International Journal of Women's Health

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Identification of Dietary Patterns Among Women Undergoing Assisted Reproduction and Its Association with Reproductive Outcomes

Rongyan Zhang*, Shengnan Cong*, Jing Zhao*, Yuxuan Wu, Yueyue Cai, Linhong Li

Department of Reproductive Medicine, Women's Hospital of Nanjing Medical University (Nanjing Women and Children's Healthcare Hospital), Nanjing, People's Republic of China

*These authors contributed equally to this work

Correspondence: Linhong Li, Department of Reproductive Medicine, Women's Hospital of Nanjing Medical University (Nanjing Women and Children's Healthcare Hospital), Nanjing, People's Republic of China, Email 183766717@qq.com

Objective: This study aimed to identify dietary patterns among women undergoing assisted reproductive technology (ART) and to analyze the association between these patterns and reproductive outcomes.

Methods: This study included 331 women who underwent assisted reproductive technology at a tertiary hospital in Jiangsu Province between June and December 2024. Dietary intake was assessed using a semi-quantitative food frequency questionnaire, and nutrient values were calculated with a nutrition calculator. Reproductive outcomes were obtained from medical records. Then, we used principal component analysis to identify dietary patterns, and we performed non-parametric tests and multivariate regression analyses to explore associations between dietary patterns, nutrient intake, and reproductive outcomes.

Results: Three dietary patterns were identified: the Diversified Diet Pattern, the Snack-Beverage-Staple Pattern, and the Staple-Vegetable Pattern. No significant association was found between dietary patterns and reproductive outcomes ($p > 0.05$). Regarding individual nutrients, higher vitamin B2 intake was linked to more high-scoring blastocysts ($p = 0.003$). Higher cholesterol intake was associated with fewer retrieved oocytes ($p = 0.008$) and morphologically normal oocytes ($p = 0.029$). Higher zinc intake was associated with fewer morphologically normal oocytes ($p = 0.012$), number of mature oocytes (MII oocytes) ($p = 0.039$), and high-quality embryos ($p = 0.036$). No significant associations were found between other nutrients and reproductive outcomes (all $p > 0.05$).

Conclusion: Although different dietary patterns were not associated with reproductive outcomes, the intake of specific nutrients, such as cholesterol, vitamin B2, and zinc, may influence reproductive outcomes. Further research is needed to explore the underlying mechanisms and to develop targeted interventions for women undergoing ART.

Keywords: diet, nutrients, reproductive techniques

Introduction

Infertility refers to the situation where a couple has a normal sexual life for more than one year without using contraception but fails to achieved pregnancy.[1] Approximately 17% of couples worldwide are affected by infertility, with a higher prevalence in developing countries.[2] In China, the proportion of women experiencing infertility reaches as high as 12.5%.[3] Assisted reproductive technology has become an important approach for treating infertility, but its reproductive outcomes are influenced by multiple factors, and dietary factors are among them. Emerging evidence has increasingly implicated dietary factors in the pathogenesis and treatment of infertility, highlighting the potential role of both overall dietary patterns and specific nutrient intakes in reproductive health.[4,5]

Dietary pattern is composed of the variety, quantity, and intake frequency of various food types in an individual's daily diet, reflecting the complex interplay between nutritional adequacy and individual food preferences.[6,7] In recent years, a growing body of research has examined the relationship between various dietary patterns (eg, Mediterranean diet, Dietary Approaches

https://doi.org/10.2147/IJWH.S603264
Received: 13 February 2026
Accepted: 22 April 2026
Published: 29 April 2026

to Stop Hypertension (DASH) diet, plant-based diets, Western diets) and health outcomes (eg, cardiovascular disease, diabetes, metabolic disorders).[8–11] Among these, the Mediterranean diet and Western diet have received particular attention in the field of reproductive health. The Mediterranean diet is a dietary pattern with high intakes of vegetables, legumes, vegetable oils, and fish[12] and has been associated with favorable pregnancy outcomes in women undergoing assisted reproductive technology (ART).[13] In contrast, the Western diet-high in calories, fat, additives, and sugar content, while low in vitamins, minerals, and fiber,[11] has been linked to experimental evidence suggesting that it may disrupt ovarian cyclicity and alter reproductive hormone profiles.[14] However, most of these studies have been conducted in Western populations, where dietary habits differ substantially from those in China. The traditional Chinese diet is characterized by high consumption of cereals, vegetables, and legumes,[15] with 62–68% of total energy from carbohydrates, whereas the Western diet obtains approximately 35% of total energy from fat.[16] Given these fundamental differences, findings from Western populations may not be directly generalizable to Chinese settings. Therefore, it is necessary to investigate the relationship between dietary patterns and reproductive outcomes specifically within the Chinese population.

Meanwhile, nutrients in the diet are also crucial for reproductive health. Nutritional imbalance may interfere with reproductive function.[17,18] However, there are conflicting results. For vitamins A and C, a study based on the NHANES database indicated that higher intakes were associated with reduced risk of female infertility.[19] In contrast, another study reported that the total consumption of vitamins A, C, and E was not associated with the live birth rate before starting infertility treatment with assisted reproductive technology (ART).[20] Similarly, Folic acid has always been used as a supplement to prevent neural tube defects. A recent study found that the number of antral follicles in women who took folic acid daily increased significantly.[21] However, another study found that high doses of folic acid did not increase the pregnancy probability of infertile women.[22]

Given this background, this study aims to investigate the associations between dietary patterns, nutrient intake, and reproductive outcomes in Chinese women undergoing in vitro fertilization. By clarifying these relationships, we hope to provide evidence-based dietary recommendations for couples planning pregnancy.

Materials and Methods

Participants

In this study, we recruited 360 patients who underwent IVF treatment in Women's Hospital of Nanjing Medical University from June 2024 to December 2024. Infertile women who underwent their first IVF/intracytoplasmic sperm injection (ICSI)-embryo transfer (ET) were evaluated.

Inclusion criteria: i) Meeting the diagnostic criteria for infertility; ii) Undergoing IVF or ICSI was used for insemination; iii) Willingness to participate and provision of written informed consent.

Exclusion criteria: i) Suffering from severe chronic diseases such as diabetes, hypertension, heart disease, etc, which may affect nutritional metabolism and reproductive outcomes. ii) Having mental illness or cognitive impairment, thus causing inability to accurately answering the food frequency questionnaire. iii) Using drugs that may affect nutritional metabolism or reproductive outcomes recently (within 3 months before the study). iv) Having congenital reproductive system malformations or chromosomal abnormalities. v) Being on special dietary treatments (such as intermittent fasting, ketogenic diet, or other structured dietary interventions) for more than 8 weeks prior to enrollment.

This study was approved by the medical ethics committee of Women's Hospital of Nanjing Medical University (2024KY-009) and was conducted in accordance with the Declaration of Helsinki.

Data Collection

Baseline Characteristics

Demographic and clinical data were collected from the electronic medical records of the reproductive center. Female characteristics include age, educational level, body mass index (BMI), duration and type of infertility, as well as basal endocrine parameters: follicle-stimulating hormone (FSH), luteinizing hormone (LH), estradiol (E2), progesterone (P), testosterone (T), prolactin (PRL), and anti-Müllerian hormone (AMH). The percentage of sperm with normal morphology in the male partner was also assessed on the day of Ovum Pick Up (OPU).

Dietary Characteristics

Daily Intake Characteristics

The semi-quantitative food frequency questionnaire (SQFFQ) was self-developed based on the method proposed by Willett,[23] which consists of three parts, namely, food list, food consumption frequency, and food consumption amount. There are 154 items on the food list, which are divided into 11 groups (Supplementary Appendix Table S1). The food varieties are all based on the Dietary Guidelines for Chinese Residents[24] and Chinese eating habits.The frequency options provided in the SQFFQ are (1) daily; (2) weekly; (3) monthly. The consumption amount is recorded in "grams" or "milliliters", while the food models and photos of standard food portions were provided for participants in order to facilitate accurate recording of consumption amount. All participants were asked to fill in the questionnaire based on their dietary situation in the past three days after receiving qualified guidance.

Nutrition Intake Characteristics

Utilizing the "Recipe Nutrition Calculator (Standard Edition) V2.65" developed by the National Institute for Nutrition and Health Chinese Center for Disease Control and Prevention, and the "Dietary Reference Intakes for China (2023 Edition)" published by the Chinese Nutrition Society, we calculated the intake of protein, fat, carbohydrates, dietary fiber, cholesterol, vitamin A, vitamin D, vitamin E, vitamin B1, vitamin B2, vitamin B6, vitamin C, folate, calcium, magnesium, iron, and zinc from from the food consumed by participants. After training, one researcher was responsible for data entry and another verified the data.

Reproductive Outcomes

Laboratory Outcomes

A total of six laboratory outcomes were collected, as below:

Total number of oocytes retrieved The total number of oocytes collected from follicular aspiration.

Morphologically normal oocyte Oocytes with normal morphological characteristics, including an intact first polar body, clear zona pellucida, homogeneous cytoplasm, and appropriate perivitelline space, as assessed by inverted microscopy prior to insemination. Only morphologically normal oocytes were used for subsequent fertilization procedures.

Number of mature oocytes (MII oocytes) Oocytes that have extruded the first polar body, indicating completion of the first meiotic division and readiness for fertilization.

Number of high-quality embryos Cleavage-stage embryos on day 3 post-fertilization with 7–9 evenly sized blastomeres and less than 10% fragmentation.

Number of blastocysts formed The number of embryos that reach the blastocyst stage, typically on day 5 or day 6 after fertilization.

The number of high-scoring blastocysts Blastocysts were graded by Gardner's embryo grading and were considered a high-quality blastocyst if 3BB or better.

Clinical Outcome

The clinical pregnancy rate was defined as the presence of an intrauterine gestational sac confirmed by ultrasound 4 weeks after embryo transfer.

Statistical Analysis

Data analysis was performed using the SPSS (version 27; IBM SPSS Statistics, IBM Corporation, Armonk, NY). Categorical data were described using frequencies and percentages, while continuous data were presented as mean with standard deviation (SD) or median with interquartile range (IQR), depending on normality as assessed by the Kolmogorov–Smirnov test. All continuous variables, including duration of infertility, body mass index, basal endocrine parameters (FSH, E2, P, PRL, LH, T, and AMH) etc, violated the normality assumption (all $p < 0.01$). Therefore, these variables were presented as median with interquartile range (IQR).

Principal component analysis with varimax rotation was performed on 11 food groups. The KMO value was 0.839, and Bartlett's test of sphericity was significant ($p < 0.01$), indicating that factor analysis was appropriate. Factors with eigenvalues > 1.0 were selected based on the scree plot and interpretability. Factor loadings ≥ 0.30 were retained to label each dietary pattern. Factor scores were calculated for each participant by summing food group intake weighted by factor loadings; higher scores indicated greater adherence to the pattern.

Non-parametric tests were used to compare continuous variables (eg, nutrient intake, baseline characteristics) across the three dietary patterns. Multivariable linear and logistic regression analyses were conducted to assess the associations of both dietary patterns and nutrient intakes with reproductive outcomes.

Results

Sample Characteristics

In this study, of 360 participants enrolled, 331 questionnaires were eventually included in the analysis. Among 29 excluded participants, 11 participants were excluded because less than 50% of the questionnaire items were completed, and 18 participants were excluded because the missing rate of key information exceeded 20%. The final questionnaire recovery rate was 91.9%.

Table 1 shows the basic characteristics of the 331 participants in this study. Among them, there were 108 women aged ≤30 years (32.63%), 192 women aged 31–40 years (58.06%), and 31 women aged ≥41 years (9.36%).

Dietary Pattern Analysis of Women Undergoing ART

As shown in Figure 1, the scree plot revealed an inflection point after the third component, supporting the retention of three dietary patterns. These three factors with eigenvalues greater than 1.0 cumulatively explained 58.93% of the total variance.

Table 2 presents the food groups and factor loadings for each dietary pattern. Dietary Pattern 1 (Diversified Diet Pattern) accounted for 36.25% of the explained variance, determined by high factor loadings for fruits, soy products, aquatic/seafood, nuts, vegetables, mushrooms, meat, dairy and eggs, beverages, snacks, and staple foods. Dietary Pattern 2 (Snack-Beverage-Staple Pattern) accounted for 13.12% of the explained variance, determined by high factor loadings

Table 1 Basic Characteristics of Women Undergoing Assisted Reproduction

Variables	Category	Overall
Maternal Age	≤30 years old	108 (32.63%)
	31–40 years old	192 (58.06%)
	≥41 years old	31 (9.36%)
Education Level	High School or Below	94 (28.40%)
	Technical Secondary School and Junior College	91 (27.49%)
	Bachelor's Degree	127 (38.37%)
	Master's Degree or Above	19 (5.74%)
Type of Infertility	Primary Infertility	143 (43.20%)
	Secondary Infertility	188 (56.80%)
Duration of Infertility[Median(IQR), years]		2.00 (3.00)
Body Mass Index [Median(IQR), kg/m^2]		22.60 (4.60)
(Basal Endocrine) FSH [Median(IQR), mIU/mL]		7.55 (3.25)
(Basal Endocrine) E2 [Median(IQR), pg/mL]		39.00 (24.00)
(Basal Endocrine) P [Median(IQR), ng/mL]		0.41 (0.41)
(Basal Endocrine) PRL [Median(IQR), ng/mL]		14.37 (9.06)
(Basal Endocrine) LH [Median(IQR), mIU/mL]		4.77 (3.17)
(Basal Endocrine) T [Median(IQR), ng/mL]		0.40 (0.25)
(Basal Endocrine) AMH [Median(IQR), ng/mL]		3.15 (3.92)
The percentage of sperm with normal morphology [Median(IQR), %]		3.50 (1.00)

Abbreviations: FSH, follicle-stimulating hormone; E2, estradiol; P, progesterone; PRL, prolactin; LH, luteinizing hormone; T, testosterone.

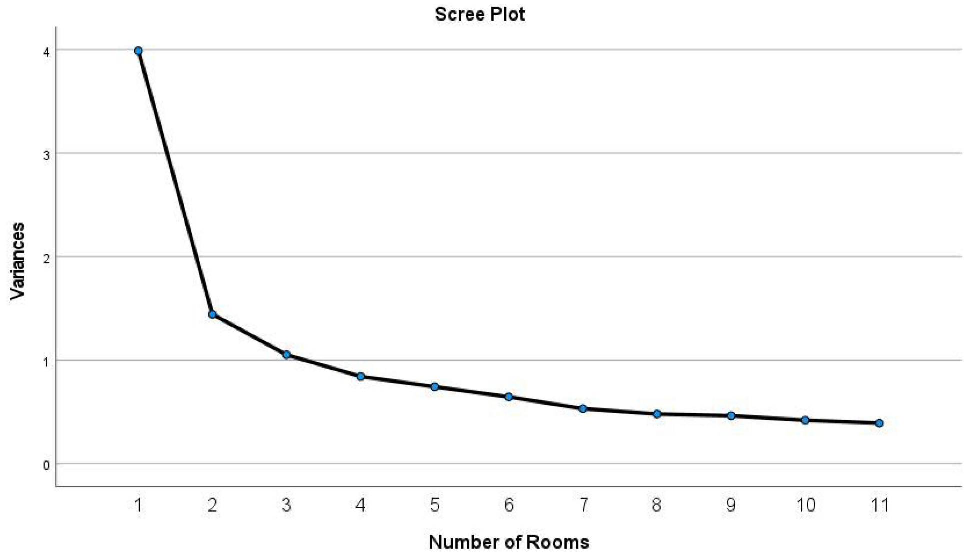

Figure 1 Scree plot of principal component analysis method of dietary patterns.

for beverages, snacks, and staple foods. Dietary Pattern 3 (Staple-Vegetable Pattern) accounted for 9.56% of the explained variance, determined by high factor loadings for staple foods and vegetables.

Analysis and Comparison of Nutrients in Different Dietary Patterns

As shown in Table 3, all nutrients showed statistically significant differences across the three patterns (all $p < 0.05$). For most nutrients (except cholesterol), the Staple-Vegetable Pattern had the highest intake, followed by the Diversified Pattern and the Snack-Beverage-Staple Pattern.

The Association Between Dietary Patterns, Nutrient Intake, and Reproductive Outcomes

Of the 331 participants, 189 (57.09%) participants achieved clinical pregnancy, 73 did not achieve clinical pregnancy (22.05%) and 69 (20.84%) ultimately did not undergo embryo transfer. After adjusting for confounding factors such as age, BMI, and basal endocrine levels (FSH, LH, P, E2, AMH), and the percentage of sperm with normal morphology, no association was found between various dietary patterns and reproductive outcomes including total number of oocytes

Table 2 The Food Groups and Factor Loadings for Each Dietary Pattern

Food Groups	Factor 1 Diversified Diet Pattern (36.25%)	Factor 2 Snack-Beverage-Staple Diet Pattern (13.12%)	Factor 3 Staple-Vegetable Diet Pattern (9.56%)
Fruits	0.729	0.032	−0.051
Soy Products	0.704	−0.292	0.159
Aquatic/Seafood	0.684	−0.041	−0.415
Nuts	0.675	−0.116	−0.160
Vegetables	0.658	−0.335	0.369
Mushrooms	0.657	−0.227	−0.023
Meat	0.657	−0.007	−0.210
Dairy and Eggs	0.560	−0.008	0.018
Beverages	0.296	0.773	−0.184
Snacks	0.476	0.684	0.015
Staple Foods	0.337	0.334	0.782

Table 3 Nutrient Analysis in Different Dietary Patterns

	Dietary Patterns			H	p
	Staple-Vegetable Food Pattern (n=124)	Snack-Beverage-Staple Pattern (n=122)	Diversified Diet Pattern (n=85)		
Protein [M(IQR), (g)]	116.10 (87.30)	50.90 (48.2)	56.10 (62.90)[ab]	60.20	<0.001
Fat [M(IQR), (g)]	66.50 (67.20)	26.45 (28.60)	35.95 (31.90)[ab]	48.95	<0.001
Carbohydrates [M(IQR), (g)]	164.70 (118.10)	103.95 (123.40)[a]	135.60 (85.70)[b]	12.50	0.02
Dietary Fiber [M(IQR), (g)]	17.80 (25.50)	5.50 (7.70)[a]	9.30 (9.70)[ab]	74.23	<0.001
Cholesterol [M(IQR), (mg)]	627.00 (550.00)	436.00 (445.00)	393.00 (491.00)[ab]	23.12	<0.001
Vitamin A [M(IQR), (μgRAE)]	625.00 (624.00)	294.50 (316.00)	377.50 (378.00)[ab]	40.92	<0.001
Vitamin D [M(IQR), (μg)]	10.90 (29.20)	2.00 (3.90)	2.10 (7.40)[ab]	47.89	<0.001
Vitamin E [M(IQR), (mg)]	27.85 (47.99)	6.955 (9.09)[a]	8.95 (19.28)[ab]	67.25	<0.001
Vitamin B1 [M(IQR), (mg)]	1.02 (0.73)	0.46 (0.48)[a]	0.55 (0.60)[ab]	47.39	<0.001
Vitamin B2 [M(IQR), (mg)]	1.43 (1.23)	0.75 (0.67)[a]	0.88 (0.84)[ab]	56.20	<0.001
Vitamin B6 [M(IQR), (mg)]	0.18 (0.28)	0.05 (0.10)[a]	0.08 (0.13)[ab]	41.74	<0.001
Vitamin C [M(IQR), (mg)]	129.30 (156.10)	53.95 (78.10)[a]	78.15 (99.25)[ab]	39.55	<0.001
Folate [M(IQR), (μg)]	270.10 (336.40)	78.70 (118.5)[a]	133.35 (154.00)[ab]	68.24	<0.001
Calcium [M(IQR), (mg)]	765.00 (629.00)	373.50 (357.00)[a]	475.00 (499.00)[ab]	57.27	<0.001
Magnesium [M(IQR), (mg)]	500.00 (473.00)	184.00 (161.00)[a]	249.00 (258.00)[ab]	64.36	<0.001
Iron [M(IQR), (mg)]	33.60 (38.30)	13.10 (9.90)[a]	16.65 (16.90)[ab]	63.16	<0.001
Zinc [M(IQR), (mg)]	15.32 (12.75)	7.97 (6.54)	8.49 (8.31)[ab]	49.47	<0.001

Notes: [a]Statistically significant difference when comparing group Staple-Vegetable food pattern with the other two groups. [b]Statistically significant difference when comparing group Snack-Beverage-Staple eating pattern with Diversified eating patterns.

retrieved, number of morphologically normal oocytes, number of mature oocytes (MII oocytes), number of high-quality embryos, number of blastocyst formed, number of high-scoring blastocysts (all p > 0.05) (Table 4).

Clinical pregnancy. Logistic regression analysis showed no significant association between dietary patterns and clinical pregnancy. Compared with the Diversified Diet Pattern, the Snack-Beverage-Staple Pattern (OR = 0.554, 95% CI: 0.244 to 1.257, p = 0.158) and the Staple-Vegetable Food Pattern (OR = 0.517, 95% CI: 0.236 to 1.130, p = 0.098) were not significantly associated with clinical pregnancy.

Further analysis of the impact of various nutrients in the diet on infertile women revealed that higher vitamin B2 intake was associated with more high-scoring blastocysts (β = 0.099, 95% CI: 0.034 to 0.164, p = 0.003). Higher cholesterol intake was associated with fewer total retrieved oocytes (β = −0.001, 95% CI: −0.002 to −0.001, p = 0.008) and morphologically normal oocytes (β = −0.001, 95% CI: −0.002 to −0.001, p = 0.029). Higher zinc intake was associated with fewer morphologically normal oocytes (β= −0.001, 95% CI: −0.002 to −0.001, p = 0.012), number of mature oocytes (MII oocytes) (β= −0.001, 95% CI: −0.002 to −0.001, p = 0.039), and high-quality embryos (β= −0.001, 95% CI: −0.002 to −0.001, p = 0.036). No significant associations were found between the remaining nutrients and clinical outcome (all p > 0.05). Detailed results are presented in Table 5.

Table 4 Dietary Pattern and ART Fertility Outcomes

Variable	Snack-Beverage-Staple Pattern vs Diversified Diet Pattern (REF)		Vegetable-Staple Food Pattern vs Diversified Diet Pattern (REF)	
	β (95% CI)	p	β (95% CI)	p
Total Number of Oocytes Retrieved	0.004 (−1.146, 1.254)	0.930	0.002 (−1.102, 1.153)	0.964
Morphologically Normal Oocyte	0.004 (−1.177, 1.267)	0.942	−0.021 (−1.385, 0.901)	0.677
Number of Mature Oocytes (MII oocytes)	0.015 (−1.021, 1.358)	0.781	−0.039 (−1.525, 0.704)	0.469
Number of High-Quality Embryos	0.034 (−0.659, 1.294)	0.523	−0.012 (−1.016, 0.813)	0.827
Number of Blastocysts Formed	0.022 (−0.696, 1.064)	0.681	−0.020 (−0.977, 0.671)	0.714
Number of High-Scoring Blastocysts	−0.029 (−0.813, 0.473)	0.603	−0.053 (−0.886, 0.318)	0.354

Table 5 Nutrients and Pregnancy Outcomes

Variable	Clinical Pregnancy	
	OR (95% CI)	*p*
Protein (g)	1.013 (0.986,1.041)	0.360
Fat (g)	0.991 (0.97,1.011)	0.372
Carbohydrates (g)	1.001 (0.995,1.007)	0.753
Dietary Fiber (g)	0.991 (0.936,1.05)	0.758
Cholesterol (mg)	1.000 (0.999,1.002)	0.466
Vitamin A (μgRAE)	1.000 (0.999,1.001)	0.572
Vitamin D (μg)	1.003 (0.988,1.018)	0.678
Vitamin E (mg)	0.996 (0.973,1.019)	0.722
Vitamin B1 (mg)	0.418 (0.049,3.532)	0.423
Vitamin B2 (mg)	0.964 (0.779,1.192)	0.732
Vitamin B6 (mg)	2.741 (0.199,37.76)	0.451
Vitamin C (mg)	1.002 (0.997,1.006)	0.442
Folate (μg)	1.001 (0.997,1.005)	0.526
Calcium (mg)	1.000 (0.998,1.002)	0.942
Iron (mg)	0.998 (0.992,1.004)	0.548
Magnesium (mg)	0.999 (0.946,1.055)	0.981
Zinc (mg)	0.999 (0.986,1.013)	0.900

Discussion

In this cohort of Chinese women undergoing ART, none of the three identified dietary patterns was significantly associated with reproductive outcomes. This finding is consistent with a recent study among Japanese women, which also reported no meaningful association between three maternal dietary patterns and IVF outcomes.[25] In contrast, several recent studies have reported positive associations. For example, a 12-week dietary intervention study in Turkey found that Mediterranean diet adherence was positively correlated with MII oocyte count ($r = 0.797$) and pronuclei formation ($r = 0.741$).[26] Several factors may contribute to this apparent discrepancy. First, dietary patterns derived by PCA are inherently population-dependent;[27] therefore, positive associations reported in Western populations may not be directly generalizable to Chinese cohorts. Second, our subsequent nutrient-level analyses suggest that the effect of overall diet on reproductive outcomes may be mediated by specific nutrients rather than by broad dietary patterns, a conclusion consistent with Salvaleda-Mateu et al.[28] Although no association was found for dietary patterns, our exploratory nutrient analyses revealed several significant and biologically plausible associations, as discussed below.

Firstly, higher vitamin B2 intake was positively associated with the number of high-quality blastocysts. Vitamin B2 is a water-soluble vitamin that acts as a coenzyme in energy metabolism and also supports the metabolism of niacin, vitamin B6, and homocysteine.[29] Mechanistically, riboflavin is essential for mitochondrial function. Adequate cytoplasmic bioenergetic capacity and mitochondrial ATP production are directly linked to oocyte competence and embryonic development.[30,31] A previous study reported that serum riboflavin levels were significantly associated with intermediate IVF outcomes; women in the middle tertile of riboflavin had a 21% higher probability of producing high-quality embryos.[32] Our findings align with these observations, suggesting that adequate riboflavin status may be an important modifiable factor for oocyte quality and blastocyst development.

Second, higher cholesterol intake was associated with fewer total oocytes retrieved and fewer usable oocytes. At the cellular level, the cholesterol's uneven distribution in the cell membrane and proportionate changes with other components such as phospholipids can affect the fluidity and microdomain structure of the membrane. When in excess, cholesterol may alter the fluidity of the membrane of follicular granulosa cells, hinder the normal transport or transmission of nutrients and signaling molecules, thereby affecting the normal development of follicles and the quality of oocytes. At the molecular level, it may disrupt intracellular signaling pathways, such as affecting the activity of key signaling molecules related to oocyte maturation, fertilization, and embryonic development, and then leading to abnormal oocyte development and a decrease in

https://doi.org/10.2147/IJWH.S603264

fertilization capacity.[33] This finding can help caregivers to identify targets for clinical nutritional counseling and intervention, and allow them to tailor diets based on patients' cholesterol levels for high success ratio of reproductive outcomes.

Third, Higher zinc intake was negatively associated with the number of morphologically normal oocytes, number of mature oocytes (MII oocytes), and high-quality embryos. Zinc plays essential roles in key physiological processes, with intracellular zinc ion levels undergoing dynamic changes during oocyte maturation and fertilization, leading to the hypothesis that a zinc ion-dependent signal is critical for these processes.[34] The results obtained in this study seem to contradict previous conclusions; however, it is important to note that previous studies have focused on zinc deficiency and have not investigated the effects of zinc intake exceeding the body's requirements. This study found that the daily zinc intake of participants in this study exceeded the recommended dietary allowance for Chinese residents. Excessive zinc intake can affect changes in women's blood lipids and immune responses,[35] which may impact the maturation quality and fertilization capacity of oocytes. In clinical practice, it is necessary to accurately monitor patients' zinc levels and maintain its appropriate range for protection of reproductive function.

Several limitations of this study should be considered. First, dietary intake was assessed using a semi-quantitative food frequency questionnaire (SQFFQ). The SQFFQ is a widely used and practical tool for large-scale nutritional studies, despite its inherent recall bias. To minimize this bias, all research staff received standardized training, and a visual food portion atlas was designed to assist participants in accurately estimating their food intake. Second, despite adjustment for age, BMI, and basal endocrine levels, residual confounding from unmeasured lifestyle factors (eg, physical activity, stress, sleep quality, supplement use) cannot be completely excluded. Third, this was a single-center study conducted in Jiangsu Province, which may limit the generalizability of our findings to other populations with different dietary habits and socioeconomic backgrounds. Future multi-center prospective studies are needed to validate our results.

Conclusion

Dietary patterns were not associated with reproductive outcomes in this Chinese cohort. Exploratory analyses identified that higher vitamin B2 intake was associated with improved blastocyst quality, whereas higher cholesterol and zinc intakes were associated with poorer oocyte and embryo parameters, suggesting that specific nutrients—rather than overall dietary patterns—may be more directly relevant to reproductive outcomes. Our findings offer several tentative clinical implications: monitoring cholesterol intake, ensuring adequate vitamin B2 intake, and avoiding excessive zinc supplementation in women undergoing ART, which may help improve reproductive outcomes.

Acknowledgments

We acknowledge the support of the nurses from the Reproductive Medicine Center of Women's Hospital of Nanjing Medical University for their assistance in patient care and data collection.

Funding

This study was funded by the Science and Technology Development Fund of Nanjing Medical University (NMUB20240093).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Farquhar CM, Bhattacharya S, Repping S, et al. Female subfertility. *Nat Rev Dis Primers*. 2019;5(1):7. doi:10.1038/s41572-018-0058-8
2. Suvorov A. Population numbers and reproductive health. *Endocrinology*. 2021;162(11):bqab154. PMID: 34427630. doi:10.1210/endocr/bqab154
3. Yang MY, Zhang Y, Niu FF. Research progress on health information needs and interventions for patients receiving assisted reproductive technology for pregnancy. *Chin J Nurs*. 2021;56(1):143–148.
4. Gaskins AJ, Chavarro JE. Diet and fertility: a review. *Am J Obstet Gynecol*. 2018;218(4):379–389. PMID: 28844822; PMCID: PMC5826784. doi:10.1016/j.ajog.2017.08.010
5. Bala R, Singh V, Rajender S, Singh K. Environment, lifestyle, and female infertility. *Reprod Sci*. 2020;28(3):617–638. doi:10.1007/s43032-020-00279-3

6. Quan S, Zhu W. Measuring global dietary diversity by considering nutritional functional dissimilarity and dietary guidelines. *Foods*. 2025;14(10):1759. doi:10.3390/foods14101759
7. Wei MQ, Yu SH, Yang BX, Luo D. Research status of the influence of common dietary patterns on depression. *Chin Evid-Based Nurs*. 2024;10(10):1762–1768.
8. Ditano-Vázquez P, Torres-Peña JD, Galeano-Valle F, et al. The fluid aspect of the mediterranean diet in the prevention and management of cardiovascular disease and diabetes: the role of polyphenol content in moderate consumption of wine and olive oil. *Nutrients*. 2019;11(11):2833. PMID: 31752333; PMCID: PMC6893438. doi:10.3390/nu11112833
9. Filippou CD, Tsioufis CP, Thomopoulos CG, et al. Dietary Approaches to Stop Hypertension (DASH) diet and blood pressure reduction in adults with and without hypertension: a systematic review and meta-analysis of randomized controlled trials. *Adv Nutr*. 2020;11(5):1150–1160. PMID: 32330233; PMCID: PMC7490167. doi:10.1093/advances/nmaa041
10. Key TJ, Papier K, Tong TYN. Plant-based diets and long-term health: findings from the EPIC-Oxford study. *Proc Nutr Soc*. 2022;81(2):190–198. PMID: 35934687; PMCID: PMC7613518. doi:10.1017/S0029665121003748
11. Christ A, Lauterbach M, Latz E. Western diet and the immune system: an inflammatory connection. *Immunity*. 2019;51(5):794–811. PMID: 31747581. doi:10.1016/j.immuni.2019.09.020
12. Ricci E, Bravi F, Noli S, et al. Mediterranean diet and outcomes of assisted reproduction: an Italian cohort study. *Am J Obstet Gynecol*. 2019;221(6):627.e1–627.e14. PMID: 31288008. doi:10.1016/j.ajog.2019.07.011
13. Muffone ARMC, de Oliveira Lübke PDP, Rabito EI. Mediterranean diet and infertility: a systematic review with meta-analysis of cohort studies. *Nutr Rev*. 2023;81(7):775–789. PMID: 36346903. doi:10.1093/nutrit/nuac087
14. Bishop CV, Takahashi D, Mishler E, et al. Individual and combined effects of 5- year exposure to hyperandrogenemia and Western-style diet on metabolism and reproduction in female rhesus macaques. *Hum Reprod*. 2021;36(2):444–454. doi:10.1093/humrep/deaa321
15. Hu XF, Zhang R, Chan HM. Identification of Chinese dietary patterns and their relationships with health outcomes: a systematic review and meta-analysis. *Public Health Nutr*. 2024;27(1):e209. PMID: 39397510; PMCID: PMC11604330. doi:10.1017/S1368980024001927
16. Lee MM, Wu-Williams A, Whittemore AS, et al. Comparison of dietary habits, physical activity and body size among Chinese in North America and China. *Int J Epidemiol*. 1994;23(5):984–990. doi:10.1093/ije/23.5.984
17. Afrin S, AlAshqar A, El Sabeh M, et al. Diet and nutrition in gynecological disorders: a focus on clinical studies. *Nutrients*. 2021;13(6):1747. doi:10.3390/nu13061747
18. Silvestris E, Lovero D, Palmirotta R. Nutrition and female fertility: an interdependent correlation. *Front Endocrinol*. 2019;10:346. doi:10.3389/fendo.2019.00346
19. Ji X, Ye Y, Wang L, Liu S, Dong X. Association between nutrient intake and female infertility: a study based on NHANES database. *J Obstetrics Gynaecol*. 2023;43(2). doi:10.1080/01443615.2023.2285025
20. Li MC, Nassan FL, Chiu YH, et al; EARTH Study Team. Intake of antioxidants in relation to infertility treatment outcomes with assisted reproductive technologies. *Epidemiology*. 2019;30(3):427–434. PMID: 30789428; PMCID: PMC6456381. doi:10.1097/EDE.0000000000000976
21. Kadir M, Hood RB, Mínguez-Alarcón L, et al. Folate intake and ovarian reserve among women attending a fertility center. *Fertil Steril*. 2022;117(1):171–180. doi:10.1016/j.fertnstert.2021.09.037
22. Murto T, Skoog Svanberg A, Yngve A, et al. Folic acid supplementation and IVF pregnancy outcome in women with unexplained infertility. *Reprod BioMed Online*. 2014;28(6):766–772. doi:10.1016/j.rbmo.2014.01.017
23. Willett W. Reproducibility and validity of food frequency questionnaires. In: *Nutritional Epidemiology*. Oxford, UK: Oxford University Press; 2012:96–141.
24. Nutrition Society T.C. *Dietary Guidelines for Chinese Residents*. Beijing, China: People's Medical Publishing House; 2016.
25. Sugawa M, Okubo H, Sasaki S, Nakagawa Y, Kobayashi T, Kato K. Lack of a meaningful association between dietary patterns and in vitro fertilization outcome among Japanese women. *Reprod Med Biol*. 2018;17(4):466–473. PMID: 30377401; PMCID: PMC6194274. doi:10.1002/rmb2.12223
26. Cemali Ö, Akdevelioğlu Y, Berkkan A, et al. Mediterranean diet adherence, fatty acid profiles, and early assisted reproduction outcomes: findings from a 12-week dietary intervention. *Medicina*. 2026;62(3):539. PMID: 41901619; PMCID: PMC13028347. doi:10.3390/medicina62030539
27. Murakami K, Shinozaki N, Fujiwara A, et al. A systematic review of principal component analysis-derived dietary patterns in Japanese adults: are major dietary patterns reproducible within a country? *Adv Nutr*. 2019;10(2):237–249. PMID: 30785205; PMCID: PMC6416039. doi:10.1093/advances/nmy079
28. Salvaleda-Mateu M, Rodríguez-Varela C, Labarta E. Do popular diets impact fertility? *Nutrients*. 2024;16(11):1726. PMID: 38892663; PMCID: PMC11174414. doi:10.3390/nu16111726
29. Chinese Nutrition Society. *Dietary Reference Intakes for Chinese Residents (2023 Edition)*. Beijing: Science Press; 2023.
30. Richani D, Dunning KR, Thompson JG, Gilchrist RB. Metabolic co-dependence of the oocyte and cumulus cells: essential role in determining oocyte developmental competence. *Hum Reprod Update*. 2021;27:27–47. doi:10.1093/humupd/dmaa043
31. Van Blerkom J. Mitochondrial function in the human oocyte and embryo and their role in developmental competence. *Mitochondrion*. 2011;11(5):797–813. PMID: 20933103. doi:10.1016/j.mito.2010.09.012
32. Zhang L, Wu LM, Xu WH, et al. Status of maternal serum B vitamins and pregnancy outcomes: new insights from in vitro fertilization and embryo transfer (IVF-ET) treatment. *Front Nutr*. 2022;9:962212. PMID: 36438768; PMCID: PMC9691978. doi:10.3389/fnut.2022.962212
33. Arias A, Quiroz A, Santander N, Morselli E, Busso D. Implications of high-density cholesterol metabolism for oocyte biology and female fertility. *Front Cell Dev Biol*. 2022;10:941539. PMID: 36187480; PMCID: PMC9518216. doi:10.3389/fcell.2022.941539
34. Kageyama A, Suyama A, Kinoshita R, Ito J, Kashiwazaki N. Dynamic changes of intracellular zinc ion level during maturation, fertilization, activation, and development in mouse oocytes. *Anim Sci J*. 2022;93(1):e13759. PMID: 35880318. doi:10.1111/asj.13759
35. Garner TB, Hester JM, Carothers A, Diaz FJ. Role of zinc in female reproduction. *Biol Reprod*. 2021;104(5):976–994. PMID: 33598687; PMCID: PMC8599883. doi:10.1093/biolre/ioab023