) shrimps and crabs, 8) visceral, 9) animal blood, 10) soy and soy-based products (such as soybean milk, tofu curb, tofu, bean curd pieces.), 11) green leafy vegetables, 12) other vegetables (such as eggplant, wax gourd.), 13) fruits, 14) seed (sunflower, pumpkin) 15) nut (walnut, hazelnut).

Table 2. Characteristics of the participants

	Urban		Suburban		Totals	
	n	%	n	%	n	%
Age (years)						
<25	111	11.1	312	31.4	423	21.2
25~30	586	58.5	534	53.7	1120	56.1
>30	305	30.4	129	15.0	454	22.7
Education						
Primary school	13	1.3	42	4.2	55	2.7
Middle school	112	11.2	410	40.8	522	26.0
High school	262	26.1	347	34.6	609	30.3
Junior college / vocational college	300	29.9	155	15.4	455	22.7
College and above	317	31.6	50	5.0	367	18.3
Annual household income (yuan)						
<10 k	127	12.9	137	13.9	264	13.4
10~40 k	257	26.1	520	52.7	777	39.4
40~100 k	410	41.7	281	28.5	691	35.1
>100 k	190	19.3	48	4.9	238	12.1
Mode of delivery						
Vaginal delivery	523	51.9	688	68.4	1211	60.1
Cesarean section	484	48.1	318	31.6	802	39.8
Parity						
Primipara	946	93.9	786	78.1	1732	86.0
Multipara	61	6.1	220	21.9	281	14.0

Table 3. Intake of food during postpartum period P_{50} ($P_{25} \sim P_{75}$, g/d)

Food	Urban	Suburban	Total	DG	p
Yang food					
Brown sugar	0 (0, 10)	0 (0, 10)	0 (0, 6)		<0.001[*]
Fish	100.0 (36.0, 200.0)	88.5 (29.0, 150.0)	100.0 (30.0, 180.0)	75~100-	0.124
Poultry	100.0 (43.0, 200.0)	153.5 (86.0, 300.0)	143.0 (57.0, 300.0)	75~100	<0.001[*]
Red meat	200 (100.0, 300.0)	160 (100.0, 300.0)	177.5 (100.0, 300.0)		0.028[*]
Eggs	80.0 (50.0, 120.0)	145.0 (60.0, 260.0)	100.0 (50.0, 200.0)	50	<0.001[*]
Total fish, poultry, red meat and eggs	517.0 (335.0, 850.0)	664.0 (460.8, 958.5)	605.0 (600.0, 900.0)	200~250	<0.001[*]
Yin food					
Soybeans and soybean products	0 (0, 43.0)	10 (0, 18.0)	0 (0, 29.0)	25	<0.001[*]
Green leafy vegetables	200.0 (107.0, 400.0)	150.0 (50.0, 300.0)	200.0 (100.0, 300.0)	400~500	<0.001[*]
Other vegetables	0 (0, 64.0)	14.0 (0, 64.0)	5.0 (0, 64.0)		0.051
Fruits	50.0 (0, 150)	29.5 (0, 120.0)	43.0 (0, 150)	200~400	0.004[*]
Dairy	200.0 (14.0, 250)	0 (0, 150.0)	57.0 (0, 250)	300~500	<.000[*]
Crab/Shrimp	0 (0, 0)	0 (0, 0)	0 (0, 0)		<0.001[*]
Cereals	303.5 (225.0, 450.0)	300.0 (225.0, 450.0)	300.0 (225.0, 450.0)	300~350	0.189
Nuts	0 (0, 3.0)	0 (0, 0)	0 (0, 0)	10	<0.001[*]

DG: recommended food intake according to the Dietary Guidelines for Chinese lactating women.
[*]$p<0.05$, p was derived from nonparametric test across two groups.

Table 4. Scores for the DBI components and the percentage of the participants with each score (%)

Score	Cereals	Vegetables	Fruits	Dairy	Soybean	Meat and poultry	Fish and shrimp	Eggs	Food variety
(-12) ~ (-11)	2.9	—	—	—	—	—	—	—	0
(-10) ~ (-9)	3.7	—	—	—	—	—	—	—	0.4
(-8) ~ (-7)	6.8	—	—	—	—	—	—	—	5.1
(-6) ~ (-5)	7	5.2	30.3	53.7	58.1	—	—	—	21.9
(-4) ~ (-3)	8.8	46.1	50.7	20	12.5	1	32	3.6	26.7
(-2) ~ (-1)	26.5	29.9	13.9	14.7	6.9	2.6	13.6	10.3	20.1
0	5.2	18.8	5.2	11.5	22.5	6.1	54.5	13.9	25.7
1~2	6.3	—	—	—	—	8.1	—	12.3	—
3~4	16.9	—	—	—	—	82.1	—	59.9	—
5~6	3.1	—	—	—	—	—	—	—	—
7~8	0.3	—	—	—	—	—	—	—	—
9~10	5.2	—	—	—	—	—	—	—	—
11~12	7.3	—	—	—	—	—	—	—	—
Total	100	100	100	100	100	100	100	100	100

Table 5. Behavior practice during postpartum period

	Urban		Suburban		Total		p
	n	%	n	%	n	%	
Infant feeding pattern within 4 months							
Breastfeeding	331	32.9	513	51.0	844	42.0	
Mixed feeding	331	59.9	411	40.9	1013	50.4	<0.001*
Artificial feeding	72	7.7	81	8.1	153	7.6	
Time of bed rest							
<12 h	416	41.3	490	48.7	906	45.0	
12-18 h	376	37.3	369	36.7	745	37.0	<0.001*
>18 h	215	21.4	147	14.6	362	18.0	
Bedroom ventilation							
No	7	0.7	9	0.9	16	0.8	0.628
Yes	1000	99.3	997	99.1	1997	99.2	
Get out of bed within two days							
No	400	39.7	312	31.0	712	35.4	<0.001*
Yes	607	60.3	694	69.0	1301	64.6	
Sleeping time							
>8 h	571	56.7	513	51.0	1084	53.8	0.011*
<8 h	436	43.3	493	49.0	929	46.2	
Postpartum exercise							
Per day/week	100	9.9	68	6.8	168	8.3	0.010*
Never/less	907	90.1	938	93.2	1845	91.7	
Housework							
Often	255	25.3	213	21.2	468	23.2	
Sometimes	457	45.4	526	52.3	983	48.8	0.007*
Never	295	29.3	267	26.5	562	27.9	
Basking							
Often	472	46.9	431	42.8	903	44.9	
Sometimes	361	36.8	443	44.0	804	39.9	<0.001*
Never	174	17.3	132	13.1	306	15.2	
Warmth keeping							
As usual	359	35.7	443	44.0	802	39.8	
Slightly more	631	62.7	542	53.9	1173	58.3	<0.001*
Far more	17	1.7	21	2.1	38	1.9	

*p<0.05, p was derived from chi square test.

Table 6. Prevalence of health problem during postpartum period

	Urban		Suburban		Total		p
	n	%	n	%	n	%	
Prolonged duration of lochia	810	80.4	606	60.2	1416	70.3	<0.001*
Backache	487	48.4	378	37.6	865	43.0	<0.001*
Constipation	201	20.0	274	27.2	475	23.6	<0.001*
Insufficient milk secretion	225	22.3	161	16.0	386	19.2	<0.001*
Breast swelling	196	19.5	176	17.5	372	18.5	0.255
Hemorrhoid	127	12.6	151	15.0	278	13.8	0.119
Leg cramps	101	10.0	133	13.2	234	11.6	0.026*
Dizziness	83	8.2	146	14.5	229	11.4	<0.001*

*$p<0.05$, p was derived from chi square test.

Table 7. Logistic regression analysis of factors influencing puerperium health problems[†]

Factors	p	OR	95% CI for OR	
			Lower	Upper
Prolonged duration of lochia				
Doing postpartum excise				
Never		1		
Every day/week	0.031	0.674	0.471	0.965
Time of bed rest (>18 h/d)				
No		1		
Yes	<0.001	2.079	1.509	2.864
Time of bed rest (<12 h/d)				
No		1		
Yes	<0.001	1.497	1.193	1.877
Place of residence				
Urban resident		1		
Suburban resident	<0.001	0.292	0.231	0.371
Intake of ginger vinegar				
No		1		
Yes	<0.001	1.868	1.503	2.323
Score of vegetable intake	0.001	0.894	0.839	0.953
Score of milk intake	<0.001	0.894	0.845	0.945
Breast swelling				
Basking				
Never		1		
Occasionally	0.006	0.627	0.448	0.876
Everyday/week	0.008	0.638	0.458	0.888
Time of bed rest (12-18 h/d)	0.007	0.721	0.569	0.913
Often	0.001	1.738	1.252	2.413
Positive score of cereals intake	0.004	1.043	1.013	1.073
Score of fish and shrimp intake	0.002	0.897	0.838	0.961
Insufficient milk secretion				
Place of residence				
Urban resident		1		
Suburban resident	<0.001	0.595	0.467	0.757
Basking				
Never		1		
Every day/week	0.027	0.686	0.491	0.958
Delivery way				
Vaginal delivery		1		
Caesarean birth	0.006	1.383	1.095	1.748
Time of bed rest (<12 h/d)				
No		1		
Yes	<0.001	1.609	1.276	2.029
Intake of ginger vinegar				
No		1		
Yes	0.026	1.322	1.034	1.689
Score of fruit intake	0.002	0.886	0.822	0.956

[†]The independent variables above were selected using the stepwise forward method. All potential independent variables are listed in the statistical analysis methods section.

Table 8. Logistic regression analysis of factors influencing puerperium increase health problems [†]

Factors	p	OR	95% CI for OR	
			Lower	Upper
Backache				
Breastfeeding				
No		1		
Yes	0.013	0.768	0.624	0.945
Basking				
Never		1		
Everyday/week	0.034	0.736	0.554	0.978
Doing housework				
No		1		
Yes	<0.001	1.280	1.120	1.464
Time of bed rest (12-18h/d)				
No		1		
Yes	<0.001	0.666	0.550	0.807
Delivery way				
Vaginal delivery		1		
Caesarean birth	<0.001	1.413	1.169	1.708
Hemorrhoids				
Basking				
Never		1		
Every day/week	0.028	0.820	0.687	0.979
With constipation				
No		1		
Yes	<0.001	1.881	1.431	2.472
Constipation				
Place of residence				
Urban resident		1		
Suburban resident	<0.001	1.574	1.271	1.949
Breastfeeding				
No				
Yes	0.004	0.724	0.582	0.900
Leg cramps				
Positive score of cereals intake	0.009	1.052	1.013	1.093
Getting out of bed within 2 days after delivery				
No		1		
Yes	0.008	0.651	0.474	0.893
Leg cramps during pregnancy	<0.001	2.243	1.624	3.097
Dizziness				
Getting out of bed within 2 days after delivery				
No		1		
Yes	0.046	0.744	0.557	0.994
Positive score of cereals intake	0.007	1.060	1.016	1.107
Negative score of cereals intake (absolute value)				
<0.001		1.117	1.068	1.168
Place of residence				
Urban resident		1		
Suburban resident	0.001	1.726	1.245	2.393

[†]The independent variables above were selected using the stepwise forward method. All potential independent variables are listed in the statistical analysis methods section.

Table 9. Logistic regression analysis of factors influencing postpartum weight retention[†‡]

Factors	*p*	OR	95% CI for OR	
			Lower	Upper
Doing postpartum excise				
Never		1		
Every day/week	0.039	0.701	0.501	0.983
Pre-pregnancy BMI (kg/m^2)	<0.001	0.887	0.853	0.923
Time interval between the data of investigation and delivery (months)	<0.001	0.919	0.891	0.948
Delivery way				
Vaginal delivery		1		
Caesarean birth	0.005	1.306	1.083	1.574
Score of milk intake	0.025	0.947	0.903	0.993

[†]The independent variables above were selected using the stepwise forward method. All potential independent variables are listed in the statistical analysis methods section.

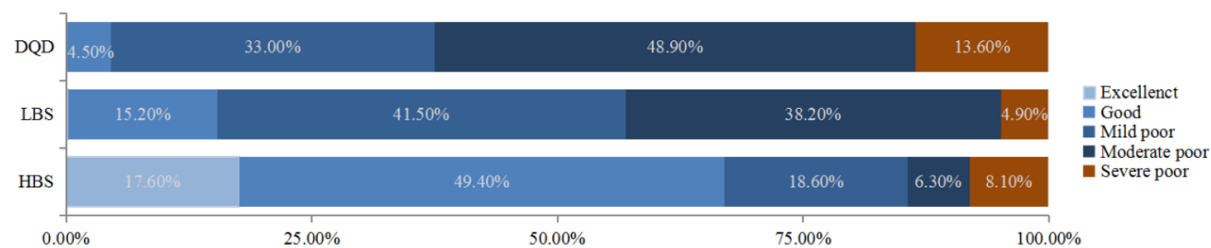[‡]Postpartum weight retention=current reported body weight minus pre-pregnancy weight.

Figure. 1. Distribution of women reached the dietary recommend intake (n=2013).
HBS: Higher Bound Score of Dietary Balance Index (DBI), an excessive intake indicator; LBS: Lower Bound Score of DBI, an inadequate intake indicator; DQD: Diet Quality Distance of DBI, an overall imbalanced food intake indicator. Score range of HBS is 0~20; Excellent:0; Good: 1~4; mild poor:5~8; Moderate poor: 9~12; Severe poor: 13~20; Score range of LBS is 0~60; No problem: 0; Good: 1~12; Mild poor: 13~24; Moderate poor: 25~36; Severe poor: 37~60; Score range of DQD is 0~60;Excellent: 0; Good: 1~12; Mild poor: 13~24; Moderate poor: 25~36; Severe poor: 37~60.

Supplementary table 1. The frameworks referenced of each categories of food

Categories	Food
Yin	
Fruit	Include fresh fruit and dry fruit
Vegetable	Green leafy vegetables
	Other vegetables (e.g eggplant, wax gourd, etc)
Shrimps and crabs	Shrimps
	Crabs
Dairy	Dairy (e.g milk, dried milk, yogurt, etc)
Yang	
Eggs	Eggs (Chicken egg, duck egg, etc)
Red meat	Red meat (e.g pork, beef, mutton, etc)
Fish	Fishes
Poultry	Poultry (e.g chicken, duck, goose, etc)
Brown sugar	
Neutral	
Cereals	Cereals (e.g. rice, noodle, coarse grain, etc)
	Tuber (e.g sweet potato, Chinese yam, taro, potato, etc)
Soybean and its products	Soy-based products (soybean milk, tofu curb)
	Soy-based products (e.g tofu, dried pieces of bean curd, etc)
Nuts	Seed (sunflower, pumpkin) or nut (walnut, hazelnut, etc)

Supplementary Table 2. How the present findings differ or compliment the authors' previous publication in this field

Factor	Previous study	Present study
Place	Wuhan, Hubei (central China)	Guangzhou, Guangdong (South China)
Dietary assessment	None	Use DBI to assess overall diet quality in aspects of inadequate intake and excessive intake.
Regression analyses	Considered intake of each kind of food as independent variables	Set DBI of each kind of food as independent variables, which can assess the association of both inadequate intake and excessive intake and postpartum outcomes.
Postpartum outcomes	The most common postpartum problems were backaches (29.6%), leg cramp (12.7%), breast problems (19.6%), constipation (18.7%), haemorrhoids (11.7%), dizziness or headaches (14.8%), anaemia (10.0%) in Wuhan.	The most common problems were prolonged duration of lochia (70.0%) and backache (43.0%), followed by constipation (23.6%), insufficient milk secretion (19.2%), breast swelling (18.5%) and hemorrhoids (13.8%) in Guangzhou. Consider postpartum weight retention as a postpartum outcome.
Traditional dietary culture	The sugar consumption (mainly brown sugar) of the participants was excessive (81.3 g/dL).	Less brown sugar intake. Most women in Guangzhou preference ginger vinegar (63.1%).