Original Article

Association of dietary diversity with uterine fibroids among urban premenopausal women in Shijiazhuang, China: A cross-sectional study

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Background and Objectives: Uterine fibroids (UFs) are the most common neoplasm affecting reproductive-age women. The purpose of the present study is to explore the association between dietary diversity and risk of UFs in a cross-sectional study of urban premenopausal women. **Methods and Study Design:** A total of 248 urban premenopausal women with age of 20-45 were recruited in 3 randomly chosen hospitals in Shijiazhuang, China. Dietary diversity was assessed from food frequency intake data using dietary diversity score (DDS), Prime Diet Quality Score (PDQS) and food variety score (FVS). UFs were diagnosed by the methods of ultrasound, pelvic exam, or surgery. Binary logistic regression was used to estimate the relationship between dietary diversity and risk of UFs. **Results:** 37 of the study subjects (14.9%) had UFs. Participants with a low education level and single marital status participants had a lower DDS and PDQS, respectively. After adjustment for confounding factors, a higher DDS 24 was associated with decreased UF risk (OR=0.22, 95% CI=0.05–1.01). Similar trends were observed for the plant-based FVS (p_{trend}=0.025). Carrot (OR=0.04, 95% CI=0.00–0.48) and kiwi fruit (OR=0.03, 95% CI=0.00–0.47) were also inversely associated with risk of UFs after adjustment for confounding factors. **Conclusions:** Multifarious food groups and the increase of variety of plant-based food, especially carrot and kiwi fruit, may be associated with the lower risk of UFs; they may play an important role in inhibiting the formation of UFs.

Key Words: uterine fibroids, premenopausal women, dietary diversity score, plant-based food variety score, Prime Diet Quality Score

INTRODUCTION

Uterine fibroids (UFs), also known as uterine leiomyoma, are hormone-responsive benign myometrial neoplasms.[1] UFs are the most common neoplasm affecting reproductive-age women. Their incidence and prevalence both have a wide range, being particularly high in older and black women.[2] UFs typically remain asymptomatic; however, an estimated 15%–30% of women with UFs experience chronic and severe symptoms, including dysmenorrhea, menorrhagia, pelvic pain, anemia, recurrent pregnancy loss and preterm labour, and infertility.[3,4] In the presence of these symptoms, UFs pose a major threat to quality of life, especially because of the need for hysterectomy. Notably, the prevalence of UFs among young women has been increasing gradually.

Although knowledge regarding the etiology of UFs is limited, age is a known risk factor: the incidence of UFs increases with age. A family history of UFs and a relatively long interval since last birth also increase the UF risk. Parity and use of oral contraceptives are considered protective factors against UFs.[5] Some studies have also indicated that overweight and obesity, smoking, lack of exercise, and diet are correlated with increased UF incidence.[6,7]

Studies examining the relationship between dietary components, including carotenoids, and UF risk have provided inconsistent results.[8-12] This may be because the studies were limited to assessing the effect of a single nutrient or a single type of food species on UFs and used varying intervention doses. Some nutritional epidemiology studies have used dietary pattern analysis, which considers the cumulative and interactive effects among dietary components to reflect the complexity of the human diet; such

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Manuscript received 16 June 2020. Initial review completed 28 July 2020. Revision accepted 23 September 2020.
doi: 10.6133/apjcn.202012_29(4).0012

studies examine the effect of the overall quality of diet on diseases rather than focusing on single nutrients or food types.[13] Two overarching categories of dietary pattern analysis approaches are used: data-driven approaches that use multivariate statistical techniques, such as factor or cluster analysis, and dietary quality indices or dietary scoring methods, which are based on a priori guidelines or a previously validated and reliability-tested a priori dietary quality index, such as dietary diversity score (DDS), Prime Diet Quality Score (PDQS), and food variety score (FVS). These approaches can provide some evidence to evaluate whether dietary patterns are beneficial to health and can also determine the association between overall dietary quality and health status to help reduce the risk of diseases. To our knowledge, no studies have investigated the association between dietary diversity and risk of UFs. Therefore, this cross-sectional study of urban premenopausal women explored the relationship between DDS, PDQS, and FVS and UF risk.

METHODS

Study participants

A cross-sectional study was conducted from May 2016 to October 2016 at hospital physical examination centers of 3 randomly chosen hospitals in Shijiazhuang, China. The study protocol was reviewed and approved by the Ethics Committee of Hebei Medical University (No. 2016010), and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

A total of 261 Chinese women aged 20–45 years who were not pregnant, lactating or menopausal were recruited. All participants were free of signs, symptoms, and history of any overt chronic disease. After 13 participants were excluded who had >10 missing food items on the food frequency questionnaire (FFQ), data from 248 participants were used for analysis.

Dietary assessment

Food items included in this study were based on the Handbook of Monitoring the Nutrition and Health Status of Chinese Residents (2010), adjusted for local eating habits and seasonal characteristics. The FFQ included 100 food items, and consumption frequencies were divided into the following: never/rare, 1-3 times a month, once a week, 2-4 times a week, 5-6 times a week, once a day, and ≥2 times a day. To evaluate the relationship between food items and UF risk, consumption frequencies were grouped into three levels for statistical analysis: low-level intake (never/rare), moderate intake (1-3 times a month or once a week), and high-level intake (from 2-4 times a week to ≥2 times a day).

Assessment of dietary diversity

Using the 100-item FFQ mentioned earlier, we assessed dietary diversity. According to the method of Jin et al., DDS 9 and DDS 28 were calculated.[14] Because the study participants consumed relatively low amounts of molluscs, starch and starchy products, medicinal food, and other species, DDS 28 was adjusted to DDS 24; the food groups are presented in Table 1. Participants received 1 point for a food group in either DDS 9 or DDS 24 if they consumed a food in it at least 2–4 times per week; otherwise, no point was awarded. The same food group was not scored repeatedly. The total DDS was the sum of the score of all nine food groups for DDS 9 (range, 0–9) or all 24 food groups for DDS 24 (range, 0–24), with higher scores indicating greater dietary diversity.

The PDQS is a score based on 23 food groups; it contains 16 ‘healthy’ food groups (whole grains; legumes; leguminous vegetables; root vegetables; stem, leafy, and flowering vegetables; cucurbitaceous vegetables; solanaceous vegetables; fungi and algae; scallion and garlic; orange/mandarin; other fruit; nuts; poultry; fish; eggs; and liquid vegetable oils) and seven ‘unhealthy’ food groups (refined grains and desserts, red meat, sweet potato and potato, dairy products, sugar, sugar-sweetened beverages, and alcohol). Scores are allocated according to the consumption frequency (healthy foods: 0 points for 0–1 times/week, 1 point for 2–4 times/week, and 2 points for more than 5 times/week, with reverse scoring for unhealthy foods). PDQS has a range of 0–46.[15]

Food variety was measured as the total number of the individual food items consumed. The food items and their corresponding points for the total FVS were as follows: whole grain cereals (1), legumes (4), vegetables (22), fruits (9), nuts (4), dairy products (2), meats and fish (12), and eggs (1). Refined grains, desserts, oils and fats, sugar-sweetened beverages, sugar, and condiments were excluded.[16] The FVS of each food group, the plant-based (whole grain cereals, legumes, vegetables, fruits, and nuts) FVS, and the animal-based (dairy products, meats and fish, and eggs) FVS were further assessed. One point was awarded for each food item consumed at least twice a week.

The DDS 9, DDS 24, PDQS, total FVS, plant-based FVS, and animal-based FVS were further divided into low, medium, and high categories according to their tertiles.

Diagnosis of UFs

UFs were diagnosed using ultrasound, through a pelvic exam, or during surgery, with a tumour diameter of ≥0.5 cm confirming UFs.

Measurement of variables

Information on demographic details, personal behaviour, dietary pattern, reproductive characteristics, and UFs were collected using a self-reported questionnaire, which was developed on the basis of information from numerous relevant articles.

Demographic factors included the following: age in years (20-24, 25-29, 30-34, 35-39, or 40-45); education level (less than high school degree, high school degree, bachelor’s degree, master’s degree, or higher than master’s degree), income per month (<\$300, \$300-449, \$450-749, \$750-1499, or ≥\$1500), occupation (civil servant/financial industry, institution, office worker, freelance, or others), marital status (married, single, or divorced), and activity at work (sedentary or other).

The questionnaire collected the following information: smoking status (never, current, or former), drinking status (never, current, or former), and physical exercise frequency (never, 1–3 times a month, once a week, 2–4 times a week, 5-6 times a week, or once a day).

BMI was calculated as body weight (kg) divided by height squared (m^2; categories: <18.5, 18.5-23.9, 24.0-27.9,

Table 1. Components of the food groups categories used in this study

Food Groups		Samples
DDS 9	DDS 24	
Cereals	Cereals	Bread, steamed bun, rice, noodles, porridge, fried dough cake, fried dough bars, other fried dough pasta Millet, corn, oats (Whole grain cereals)
	Dessert	Cream cake, biscuits, other cake
Legumes	Soybean products	Soybean, soybean milk, tofu, fermented bean curd, ready-to-eat soy product, bean curd skin
Vegetables	Leguminous vegetable	Green bean, cowpea
	Root vegetable	Sweet potato, potato, carrot, lotus root, turnip
	Stem, leafy and flowering vegetable	Dark green vegetable (rape, dark green chives and spinach), celery, broccolis, cauliflower, purple cabbage, Chinese cabbage, cabbage
	Cucurbitaceous vegetable	Cucumber, pumpkin
	Solanaceous vegetable	Tomato, green pepper, aubergine
	Fungi and algae	Agaric and mushroom (dried), variety mushroom (fresh), seaweed, kelp
	Allium vegetable	Onion
Fruits	Fresh fruits	Orange, mandarin, apple, banana, peach, pear, grape, kiwi fruit, watermelon, melon
Eggs	Eggs and egg products	Chicken egg, duck egg, quail egg
Dairy	Milk and milk products	Liquid milk, yogurt
Meats	Red meat	Pork, beef, lamb, other meat
	Poultry and poultry organ	Poultry, goose liver, chicken liver, duck blood
Fish	Fish and other seafood	Freshwater fish, sea fish
	Shrimp and crab	Shrimp, crab
Oils	Oils and fats	Vegetable oil
	Nuts	Peanut, melon seed, walnut, other nuts
	Tea, coffee and beverage	Green tea, black tea (brewing), Cola etc. (Diet, zero cola), 100% fruit juice, fresh vegetable juice, tea beverage, coffee
	Sugars	Sugars, chocolate
	Condiments	Chili products, broad bean sauce, soybean paste
	Dietary supplement	Vitamin A, vitamin B, vitamin C, vitamin D, vitamin E, calcium, protein powder, multi vitamin, other supplements
	Alcohol	Beer, wine, liquor

DDS: dietary diversity score.

or ≥28.0).

Information collected on reproductive characteristics included the following: age at menarche (≤10, 11, 12, 13, 14, or ≥15), age at first birth (nullipara, 20-24, 25-29, 30-34, or 35-39), artificially induced abortion status (0, 1, or ≥2), time since last birth (nullipara, <5 years, 5-9, 10-14, or ≥15), current contraceptive ring use, and family history of UFs.

Statistical analysis

EpiData version 3.1 (EpiData Odense, Denmark) was used for data input, and consistency checks were performed to avoid erroneous inputs. Chi-square tests were performed to assess the differences in participant characteristics. Binary unconditional logistic regression was used to estimate ORs and 95% CIs to quantify the association between DDS 9, DDS 24, PDQS, FVS, and risk of UFs. Chi-square tests were used to calculate the *p* value of trends between changes in quantities of foods consumed (ordinal data) and prevalence of UFs before considering confounders. Binary unconditional logistic regression was used after including confounders. The confounders included age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use (covariant).

All analyses were conducted using SPSS (version 20.0, SPSS Inc., Chicago, IL, USA), and $p<0.05$ was considered significant.

RESULTS

Of the 248 participants, 37 had UFs, representing a prevalence rate of 14.9%. Table 2 presents the participants' demographic information. A higher incidence of UFs was observed in participants with the following characteristics: married, older, higher BMI, lower education level, employed as a freelancer or in 'other' occupations, and current alcohol consumer. Participants with UFs were also younger at first pregnancy, had undergone more artificially induced abortions, had experienced a longer interval since last birth, and were more likely to use contraceptive rings. In addition, there was no difference in median and interquartile range of DDS 9, DDS 24, PDQS, total FVS between with UFs group and without UFs group.

Table 2. Basic characteristics and dietary diversity score of the study women with and without uterine fibroids

	With UFs (n=37)	Without UFs (n=211)	*p*-value[†]
Age (years), n (%)			<0.0001
20~24	0 (0.0)	26 (12.3)	
25~29	2 (5.4)	57 (27.0)	
30~34	4 (10.8)	54 (25.6)	
35~39	5 (13.5)	40 (19.0)	
40~45	26 (70.3)	34 (16.1)	
Education level, n (%)			<0.0001
Less than high school	8 (21.6)	2 (0.9)	
High school	5 (13.5)	13 (6.2)	
Bachelor	16 (43.2)	107 (50.7)	
Master	3 (8.1)	73 (34.6)	
Higher than master	5 (13.5)	16 (7.6)	
Occupation, n (%)			0.032
Civil servant/financial industry	3 (8.1)	32 (15.2)	
Institution	20 (54.1)	124 (58.8)	
Office worker	3 (8.1)	31 (14.7)	
Freelance	5 (13.5)	8 (3.8)	
Others	6 (16.2)	16 (7.6)	
Marital status, n (%)			0.001
Single	1 (2.7)	54 (25.6)	
Married	36 (97.3)	156 (73.9)	
Divorced	0 (0.0)	1 (0.5)	
BMI (kg/m^2) [‡], n (%)			0.001
<18.5	0 (0.0)	20 (9.5)	
18.5~23.9	24 (64.9)	158 (74.9)	
24.0~27.9	9 (24.3)	28 (13.3)	
≥28.0	4 (10.8)	5 (2.4)	
Drinking status, n (%)			0.035
Current	7 (18.9)	13 (6.2)	
Never	30 (81.1)	194 (91.9)	
Former	0 (0.0)	4 (1.9)	
Age at first birth, n (%)			<0.0001
Nullipara	6 (16.2)	70 (33.2)	
18~24	12 (32.4)	16 (7.6)	
25~29	16 (43.2)	88 (41.7)	
30~34	3 (8.1)	36 (17.1)	
35~39	0 (0.0)	1 (0.5)	
Artificially induced abortion status, n (%)			<0.0001
0	17 (45.9)	162 (76.8)	
1	11 (29.7)	33 (15.6)	
≥2	9 (24.3)	16 (7.6)	
Time since last birth, n (%)			<0.0001
Nullipara	6 (16.2)	71 (33.6)	
<5 years	4 (10.8)	60 (28.4)	
5-9 years	1 (2.7)	41 (19.4)	
10-14 years	11 (29.7)	18 (8.5)	
≥15 years	15 (40.5)	21 (10.0)	
Current contraceptive ring use, n (%)			0.009
Yes	12 (32.4)	31 (14.7)	
No	25 (67.6)	180 (85.3)	
Family history of uterine fibroids			0.099
Yes	9 (24.3)	29 (13.7)	
No	28 (75.7)	182 (86.3)	
Dietary diversity score 9, median (IQR)	7 (2)	7 (2)	0.161
Dietary diversity score 24, median (IQR)	13 (3)	14 (4)	0.077
Prime Diet Quality Score, median (IQR)	20 (6)	21 (6)	0.715
Total food variety score, median (IQR)	18 (14)	16 (10)	0.075

BMI: body mass index; IQR: interquartile range.
[†]Two independent samples nonparametric tests of variance.
[‡]Based on the China recommendations.

The basic characteristics of study participants based on DDS, PDQS, and total FVS are summarized in Table 3. The age of the study participants in the third and second tertiles with DDS 24 and PDQS score was significantly older than that of the first tertile group respectively, and the proportion of participants with lower than high school and high school education in the first tertile group of DDS 9 and DDS 24 was higher. And the single population had a higher proportion in the first tertile group of PDQS. No differences were observed in BMI and other clinical de-

Table 3. Dietary diversity scores according to basic characteristics of study participants

	DDS 9				DDS 24			
	Tertile 1 (Score 3-6) (n=67)	Tertile 2 (Score 7-8) (n=139)	Tertile 3 (Score 9) (n=42)	*p* value†	Tertile 1 (Score 3-12) (n=81)	Tertile 2 (Score 13-15) (n=92)	Tertile 3 (Score 16-21) (n=75)	*p* value†
Age (year), medium (IQR)	31 (14)	32 (11)	35 (10)	0.171	30 (10)	34 (11)	34 (12)	0.006
Age at first birth (year), mean (SD)	26.8±3.3	27.8±2.6	27.6±2.3	0.172	26.7±2.8	27.9±2.8	27.9±2.6	0.708
Occupation, n (%)				0.097				0.273
Civil servant/financial industry	12 (17.9)	18 (12.9)	5 (11.9)		19 (23.5)	8 (8.7)	8 (10.7)	
Institution	27 (40.3)	89 (64.0)	28 (66.7)		32 (39.5)	58 (63.0)	54 (72.0)	
Office worker	9 (13.4)	16 (11.5)	9 (21.4)		12 (14.5)	12 (13.0)	10 (13.3)	
Freelance	6 (9.0)	7 (5.0)	0 (0.0)		8 (9.9)	4 (4.3)	1 (1.3)	
Others	13 (19.4)	9 (6.5)	0 (0.0)		10 (12.3)	10 (10.9)	2 (2.7)	
Education level, n (%)				0.011				<0.001
Lower than high school	8 (11.9)	2 (1.4)	0 (0.0)		8 (9.9)	2 (2.2)	0 (0.0)	
High school	8 (11.9)	7 (5.0)	3 (7.1)		9 (11.1)	6 (6.5)	3 (4.0)	
Undergraduate	31 (46.3)	72 (51.8)	20 (47.6)		44 (54.3)	42 (45.7)	37 (49.3)	
Master	16 (23.9)	46 (33.1)	14 (3.3)		17 (21.0)	29 (31.5)	30 (40.0)	
Higher than master	4 (6.0)	12 (8.6)	5 (11.9)		3 (3.7)	13 (14.1)	5 (6.7)	
Marital status, n (%)				0.379				0.115
Single	18 (26.9)	31 (22.3)	6 (14.3)		24 (29.6)	16 (17.4)	15 (20.0)	
Married	48 (71.6)	108 (77.7)	36 (85.7)		57 (70.4)	75 (81.5)	60 (80.0)	
Divorced	1 (1.5)	0 (0.0)	0 (0.0)		0 (0.0)	1 (1.1)	0 (0.0)	
BMI (kg/m^2) ‡, n (%)				0.902				0.592
<18.5	7 (10.4)	11 (7.9)	2 (4.8)		10 (12.3)	6 (6.5)	4 (5.3)	
18.5-23.9	49 (73.1)	98 (70.5)	35 (83.3)		56 (69.1)	68 (73.9)	58 (77.3)	
≥24	9 (13.4)	25 (18.0)	3 (7.1)		12 (14.8)	14 (15.2)	11 (14.7)	
≥28	2 (3.0)	5 (3.6)	2 (4.8)		3 (3.7)	4 (4.3)	2 (2.7)	
Artificially induced abortion status, n (%)				0.721				0.593
0	50 (74.6)	109 (78.4)	30 (71.4)		59 (72.8)	70 (76.1)	60 (80.0)	
1	11 (16.4)	19 (13.7)	9 (21.4)		14 (17.3)	16 (17.4)	9 (12.0)	
≥2	6 (9.0)	11 (7.9)	3 (7.1)		8 (9.9)	6 (6.5)	6 (8.0)	
Time since last birth, n (%)				0.590				0.117
Null	13 (19.4)	48 (34.5)	9 (21.4)		30 (37.0)	25 (27.3)	22 (29.3)	
<5 years	16 (23.9)	33 (23.7)	15 (35.7)		24 (29.6)	20 (21.7)	20 (26.7)	
5-9 years	12 (17.9)	23 (16.5)	7 (16.7)		10 (12.3)	20 (21.7)	12 (16.0)	
10-14 years	9 (13.4)	17 (12.2)	3 (7.1)		10 (12.3)	13 (14.1)	6 (8.0)	
≥15 years	10 (14.9)	18 (12.9)	8 (19.0)		7 (8.6)	14 (15.2)	15 (20.0)	
Current contraceptive ring use, n (%)				0.614				0.345
Yes	8 (11.9)	27 (19.4)	8 (19.0)		11 (13.6)	20 (21.7)	12 (16.0)	
No	59 (88.1)	112 (80.6)	34 (81.0)		70 (86.4)	72 (78.3)	63 (84.0)	
Family history of uterine fibroids, n (%)				0.235				0.598
Yes	8 (11.9)	26 (18.7)	4 (9.5)		12 (14.8)	12 (13.0)	14 (18.7)	
No	59 (88.1)	113 (81.3)	38 (90.5)		69 (85.2)	80 (87.0)	61 (81.3)	

DDS: dietary diversity score; IQR: interquartile range; PDQS: Prime Diet Quality Score; FVS: food variety score. †K independent samples nonparametric tests of variance. ‡Based on the China recommendations.

Table 3. Prime Diet Quality Score and food variety score according to basic characteristics of study participants (continued)

	PDQS				Total FVS			
	Tertile 1 (Score 11-18) (n=72)	Tertile 2 (Score 19-23) (n=103)	Tertile 3 (Score 24-33) (n=73)	*p* value†	Tertile 1 (Score 3-12) (n=83)	Tertile 2 (Score 13-20) (n=83)	Tertile 3 (Score 21-44) (n=82)	*p* value†
Age (year), medium (IQR)	31 (11)	33 (12)	34 (12)	0.045	31 (8)	32 (12)	35 (12)	0.078
Age at first birth (year), medium (IQR)	28 (3)	28 (4)	27 (4)	0.882	28 (3)	27 (4)	28 (4)	0.779
Occupation, n (%)				0.586				
Civil servant/financial industry	14 (19.4)	9 (8.7)	12 (16.4)		16 (19.3)	6 (7.2)	13 (15.9)	
Institution	32 (44.4)	70 (68.0)	42 (57.5)		37 (44.6)	54 (65.1)	53 (64.6)	
Office worker	8 (11.1)	13 (12.6)	13 (17.8)		11 (13.3)	11 (13.3)	12 (14.6)	0.106
Freelance	9 (12.5)	4 (3.9)	0 (0.0)		9 (10.9)	2 (2.4)	2 (2.4)	
Others	9 (12.5)	7 (6.8)	6 (8.2)		10 (12.0)	10 (12.0)	2 (2.4)	
Education level, n (%)				0.450				0.105
Lower than high school	4 (5.6)	3 (2.9)	3 (4.1)		5 (6.0)	5 (6.0)	0 (0.0)	
High school	3 (4.2)	8 (7.8)	7 (7.8)		5 (6.0)	7 (8.4)	6 (7.3)	
Undergraduate	40 (55.6)	46 (44.7)	37 (50.7)		48 (57.8)	38 (45.8)	37 (45.1)	
Master	19 (26.4)	37 (35.9)	20 (27.4)		18 (21.7)	26 (31.3)	32 (39.0)	
Higher than master	6 (8.3)	9 (8.7)	6 (8.2)		7 (8.4)	7 (8.4)	7 (8.5)	
Marital status, n (%)				0.042				0.691
Single	23 (31.9)	17 (16.5)	15 (20.5)		18 (21.7)	20 (24.1)	17 (20.7)	
Married	49 (68.1)	85 (82.5)	58 (79.5)		65 (78.3)	63 (75.9)	64 (78.0)	
Divorced	0 (0.0)	1 (1.0)	0 (0.0)		0 (0.0)	0 (0.0)	1 (1.2)	
BMI (kg/m^2) ‡, n (%)				0.795				0.870
<18.5	8 (11.1)	7 (6.8)	5 (6.8)		6 (17.2)	10 (12.0)	4 (4.9)	
18.5-23.9	49 (68.1)	78 (75.7)	55 (75.3)		58 (69.9)	58 (69.9)	66 (80.5)	
≥24	12 (16.7)	15 (14.6)	10 (13.7)		13 (15.7)	14 (16.9)	10 (12.2)	
≥28	3 (4.2)	3 (2.9)	3 (4.1)		6 (7.2)	1 (1.2)	2 (2.4)	
Artificially induced abortion status, n (%)				0.240				0.382
0	60 (83.3)	77 (74.8)	52 (71.2)		58 (69.9)	67 (80.7)	64 (78.0)	
1	7 (9.7)	18 (17.5)	14 (19.2)		21 (25.3)	9 (10.8)	9 (11.0)	
≥2	5 (6.9)	8 (7.8)	7 (9.6)		4 (4.8)	7 (8.4)	9 (11.0)	
Time since last birth, n (%)				0.075				0.364
Null	32 (44.4)	28 (27.2)	21 (28.8)		29 (34.9)	22 (26.5)	26 (31.7)	
<5 years	15 (20.8)	30 (29.1)	18 (24.7)		20 (24.1)	23 (27.7)	21 (25.6)	
5-9 years	11 (15.3)	17 (16.5)	13 (17.8)		15 (18.5)	15 (18.1)	12 (14.6)	
10-14 years	7 (9.7)	13 (12.6)	8 (11.0)		10 (12.3)	10 (12.0)	9 (11.0)	
≥15 years	7 (9.7)	15 (14.6)	13 (17.8)		9 (10.8)	13 (15.7)	14 (17.1)	
Current contraceptive ring use, n (%)				0.211				0.976
Yes	8 (11.1)	22 (21.4)	13 (17.8)		14 (16.9)	15 (18.1)	14 (17.1)	
No	64 (88.9)	81 (78.6)	60 (82.2)		69 (83.1)	68 (81.9)	68 (82.9)	
Family history of uterine fibroids, n (%)				0.667				0.223
Yes	9 (12.5)	18 (17.5)	11 (15.1)		9 (10.8)	17 (20.5)	12 (14.6)	
No	63 (87.5)	85 (82.5)	62 (84.9)		74 (89.2)	66 (79.5)	70 (85.4)	

DDS: dietary diversity score; IQR: interquartile range; PDQS: Prime Diet Quality Score; FVS: food variety score. †K independent samples nonparametric tests of variance. ‡Based on the China recommendations.

mographic characteristics among the study participants with various levels of DDS 9, DDS 24, PDQS, and total FVS scores.

Associations between DDS, PDQS, FVS, and UF risk are presented in Table 4. A higher DDS 24 was associated with decreased UF risk after adjusting for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use (OR=0.22, 95% CI=0.05–1.01). Similar trends were observed for the plant-based FVS (p_{trend}=0.025), while total FVS was associated with a reduction in the prevalence of UFs after adjustments for age. No associations were observed between DDS 9, PDQS and animal-based FVS and UF prevalence.

Table 5 shows the results of binary logistic regression between the FVSs of legumes, vegetables, fruits, nuts, dairy products, meat and fish, and UF risk. After adjustment for age, UF risk decreased significantly with an increase in FVSs of vegetables and nuts. Women who consumed a higher amount of any type of vegetable or nut had a reduced UF risk (OR=0.90 and 0.71, respectively) compared with those who did not. In addition, after adjusting for BMI, eating a variety of legumes also had a significant protective effect on UF risk (OR=0.68, 95% CI=0.47–0.98). However, the FVSs for meat/fish and fruits did not exhibit significant relationships with UFs.

The relationship between the consumption frequency of each food item and UF risk was also evaluated. Carrot, kiwi fruit, and seaweed intake were all inversely associated with risk of UFs. After adjusting for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use, carrot and kiwi fruit intake remained significantly associated with UF incidence. An inverse association for yogurt intake was observed after adjusting for age, but this association was not statistically significant after adjusting for BMI and other confounders. The inverse association for seaweed intake was significant after adjusting for age and BMI but not after adjusting for all confounders (Table 6).

DISCUSSION

In China, because of the lack of national screening for UFs and the marked difference between prevalence depending on location, definitively determining the morbidity associated with UFs is difficult. One systematic review indicated that the incidence of UFs in Chinese women was 11.21% in 2011,[17] and a group of Chinese experts estimated the prevalence may have reached 25% in 2017.[18] A Japanese researcher suggested the prevalence of UFs in women over 30 years was between 20% and 30%.[19] Age is a critical factor in the incidence of UFs; as women age increase, the incidence of UFs increases. Specifically, increased follicle-stimulating hormone levels before and after menopause, may lead to UFs.[20] Given the effects of hormone levels, this study focused on nonmenopausal women aged 20–45 years. The overall prevalence of UFs in our cohort was 14.9%, and age was found to be a risk factor.

Although the etiology of UFs is unclear, estrogen and progesterone promote its development.[21] Artificially induced abortion can disrupt endocrine regulation and hormone levels, and endometrial trauma can increase local epidermal growth factor secretion; these are related to the growth of UFs.[22] Consistent with this result, our study also indicated that the factors that affect the level of estrogen, growth hormone, progesterone, and the normal uterine environment, such as age at first pregnancy, time since last birth, number of artificially induced abortions, and use of contraceptive ring, may increase morbidity associated with UFs. Dietary habits can also affect the occurrence of UFs. The concept of dietary diversity has been widely used in studies of children, women, and adults to assess nutritional adequacy and growth and to determine the association between dietary quality and risk factors for diet-related diseases or chronic diseases. Generally, the DDS is determined by counting the number of selected food groups consumed by a household or individuals over a reference period (usually 1–3 days), and the food groups are selected from a given array of recommended food groups, which can be 9, 10, 12, or more. Although the food items within a food group may be inconsistent, leading to problems of standardization, the DDS is still being used as a measure of nutritional quality.[23] In the present study, DDS 9 and DDS 24 were analysed through the FFQ results. On the basis of the results of the current study, no association between DDS 9 and UF was identified, but an increased DDS 24 was associated with lower UF risk. Notably, DDS 24 is an overall evaluation of dietary diversity of food groups consumed and is not divided into ‘healthy’ and ‘unhealthy’ food categories. To determine whether healthy food groups are more beneficial to prevent the occurrence of UFs, the relationship between the PDQS and UF risk was also evaluated and no protective effect of PDQS on UF was identified. In PDQS, red meat and high-fat dairy are considered as ‘unhealthy’ food groups; however, Parazzini et al. indicated that the association between the consumption of red meat or dairy products and UFs is controversial.[24] For example, women with UFs ate too much beef and other meats in an Italian case–control study,[25] whereas no association with meat intake was found in Chinese study;[26] moreover, both high-fat and low-fat dairy foods have a protective effect against UFs, probably due to calcium content, which may inhibit certain aspects of carcinogenesis at the cellular level.[24] Our results also indicated that yogurt may have a protective effect against UFs with or without adjusting for age. However, the protective effect was eliminated after adjusting for BMI and other factors. These results suggest that the ‘unhealthy’ foods groups of the PDQS may not necessarily be ‘unhealthy’ with respect to UF prevalence. In addition to red meat and dairy products, almost every study participant consumed refined grains, which is an ‘unhealthy’ food group in PDQS, every day; and the consumption of other sugars and sugar-sweetened beverages was low while sweet potato and potato showed no relationship with UF. This may be why no significant association between PDQS and UFs was noted.

In addition to DDS, the FVS is frequently used to assess the relationship between dietary diversity and the risk of diseases. Unlike the DDS 24 food categories, FVS was specially calculated as the sum of the scores for four beans, 22 vegetables, nine fruits, four nuts, two dairy products, and 12 meats. We found that total FVS was not associated with UF risk, but plant-based FVS was significantly negatively associated with UF risk even after adjusting for age, BMI, and other factors. We also found that UF risk decreased by 10% and 29% with the addition of each type of

Table 4. ORs and 95% CIs of different assessments of dietary diversity with incidence of uterine fibroids before and after adjusting for confounders†

Variable	Range of score	UF incidence (n/N)	Unadjusted	Model 1‡	Model 2‡	Model 3‡
Dietary diversity score (DDS 9)						
Tertile 1 (low)	3-6	13/67	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	7-8	18/139	0.62 (0.28-1.35)	0.51 (0.21-1.26)	0.55 (0.24-1.28)	0.98 (0.27-3.48)
Tertile 3 (high)	9	6/42	0.69 (0.24-1.99)	0.50 (0.15-1.62)	0.67 (0.21-2.11)	1.22 (0.26-5.78)
p for trend§			0.477	0.301	0.384	0.937
Dietary diversity score (DDS 24)						
Tertile 1 (low)	3-12	15/81	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	13-15	17/92	1.00 (0.46-2.15)	0.54 (0.21-1.36)	1.09 (0.48-2.50)	1.27 (0.37-4.34)
Tertile 3 (high)	16-21	5/75	0.31 (0.11-0.91)*	0.13 (0.04-0.44)**	0.27 (0.09-0.84)*	0.22 (0.05-1.01)
p for trend§			0.071	0.005	0.038	0.038
Prime Diet Quality Score (PDQS)						
Tertile 1 (low)	11-18	10/72	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	19-23	17/103	1.23 (0.53-2.86)	0.92 (0.35-2.43)	1.38 (0.56-3.43)	1.36 (0.43-4.32)
Tertile 3 (high)	24-33	10/73	0.98 (0.38-2.53)	0.60 (0.20-1.76)	1.05 (0.38-2.93)	0.94 (0.26-3.45)
p for trend§			0.840	0.578	0.734	0.770
Total food variety score (TFVS)						
Tertile 1 (low)	3-12	12/83	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	13-20	17/83	1.52 (0.68-3.43)	1.17 (0.46-3.02)	1.84 (0.77-4.41)	2.50 (0.75-8.37)
Tertile 3 (high)	21-44	8/82	0.64 (0.25-1.66)	0.34 (0.12-1.00)	0.65 (0.24-1.79)	0.66 (0.17-2.58)
p for trend§			0.162	0.047	0.090	0.064
Plant-based food variety score (PFVS)						
Tertile 1 (low)	3-10	12/86	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	11-17	19/85	1.78 (0.80-3.93)	1.25 (0.50-3.12)	2.35 (0.99-5.56)	2.98 (0.91-9.74)
Tertile 3 (high)	18-39	6/77	0.52 (0.19-1.46)	0.30 (0.10-0.96)*	0.53 (0.18-1.59)	0.59 (0.14-2.47)
p for trend§			0.040	0.034	0.013	0.025
Animal-based food variety score (AFVS)						
Tertile 1 (low)	0-2	19/102	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Tertile 2 (moderate)	3	10/66	0.78 (0.34-1.80)	0.46 (0.17-1.21)	0.77 (0.32-1.88)	0.59 (0.18-1.93)
Tertile 3 (high)	4-10	8/80	0.48 (0.20-1.18)	0.46 (0.17-1.23)	0.52 (0.20-1.33)	0.70 (0.22-2.25)
p for trend§			0.277	0.166	0.390	0.659

OR: odds ratio; CI: confidence interval; DDS: dietary diversity score; PDQS: Prime Diet Quality Score; TFVS: total food variety score; PFVS: plant-based food variety score; AFVS: animal-based food variety score.
†The ORs (95%CI) were calculated by logistic regression.
‡Model 1: adjusted for age.
Model 2: adjusted for BMI.
Model 3: adjusted for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use.
§Calculated using score of different assessments of dietary diversity as continuous variable. *p*-value from linear regression analysis for quantitative variables.
*$p<0.05$, **$p<0.01$.

Table 5. ORs (95% CI) of individual food group variety score with uterine fibroids risk before and after adjusting for confounders†

Variable‡	Unadjusted		Model 1‡		Model 2‡		Model 3‡	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Legumes	0.95 (0.89, 1.01)	0.062	0.70 (0.48, 1.02)	0.063	0.68 (0.47, 0.98)*	0.040	0.72 (0.46, 1.14)	0.159
Vegetables	0.73 (0.52, 1.02)	0.112	0.90 (0.83, 0.98)*	0.012	0.95 (0.89, 1.02)	0.157	0.93 (0.84, 1.02)	0.134
Fruits	0.88 (0.74, 1.04)	0.137	0.84 (0.68, 1.03)	0.093	0.90 (0.75, 1.07)	0.236	0.96 (0.75, 1.22)	0.719
Nuts	0.83 (0.63, 1.10)	0.204	0.71 (0.51, 0.99)*	0.047	0.76 (0.56, 1.04)	0.089	0.70 (0.46, 1.06)	0.093
Dairy products	0.83 (0.53, 1.29)	0.405	0.80 (0.48, 1.35)	0.401	0.94 (0.59, 1.51)	0.813	1.06 (0.56, 2.03)	0.849
Meats and fish	0.74 (0.53, 1.03)	0.080	0.70 (0.47, 1.05)	0.082	0.70 (0.49, 1.01)	0.056	0.73 (0.46, 1.16)	0.186

OR: odds ratio; CI: confidence interval.
†The ORs (95%CI) were calculated by logistic regression.
‡Model 1: adjusted for age. Model 2: adjusted for BMI. Model 3: adjusted for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use.
*$p<0.05$.

Table 6. ORs and 95% CIs for uterine fibroids in relation to intake of specific foods†

Food item	Number (n)	UF incidence (%)	Unadjusted	Model 1‡	Model 2‡	Model 3‡
Carrot						
Low intake	39	28.2	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium intake	140	16.4	0.50 (0.22-1.15)	0.35 (0.13-0.96)*	0.63 (0.25-1.55)	0.42 (0.09-2.01)
High intake	69	4.3	0.12 (0.03-0.45)**	0.09 (0.02-0.37)**	0.16 (0.04-0.64)*	0.04 (0.00-0.48)**
p for trend§			0.001	0.001	0.008	0.011
Kiwi fruit						
Low intake	88	25.0	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium intake	117	10.2	0.34 (0.16-0.74)*	0.50 (0.21-1.19)	0.50 (0.22-1.13)	1.26 (0.30-5.28)
High intake	43	7.0	0.23 (0.06-0.80)*	0.16 (0.04-0.63)*	0.21 (0.05-0.79)*	0.03 (0.00-0.47)**
p for trend§			0.003	0.005	0.009	0.034
Seaweed						
Low intake	72	25.0	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium intake	139	11.5	0.39 (0.19-0.82)*	0.46 (0.20-1.06)	0.42 (0.19-0.93)*	0.45 (0.13-1.60)
High intake	37	8.1	0.27 (0.07-0.97)*	0.27 (0.07-1.10)	0.27 (0.07-1.06)	0.74 (0.13-4.30)
p for trend§			0.008	0.029	0.017	0.482
Yogurt						
Low intake	30	36.7	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium intake	92	12.0	0.24 (0.09-0.62)*	0.28 (0.09-0.88)*	0.31 (0.11-0.87)*	0.34 (0.06-1.77)
High intake	126	11.9	0.23 (0.09-0.58)*	0.28 (0.10-0.83)*	0.34 (0.13-0.91)*	0.36 (0.08-1.68)
p for trend§			0.009	0.050	0.082	0.269

OR: odds ratio; CI: confidence interval.
†Low intake: never/rare; medium intake: once to three times a month/once a week; high intake: from two to four times a week to more than twice a day. The ORs (95%CI) were calculated by logstic regression.
‡Model 1: adjusted for age. Model 2: adjusted for BMI. Model 3: adjusted for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use.
§Calculated using intake level as continuous variable. *p*-value from linear regression analysis for quantitative variables.
*$p<0.05$, **$p<0.01$.

vegetable or nut, respectively, after adjusting for age and that UF risk decreased by 32% with an increased intake of each legume after adjusting for BMI. Consistent with our results, Chiaffarino et al. indicated that women who ate many green vegetables and fruits had a lower risk of UFs, likely due to their high dietary fibre consumption, which restricts estrogen reabsorption.[25] Dietary fibre supplementation has been demonstrated to modulate gut microbiota composition and promote production of short-chain fatty acids, such as butyric acid, which can induce differentiation and apoptosis and inhibit proliferation and angiogenesis as an effective antitumor agent.[27] Furthermore, the current study indicated that carrot, kiwi fruit, seaweed, and yogurt can protect against UFs; carrot and kiwi fruit have stronger protective effects with increasing intake amounts (within the daily intake ranges) after adjusting for age, BMI, education, occupation, age at first birth, abortion status, time since last birth and contraceptive ring use; this is similar to the results of Wise et al. and may be due to the antioxidation and antitumor effects of β-carotene in carrot.[11] β-Carotene has been reported to reverse the carcinogenic process of cellular-level precancerous lesions, suppress cancer cell proliferation, induce cell differentiation and apoptosis, and suppress carcinogen formation. However, recent human intervention studies have not completely supported this view. Studies have indicated that β-carotene offers no protection against UFs and that UF risk may slightly increase in women who smoked with increasing β-carotene intake.[10,24] Notably, these studies were all based on total intake of β-carotene or total vegetable intake but did not consider single food types. Our results highlight that eating carrot may reduce UF risk. The protective effect is associated with adequate daily intake of β-carotene. However, further research is required to validate this claim. Kiwi fruit is a vital source of antioxidants and is rich in vitamin C, vitamin E, chlorophyll, lutein, β-carotene, and polyphenols. The phytochemicals in plant-based food groups possess anti-inflammatory, antiproliferation, antifibrosis, and antivascular properties and may thus inhibit the growth of UFs.[28]

We further identified a relationship between education level and DDS-participants with a low education level had a lower DDS. Similar relationship was observed between single marital status and PDQS. Thus, health and nutrition education is necessary to improve the awareness of the value of eating a moderately diverse variety of foods and choosing healthy food among the population to promote health and prevent diseases.

This study has some limitations. First, the observational cross-sectional design precluded the establishment of any cause–effect relationships. Second, this was a small sample size study, and thus, bias cannot be ruled out. Third, only food intake frequency data were used to evaluate the influence of dietary habits on the occurrence and development of UFs, and the influence of nutrient intake was deficient. Also all of the participants were recruited in our city, thus the association between dietary diversity and UFs might not be represented across other area in China. However, our findings do suggest that when the effects of age and estrogen are disregarded, consuming a plant-based diet may have potential protective effects against UFs. The association between a plant-based diet and UFs should be further clarified in this population. Furthermore, future studies should compare the premenopausal UF incidence between vegetarians and nonvegetarians to determine the influence of meat and vegetable intake.

ACKNOWLEDGEMENTS

We thank all the participants and investigators in this study. The research for this study received support from our local hospital.

AUTHOR DISCLOSURES

The authors declare that they have no conflict of interest.

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