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Associations of dietary patterns and pre-eclampsia: a matched case–control study

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Abstract

Little is known about the effects of dietary patterns on prevalent pre-eclampsia in Chinese population. This study aimed to investigate the associations between dietary patterns and the odds of pre-eclampsia among Chinese pregnant women. A 1:1 age- and gestational week-matched case–control study was conducted between March 2016 and February 2019. A total of 440 pairs of pre-eclampsia cases and healthy controls were included. Dietary intakes were assessed by a seventy-nine-item FFQ and subsequently grouped into twenty-eight distinct groups. Factor analysis using the principal component method was adopted to derive the dietary patterns. Conditional logistic regression was used to analyse the associations of dietary patterns with prevalent pre-eclampsia. We identified four distinct dietary patterns: high fruit-vegetable, high protein, high fat-grain and high salt-sugar. We found that high fruit-vegetable dietary pattern (quartile (Q)4 *v.* Q1, OR 0·71, 95 % CI 0·55, 0·92, $P_{trend} = 0·013$) and high protein dietary pattern (Q4 *v.* Q1, OR 0·72, 95 % CI 0·54, 0·95, $P_{trend} = 0·011$) were associated with a decreased odds of pre-eclampsia in Chinese pregnant women. Whereas high fat-grain dietary pattern showed a U-shaped association with pre-eclampsia, the lowest OR was observed in the third quartile (Q3 *v.* Q1, OR 0·75, 95 % CI 0·57, 0·98, $P_{trend} = 0·111$). No significant association was observed for high salt-sugar dietary pattern. In conclusion, pregnancy dietary pattern characterised by high fruit-vegetable or high protein was found to be associated with a reduced odds of pre-eclampsia in Chinese pregnant women.

Key words: Dietary patterns: Pre-eclampsia: Pregnancy: Case–control study: Chinese

Pre-eclampsia is a pregnancy-specific hypertension syndrome after 20 weeks' gestation, often coming with proteinuria and oedema. This disorder is a major cause of fetal and maternal morbidity and mortality worldwide, which probably affects 3–5 % of all pregnant women[1]. Although endothelial dysfunction and immunologic aberrations have been considered as important contributors to pre-eclampsia, the definite pathophysiology is not yet fully understood[2]. Until now, delivery is still the only effective treatment for pre-eclampsia, while therapeutic drugs are not routinely recommended except for low-dose aspirin for high-risk women[3]. Given limited treatment options, modifications of dietary patterns have emerged as a potential intervention to prevent the development of pre-eclampsia[4–6].

Previous researches have investigated the potential effects of single nutrient supplementation on pre-eclampsia development. Unfortunately, fish oil[7], folic acid[8], antioxidants such as vitamins C and E[9], and vitamin D[10] studies have failed to provide anticipated clinical benefits. Ca supplementation seemingly exhibits protection from pre-eclampsia, with the greatest effect among women with low-baseline Ca intake[11]. These findings suggest the complexity of nutritional intervention to reduce pre-eclampsia risk, especially in consideration of that food

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and nutrients are generally consumed in various characteristic combinations that synergistically influencing diseases[12]. Taken together, evidences estimating the overall effects of dietary patterns on pre-eclampsia risk might provide a better understanding regarding the relationship between modifiable dietary factors with pre-eclampsia.

Recently, several studies have assessed the effect of overall dietary pattern on the risk of pre-eclampsia[4,6,13] A Norway study found that women with high scores on a dietary pattern characterised by vegetables and plant foods are less likely to suffer from pre-eclampsia than those without[13]. Moreover, a meta-analysis mainly synthesising data from developed countries showed that dietary pattern with a higher intake of fruits, vegetables, whole grains and fish is associated with a decreased likelihood of pre-eclampsia[5]. Similar evidences in Chinese population, who are thought to have entirely different dietary habits from western population[14], are still limited. Only a post hoc analysis of a cluster randomised controlled trial conducted in northwestern China showed a positive association between vegetable dietary pattern and reduced risk of pre-eclampsia[15]. However, considering the small number of incident pre-eclampsia cases (n 19) in the above study, along with the lack of adjustment for confounding factors, further researches are warranted to clarify the relationship between different dietary patterns and pre-eclampsia risk in this specific population.

Therefore, we conducted a matched case–control study to investigate the associations between dietary patterns derived from the principal components factor analysis and the odds of pre-eclampsia in a central province of China.

Methods

Study population

This was a 1:1 matched case–control study conducted between March 2016 and February 2019 in the First Affiliated Hospital of Zhengzhou University, China. Eligible cases with singleton pregnancy and pre-eclampsia were included. The diagnosis of pre-eclampsia was confirmed by the presence of both gestational hypertension and proteinuria according to the Diagnosis and Treatment Guideline of Hypertensive Disorders in Pregnancy (2015)[16]. Subjects were excluded if they had any of the following: (1) patients with gestational hypertension alone, eclampsia or pregnancy complicated by chronic hypertension; (2) patients with heart disease, malignancy, hyperthyroidism, immune system diseases, chronic renal insufficiency or other endocrine system diseases and (3) patients with epilepsy, depression or other mental/cognitive dysfunction.

For each participating case, we attempted to enrol one matched healthy control according to age (±3 years) and gestational weeks (±1 week), with the same inclusion and exclusion criteria applying, except for those with a history of pre-eclampsia. All of the controls were hospitalised during the same period. All the participants provided signed informed consent before being interviewed. The details of study flow chart are presented in Fig. 1. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects/patients were ethically approved by the First Affiliated Hospital of Zhengzhou University Ethics Committee (No. Scientific research-2016-LW-34).

Data collection

The individual information was collected by trained interviewers (masters of public health) using a structured questionnaire on socio-demographic characteristics, lifestyle habits, pre-pregnancy weight, history of disease, menstrual and childbearing. Participants' weight and height were measured by a trained researcher. The detailed information has been described in previous study[17].

Dietary assessment and food grouping

Dietary consumption information was assessed using a valid seventy-nine-item FFQ[18], to evaluate the food intake during the last 3 months before recruitment. For each food item, four possible frequencies (never, per month, per week and per day) and the amount of consumption each time in gram or millilitre are available. Photographs of food portion sizes were used to help estimate the amount of food consumption. The intake of energy (kcal/d) and key nutrients from each food were calculated according to the Chinese Food Composition Tables[19,20]. To reduce the complexity of the data, the seventy-nine food items were aggregated into twenty-eight groups according to culinary usage and the similarities of the nutritional composition to identify dietary patterns.

Statistical analyses

Demographic characteristics and other potential pre-eclampsia risk factors were compared using paired t tests (continuous variables) or paired χ^2 tests (categorical variables) between cases and controls. The residual method was used to adjust total energy intake for each food item[21]. Factor analysis with factor loadings extracted using the principal component method and varimax/orthogonal rotation was used to derive the dietary patterns for the twenty-eight standardised, energy-adjusted groups. Four factors were retained based on an inspection of the scree plots, and those factors were rotated by orthogonal transformation (varimax procedure) to facilitate their interpretability. Variables that have loadings of 0·25 or greater are considered to contribute significantly to the dietary pattern[22]. Factor scores are calculated for each derived patterns by summarising all the food groups[23]. Factors are numbered and given temporary labels according to the food groups that loaded highly on the dietary pattern.

Conditional logistic regressions were used to analyse the association between dietary pattern scores and pre-eclampsia. For each factor, the bottom quartiles group (Q1) was defined as the reference group. Two multivariate logistic regression models were introduced to calculate OR with their corresponding 95 % CI: model 1: without any adjustment; model 2: adjusted for age, gestational week, education, income, pre-pregnancy BMI, passive smoking during pregnancy, folic acid supplement and physical activity.

Subgroup analyses were conducted to investigate whether the associations of dietary patterns differed across various

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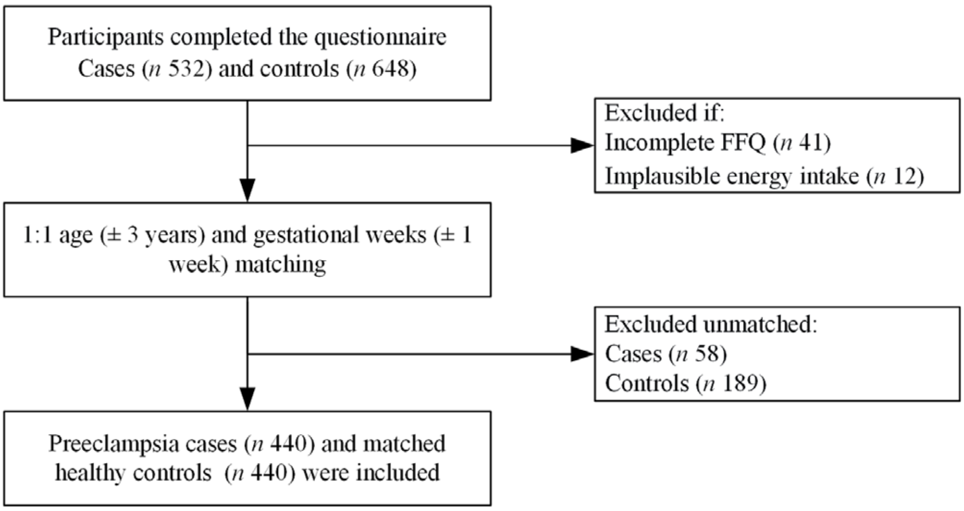

Fig. 1. Study flow chart for the inclusion and exclusion process.

subgroups classified by BMI, physical activity level and family history of hypertension or other vascular disease (including hypertension, coronary artery disease, cerebrovascular diseases, gestational hypertension, pre-eclampsia and eclampsia). All of the statistical analyses were performed using SPSS software (version 22.0), and a two-sided P value < 0·05 was considered statistically significant.

Results

The demographic and other characteristics are shown in Table 1. A total of 440 pre-eclampsia cases with a mean age of 30·88 (SD 5·03) years old were included. In addition, 440 eligible age- (±3 years) and gestational week- (±1) matched controls (age: 31·03 (SD 4·85) years) recruited from the same hospital were also enrolled. Compared with the controls, the cases were more likely to have a lower educational level, a lower serum Ca and vitamin D level but a higher pre-pregnancy BMI and total energy intake. The family history of hypertension or other vascular disease was more frequently seen in the cases group. Cases and controls did not differ in age, gestational weeks, physical activity, multivitamin use, Ca supplementation, vitamin D supplementation, folic acid supplementation or passive smoking.

Four main factors were retained from the factor analysis. The factor loadings associated with each dietary pattern are shown in Table 2. Each pattern was labelled according to the food groups with high absolute loadings. The first factor, named the high fruit-vegetable pattern, was characterised by a high intake of fruits, vegetables, and molluscs and shellfish. The second factor, named as the high protein pattern, was characterised by a high intake of poultry without skin, high fat milk, mushroom and algae, nuts, and soyabean and its products. The third factor, named as high fat-grain pattern, represented a high intake of poultry with skin, cooking oil, red meat and whole grain. The fourth factor, named as the high salt-sugar pattern, was characterised by a high intake of soft drinks, processed vegetable and processed meat. Factors 1–4 accounted for 7·97, 7·52, 5·08 and 5·06 % of the variability, respectively, and 25·63 % of the variance in food intake overall.

After adjustments for age, gestational week, education, income, pre-pregnancy BMI, passive smoking during pregnancy, folic acid supplement and physical activity, the high fruit-vegetable pattern was associated with a decreased odds of pre-eclampsia, with OR for comparison between the highest *v.* lowest quartile scores of 0·71 (95 % CI 0·55, 0·92) (P_{trend} = 0·013). Significant association was also observed between the high protein dietary pattern and the odds of pre-eclampsia (Q4 *v.* Q1, OR 0·72, 95 % CI 0·54, 0·95, P_{trend} = 0·011). Whereas high fat-grain dietary pattern showed a numerical U-shaped association with pre-eclampsia, the lowest odds of pre-eclampsia was observed in the third quartile (Q3 *v.* Q1, OR 0·75, 95 % CI 0·57, 0·98, P_{trend} = 0·111). No significant association was observed for the relationship of high salt-sugar pattern (P_{trend} = 0·335) with pre-eclampsia (Table 3).

Table 4 shows the results of subgroup analyses stratified by BMI, physical activity and family history of hypertension or other vascular disease. The associations of dietary patterns and the odds of pre-eclampsia were similar for most strata. However, stronger association between high fruit-vegetable pattern and the odds of pre-eclampsia ((Q4 *v.* Q1, OR 0·58, 95 % CI 0·38, 0·86, P_{trend} = 0·010) for participants with a below-median level of physical activity; (Q4 *v.* Q1, OR 0·87, 95 % CI 0·62, 1·24, P_{trend} = 0·488) for participants with a median or above level of physical activity ($P_{interaction}$ = 0·031)) seemed to exist among participants with a below-median level of physical activity. Similarly, those participants also have a stronger association between high protein dietary pattern and prevalent pre-eclampsia ((Q4 *v.* Q1, OR 0·51, 95 % CI 0·33, 0·81, P_{trend} = 0·001) for participants with a below-median level of physical activity; (Q4 *v.* Q1, OR 0·87, 95 % CI 0·61, 1·26, P_{trend} = 0·442) for participants with a median or above level of physical activity ($P_{interaction}$ = 0·022)). Besides, an interaction effect between high protein pattern and family history of hypertension or other vascular disease was also observed ((Q4 *v.* Q1, OR 0·55, 95 % CI 0·38, 0·79, P_{trend} = 0·001) for participants without family history

Table 1. Demographics, lifestyle characteristics and pre-eclampsia risk factors of the study population (Mean values and standard deviations; numbers and percentages)

Characteristics	Case (*n* 440)		Control (*n* 440)		*P*
Age (years)					
Mean	30·88		31·03		0·114
SD	5·03		4·85		
Gestational weeks					
Mean	34·17		34·24		0·066
SD	2·90		2·67		
Educational level (%)					0·003
Lower than primary school	44	10·0	18	4·1	
Middle or high school	238	54·1	229	52·0	
University or above	158	35·9	193	43·9	
Pre-pregnancy BMI (kg/m^2, %)*					< 0·001
Normal (< 25)	289	65·7	360	81·8	
Overweight (25–28)	94	21·4	50	11·4	
Obesity (≥ 28)	57	13·0	30	6·8	
Family history of pre-eclampsia (%)	2	0·5	1	0·2	> 0·999
Family history of hypertension or other vascular disease (%)	179	40·7	108	24·5	< 0·001
Total energy intake (kcal/d)					
Mean	1850·39		1962·08		0·001
SD	504·27		520·64		
Physical activity (MET/h·d)†					
Mean	26·95		26·60		0·241
SD	3·96		4·48		
Passive smoking (%)‡	67	15·2	59	13·4	0·488
Serum Ca (mmol/l)					
Mean	2·09		2·17		< 0·001
SD	0·16		0·15		
Ca supplementation (%)	256	58·4	273	62·2	0·298
Serum vitamin D (ng/ml)					
Mean	12·30		16·28		0·012
SD	6·97		8·58		
Vitamin D supplementation (%)	232	53·1	242	55·1	0·643
Folic acid supplementation (%)	351	79·8	359	81·6	0·543
Aspirin (%)	4	0·9	4	0·9	> 0·999

MET, metabolic equivalent.
* Pre-pregnancy BMI was defined as pre-pregnancy body weight (kg)/square of height (m^2).
† Physical activities included daily occupational, leisure time and household chores, evaluated by metabolic equivalent hours per day.
‡ Passive smoking was defined as exposure to second-hand smoke for 1 or more cigarettes daily for at least 6 consecutive months during the past year.

of hypertension or other vascular disease; (Q4 *v.* Q1, OR 1·05, 95 % CI 0·68, 1·64, $P_{trend} = 0·969$) for participants with family history of hypertension or other vascular disease ($P_{interaction} = 0·041$)).

Discussion

In this first matched case–control study of Chinese pregnant women, we investigated the associations between dietary patterns and prevalent pre-eclampsia by the means of factor analysis. We found that high fruit-vegetable dietary pattern and high protein dietary pattern were significantly associated with a lower odds of pre-eclampsia, even adjusting for confounding factors. Moreover, we also reported the potential modified effect of physical activity and family history of vascular disease on the association of dietary patterns with pre-eclampsia.

Increasing studies exploring the associations between dietary patterns and pre-eclampsia risk have shown that high fruit-vegetable dietary pattern was a protective factor for pre-eclampsia[13,15,24,25]. The Norwegian Mother and Child Cohort Study with more than 70 000 pregnancy women found that the pattern characterised with high consumption of vegetables, plant foods and vegetable oils was associated with reduced risk of pre-eclampsia[13]. The Danish National Birth Cohort found an inverse association between a seafood diet pattern featuring high fish and vegetables and pre-eclampsia development[4]. Although living with different dietary habits[14], our study conducted in central China also supports the hypothesis that high fruit-vegetable diet might be beneficial for prevention of pre-eclampsia. Comparing to a previous post hoc analysis[15] conducted in northwestern China, we revealed a smaller effect size of high fruit-vegetable dietary pattern on the decreased odds of pre-eclampsia, this could be partly attributed to different study design and younger participants in their study.

In the present study, the high fruit-vegetable dietary pattern characterised by high intake of fruits, vegetables, molluscs and shellfish is similar to traditional Mediterranean diet, which has been evidenced to reduce risk of several chronic disease[26,27]. Previous studies have demonstrated that this dietary pattern can reduce inflammatory markers level and improve insulin resistance[28,29], which were significantly involved in the pathophysiology of pre-eclampsia[30]. In addition, diets rich in fruit and vegetables have been reported to be inversely associated with

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Table 2. Varimax-rotated food group factor loading scores*

Food group	High fruit-vegetable dietary pattern	High protein dietary pattern	High fat-grain dietary pattern	High salt-sugar dietary pattern
Melon and fruit-vegetable	0·673			
Dark colour vegetable	0·671			
Light colour vegetable	0·643			
Root vegetable	0·407			
Molluscs and shellfish	0·356	0·328		
Egg				
Poultry without skin		0·564		
High fat milk		0·467		
Mushroom and algae		0·463		
Dark colour fruit		0·456		0·259
Nuts		0·451		
Soyabean and its products	0·333	0·35		
Animal organ		0·306		
Other soyas	0·266	0·281		
Sea fish		0·267		
Freshwater fish				
Chinese herb tea				
Poultry with skin			0·616	
Cooking oil			0·532	
Red meat		0·434	0·499	
Whole grain			0·436	0·387
Sodas			0·256	
Coffee				
Fruit juice				0·573
Processed vegetable				0·535
Light colour fruit	0·293			0·437
Processed meat				0·347
Defatted milk				
Variability determination, %	7·97	7·52	5·08	5·06

* Dietary patterns were determined by principal components factor analysis. Factor loadings with absolute values ≥ 0·25 were listed in the table among twenty-eight food groups.

Table 3. Association of quartiles of dietary patterns with the odds of pre-eclampsia (Numbers, odds ratios and 95 confidential intervals)

	Quartile of dietary energy-adjusted intake							
		Quartile 2		Quartile 3		Quartile 4		
Dietary pattern	Quartile 1	OR	95 % CI	OR	95 % CI	OR	95 % CI	P_{trend}
High fruit-vegetable pattern								
n (case/control)	139/89	104/112		100/109		97/130		
Model 1	1·00	0·79	0·61, 1·01	0·78	0·60, 1·01	0·70	0·54, 0·90	0·007
Model 2	1·00	0·79	0·61, 1·02	0·80	0·62, 1·03	0·71	0·55, 0·92	0·013
High protein pattern								
n (case/control)	135/85	109/101		99/120		97/134		
Model 1	1·00	0·84	0·66, 1·09	0·73	0·57, 0·95	0·68	0·52, 0·88	0·002
Model 2	1·00	0·87	0·67, 1·12	0·77	0·59, 1·00	0·72	0·54, 0·95	0·011
High fat-grain pattern								
n (case/control)	123/99	117/105		93/120		107/116		
Model 1	1·00	0·95	0·74, 1·23	0·79	0·60, 1·03	0·87	0·67, 1·12	0·139
Model 2	1·00	0·92	0·71, 1·19	0·75	0·57, 0·98	0·85	0·66, 1·11	0·111
High salt-sugar pattern								
n (case/control)	125/128	117/117		94/75		104/120		
Model 1	1·00	1·01	0·79, 1·30	1·13	0·86, 1·48	0·94	0·72, 1·22	0·836
Model 2	1·00	1·06	0·82, 1·38	1·20	0·91, 1·58	1·12	0·83, 1·51	0·335

Model 1: without any adjustment.
Model 2: adjusted for age, gestational week, education, income, pre-pregnancy BMI, passive smoking, folic acid supplementation and physical activity.

plasma homocysteine level[31], a marker promoting pre-eclampsia development[32,33].

Interventional trials have failed to build a definite relationship between protein supplementation and pre-eclampsia in pregnant women[34]. A balanced protein-energy supplementation (protein content < 25 % of total energy content) also showed no effects on reducing pre-eclampsia risk in a meta-analysis[35]. In those included studies, however, alternate treatment allocation and a number of participants lost to follow-up had largely weaken their findings. Interestingly, we found a potential protective role of high protein dietary pattern in pre-eclampsia development among Chinese pregnant women. Different from protein supplementation,

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Table 4. Stratified analyses for the association between dietary patterns and the odds of pre-eclampsia (Numbers, odds ratios and 95 confidential intervals)

		Quartile of dietary energy-adjusted intake								
			Quartile 2		Quartile 3		Quartile 4			
Dietary pattern	Case/control *n*	Quartile 1	OR	95 % CI	OR	95 % CI	OR	95 % CI	P_{trend}	$P_{interaction}$
High fruit-vegetable pattern										
BMI*										0·663
< 25 kg/m²	383/410	1·00	0·77	0·59, 1·01	0·79	0·6, 1·04	0·69	0·52, 0·91	0·013	
≥ 25 kg/m²	57/30	1·00	0·81	0·39, 1·70	0·76	0·33, 1·75	0·83	0·40, 1·75	0·624	
Physical activity†										0·031
< median	238/200	1·00	0·72	0·50, 1·06	0·72	0·49, 1·05	0·58	0·38, 0·86	0·010	
≥ median	202/240	1·00	0·86	0·61, 1·22	0·89	0·62, 1·29	0·87	0·62, 1·24	0·488	
Family history of hypertension or other vascular disease‡										0·588
No	261/332	1·00	0·76	0·55, 1·06	0·77	0·55, 1·07	0·70	0·5, 0·98	0·042	
Yes	179/108	1·00	0·78	0·52, 1·18	0·83	0·55, 1·25	0·73	0·48, 1·11	0·175	
High protein pattern										
BMI*										0·643
< 25 kg/m²	383/410	1·00	0·88	0·66, 1·16	0·79	0·59, 1·05	0·73	0·54, 0·99	0·030	
≥ 25 kg/m²	57/30	1·00	0·68	0·34, 1·38	0·49	0·19, 1·25	0·48	0·22, 1·04	0·048	
Physical activity†										0·022
< median	238/200	1·00	0·78	0·54, 1·12	0·41	0·41, 0·91	0·51	0·33, 0·81	0·001	
≥ median	202/240	1·00	0·95	0·65, 1·38	0·90	0·62, 1·31	0·87	0·61, 1·26	0·442	
Family history of hypertension or other vascular disease‡										0·041
No	261/332	1·00	0·74	0·53, 1·03	0·71	0·5, 0·99	0·55	0·38, 0·79	0·001	
Yes	179/108	1·00	1·05	0·69, 1·61	0·88	0·56, 1·36	1·05	0·68, 1·64	0·969	
High fat pattern										
BMI*										0·681
< 25 kg/m²	383/410	1·00	0·93	0·71, 1·23	0·76	0·57, 1·02	0·87	0·66, 1·14	0·163	
≥ 25 kg/m²	57/30	1·00	0·78	0·38, 1·59	0·65	0·30, 1·44	0·69	0·30, 1·56	0·316	
Physical activity†										0·136
< median	238/200	1·00	0·90	0·61, 1·31	0·77	0·51, 1·16	0·84	0·56, 1·25	0·297	
≥ median	202/240	1·00	0·94	0·66, 1·33	0·75	0·52, 1·09	0·89	0·63, 1·26	0·321	
Family history of hypertension or other vascular disease‡										0·321
No	261/332	1·00	0·88	0·64, 1·22	0·73	0·51, 1·03	0·75	0·53, 1·05	0·049	
Yes	179/108	1·00	1·02	0·67, 1·56	0·76	0·48, 1·20	1·05	0·69, 1·59	0·892	
High salt-sugar pattern										
BMI*										0·516
< 25 kg/m²	383/410	1·00	1·05	0·80, 1·38	1·18	0·87, 1·60	1·06	0·76, 1·47	0·550	
≥ 25 kg/m²	57/30	1·00	0·86	0·33, 2·24	1·30	0·61, 2·78	1·30	0·54, 3·11	0·416	
Physical activity†										0·202
< median	238/200	1·00	0·95	0·64, 1·41	1·25	0·83, 1·87	1·01	0·68, 1·51	0·665	
≥ median	202/240	1·00	1·19	0·84, 1·68	1·05	0·72, 1·52	0·98	0·68, 1·40	0·786	
Family history of hypertension or other vascular disease‡										0·704
No	261/332	1·00	1·00	0·71, 1·42	1·19	0·83, 1·70	1·21	0·82, 1·80	0·242	
Yes	179/108	1·00	1·12	0·75, 1·66	1·15	0·73, 1·81	1·01	0·62, 1·63	0·885	

* Adjusted for age, gestational week, education, income, passive smoking, folic acid supplementation and physical activity.
† Adjusted for age, gestational week, education, income, pre-pregnancy BMI, passive smoking, folic acid supplementation and physical activity.
‡ Adjusted for age, gestational week, education, income, pre-pregnancy BMI, passive smoking and folic acid supplementation.

the dietary protein sources in this study are more diverse. Some specific components like fruit, nuts and sea fish in the high protein dietary pattern have been found to decrease the odds of pre-eclampsia[34]. More importantly, a relatively high protein intake might reduce the energy demand of carbohydrate and fat, contributing to a balanced protein-energy dietary model[36]. Besides, it should be noted that a family history of hypertension or other vascular disease might attenuate the benefits of high protein intake. Considering the remarkable relationship between family history of vascular disease and pre-eclampsia[37,38], it is reasonable to speculate that dietary factors alone may not be sufficient to influence the pre-eclampsia development in pregnant women under high-risk.

Our study found a numerical but not significant U-shaped association between high fat-grain dietary pattern and prevalent pre-eclampsia, suggesting a probable threshold effect in the present analysis. In contrast, the Generation R Study and Danish National Birth Cohort study found that the traditional Northwest European dietary pattern characterised as high intake of red meat and potato was associated with increased odds of pregnancy hypertensive disorders[4,39]. Considering that a non-linear relationship exists between total fat intake and CVD in general population[40], further studies are still warranted to find the optimum dose of fat intake to prevent pre-eclampsia in Chinese pregnant women.

Strengths and limitations

The present study has several strengths. First, the investigation was the first matched case–control design with a large number of pre-eclampsia cases to find that both high fruit-vegetable dietary pattern and high protein dietary pattern were significantly associated with lower odds of pre-eclampsia. Additionally, multivariable adjustments for demographics and lifestyle factors enhance the robustness of the results. These findings add important information from Chinese population on the role of diet in pre-eclampsia and shed light on future strategy of dietary management during pregnancy. However, several limitations should be simultaneously acknowledged. First, the results derived from a case–control study make it impossible for us to investigate the causal relationships between dietary pattern and pre-eclampsia development. Second, given relatively small sample size, the results' interpretations regarding the associations should be generalised with caution. Third, our findings may be limited by recall bias during the interview for the questionnaire and selection bias due to selection of hospital-based controls. Moreover, cases were more likely to change their dietary habits after diseases. To make the measurements more accurate, trained interviewers used photographs of food portion sizes to administer the FFQ through face-to-face interview. And to decrease the recall bias, we only collected the dietary intake of the pregnant women during the 3 months before delivery. Finally, it is well known that FFQ could bring a certain degree of measurement error even though we used the FFQ which has been previously validated[18].

Conclusion

Our findings indicate that high fruit-vegetable dietary pattern and high protein dietary pattern might protect against pre-eclampsia in Chinese pregnant women. Further prospective cohort studies with larger sample size are needed to verify these findings.

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There are no conflicts of interest to declare.

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