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Association between nutrient patterns and serum lipids in Chinese adult women: A cross-sectional study

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Abstract

Aim: To investigate the association between patterns of nutrient intake and serum lipids in Chinese women aged 18–80 years.

Methods: In the present study, cross-sectional data were analysed from 2886 female participants aged 18–80 years from the China Health and Nutrition Survey wave 2009. Nutrient patterns were identified using factor analysis combined with cluster analysis based on the data of nutrient intake for three consecutive days. Multivariate linear regression models were used to estimate the association of nutrient patterns with serum lipids.

Results: Four nutrient patterns were identified in Chinese adult women, which were the plant-based pattern, carbohydrate and animal fat pattern, plant fat and sodium pattern, and the animal-based pattern. Participants following different patterns varied significantly in sociodemographic characteristics, lifestyle behaviours and food consumption. Compared with the plant-based pattern, the carbohydrate and animal fat pattern was positively associated with low-density lipoprotein cholesterol ($\beta = 4.57$, 95% CI: 0.29–8.85, $P = 0.036$) and total cholesterol ($\beta = 4.89$, 95% CI: 0.34–9.44, $P = 0.035$). The corresponding rises for the animal-based pattern were 4.91 (95% CI: 0.99–8.82, $P = 0.014$) and 4.98 (95% CI: 0.82–9.15, $P = 0.019$), respectively.

Conclusions: Nutrient patterns with a high intake of animal fat and a low intake dietary fibre and with high intakes of animal fat, animal protein and cholesterol may increase the serum cholesterol in Chinese women.

Key words: Chinese women, cholesterol, nutrient patterns, serum lipids.

Introduction

Dyslipidaemia has become an important public health issue in China.[1] The prevalence of dyslipidaemia was 33.5% among Chinese women in 2012.[2] Even though serum cholesterol levels fell in high-income countries, they still showed an increasing trend in the east and southeast Asia.[3] In China, from 2002 to 2012, mean total cholesterol (TC) and triglyceride (TG) in women, increased by 0.68 and 0.20 mmol/L respectively.[2] Elevated cholesterol increases the risk of cardiovascular diseases (CVD).[4,5] It was estimated that the unfavourable trend in TC will accelerate the epidemic of CVD in China.[6]

Diet is an important and modifiable risk factor of dyslipidaemia. A great body of literature has investigated the effects of certain foods and nutrients on serum lipids and has contributed to dyslipidaemia prevention.[7–9] In recent years, dietary pattern analysis, an alternative to the traditional approach, has gained more and more attention.[10,11] Compared with the traditional approach focusing on individual foods and nutrients, pattern analysis could reflect the effects of overall diet on health outcomes. Up until now, some studies have explored the association between food patterns and serum lipids.[12–14] A large-scale cross-sectional study conducted in Chinese women revealed that the traditional southern pattern was inversely associated with high-density lipoprotein cholesterol (HDL-C).[15] A Japanese cross-sectional study proved that the Western pattern was related to elevated serum lipids.[16]

However, most dietary pattern analyses were conducted on food consumption data. By contrast, limited work has been done on dietary pattern based on nutrient intake.[17] Food patterns and nutrient patterns could reflect our diet from different aspects. In the present study, we aimed to

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investigate the association between nutrient patterns and serum lipids in Chinese women aged 18–80 years.

Methods

This cross-sectional study was reported according to the Strengthening the Reporting of Observational Studies in Epidemiology Statement. The present study used data from the China Health and Nutrition Survey (CHNS). The CHNS is an ongoing population-based cohort study initiated in 1989, aiming to understand how social and economic changes in China affect food consumption, nutrition and health. The CHNS used a multistage, random cluster process to draw the samples from nine geographically diverse provinces in China.[18] Further details of the CHNS have been described elsewhere.[19] The present study used data collected in wave 2009. Two thousand eight hundred and eighty six female participants aged 18–80 years with complete data on sociodemographic characteristics, lifestyle behaviours, dietary intakes and serum lipids were included in these analyses. The CHNS was approved by the institutional review boards of the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health, Chinese Centre for Disease Control and Prevention. All participants gave written informed consent before they participated in the survey.

Data on sociodemographic characteristics and lifestyle behaviours were self-reported and recorded by trained interviewers, including age, sex, residential region, education, income, tobacco smoking, alcohol consumption and physical activity. The level of physical activity in the past 7 days (including 5 working days and 2 weekend days) was calculated by summing hours spent in each activity multiplied by metabolic equivalent tasks (METs) value for a particular activity.[18,20] Weight and height were measured by researchers. Body mass index (BMI) was calculated as weight (kg)/(height (m))^2.

Blood samples were collected in the morning after an overnight fasting. Plasma low-density lipoprotein cholesterol (LDL-C, mg/dL), HDL-C (mg/dL), TC (mg/dL) and TG (mg/dL) were measured in a national laboratory in China-Japan Friendship Hospital. Plasma non-high-density lipoprotein cholesterol (non-HDL-C) was calculated as TC minus HDL-C.[1]

Details of the dietary survey have been previously published.[21] In brief, both 3-day dietary recall and family food weight inventory were used to record dietary intakes. Participants were asked to report the kinds and amounts of foods and beverages they consumed during a 24-hour period both at home and away from home. Household food consumption was determined by examining changes in food weight inventory from the beginning to the end of each day. Individual intakes of 21 nutrients were estimated from the dietary data based on the China food composition databases.[22,23] Daily nutrient intakes were adjusted for total energy intake to 2000 kcal to reduce variation caused by correlations of nutrients with total energy intake.

Nutrient patterns from 21 nutrients were derived using factor analysis combined with cluster analysis, a two-step approach that has been used previously.[24,25] First, factor analysis using a principal component method was used to identify the major nutrient factors. We rotated the factors using an orthogonal transformation with varimax option to achieve factors with greater interpretability. A combination of eigenvalue and scree plot determined the number of factors. The scree plot levelled off after factor 5, so we kept the first five factors with a minimum eigenvalue of 2.17. These five factors explained 63% of the whole variance of nutrient intakes. Factor scores for each factor were calculated by summing the intake of each nutrient weighted by a factor loading. Subsequently, we used the factor scores in a hierarchical cluster analysis. We finally chose the four-cluster solution according to the cluster tree.

The general characteristics of participants were presented as means ± SDs for continuous variables, and differences across nutrient patterns were tested with analysis of variance. For categorical variables, values were presented as proportions and were compared using Chi-square tests. Age-adjusted means and SEs of serum lipids were estimated by the least-squares method.[26] For food groups with more than 50% of consumers, we used P50th (P25th, P75th) to describe average intakes per day, and differences across nutrient patterns were tested using Kruskal–Wallis tests. Otherwise, we categorised participants as non-consumers or consumers and showed the proportions of consumers, and the proportions were compared with chi-square tests. Linear regression models were used to estimate the differences in serum lipid levels across different nutrient patterns. In the first model, age (years), nationality (Han/others), residential region (north/south), and education (primary school and below, lower middle school, higher middle school and above) were adjusted. In the second model, BMI (kg/m^2), physical activity (<100 MET-hour/week, 100–200, ≥200), tobacco smoking (smoker/non-smoker), alcohol consumption (drinker/non-drinker) and daily energy intake (log-transformed) were also adjusted.

All the statistics in the present study were conducted within R 3.4.3. Single R package *psych*[27] was used to do the factor analysis and to compute the factor scores. All *P*-values were two-sided, and statistical significance was defined as $P < 0.05$.

Results

Four nutrient patterns were identified in Chinese women (Figure 1). The first pattern was characterised by high intakes of carbohydrate, plant protein, dietary fibre, vitamin B_1, magnesium, ferrite, copper and manganese, and was labelled as the plant-based (PB) pattern. The second pattern was characterised by high intakes of carbohydrate and animal fat and was named as the carbohydrate and animal fat (CAF) pattern. The third pattern was characterised by high consumption of plant fat, vitamin E and sodium, so we named this pattern the plant fat and sodium (PFS) pattern. The last pattern was characterised by high intakes of animal protein, animal fat, cholesterol, vitamin A, vitamin B_2, niacin, vitamin C, calcium, potassium, selenium and was labelled as animal-based (AB) pattern.

Of the 2886 female participants, 16.4% followed the PB pattern, 25.9% followed the CAF pattern, 23.3% followed the PFS pattern and 34.3% followed the AB pattern. Participants who followed the PB pattern were more likely to be of

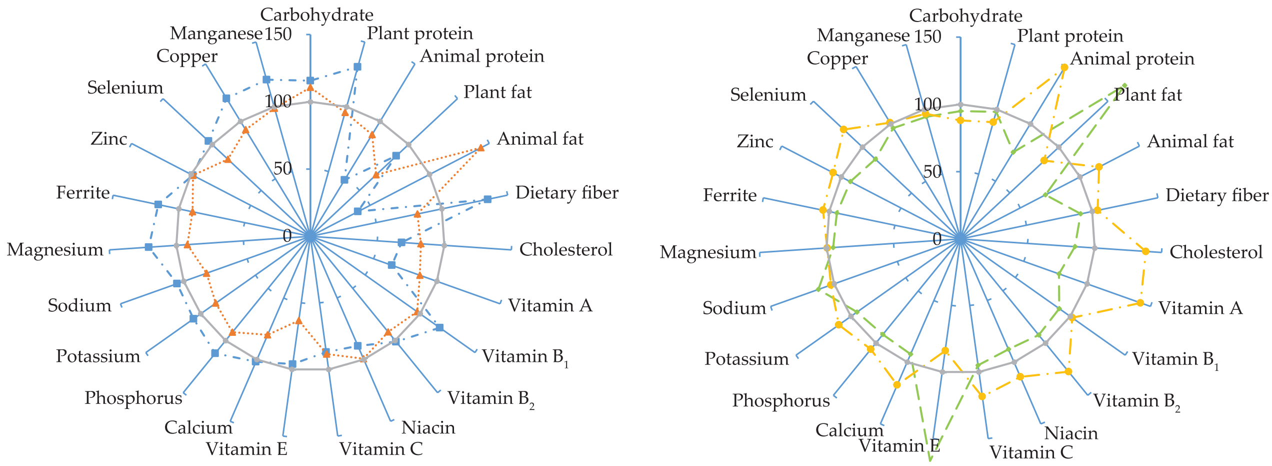

Figure 1 Nutrient patterns in Chinese women aged 18–80 years identified by factor analysis combined with cluster analysis. The reference circle of the radius (100%) corresponds to the overall mean intake of each kind of nutrient, and spikes indicate the relative values of pattern-specific mean intakes. For example, for 'carbohydrate,' the overall mean intake is 297.8 g/day, and the mean intake of the PB pattern is 344.5 g/day, so we express the overall mean as 100% and the PB pattern mean as 115.7% ((344.5/297.8) × 100).

Han nationality, were more likely to live in the north of China, had lower education and income and were less likely to be drinkers. Participants following the CAF pattern had lower BMI, were more likely to belong to minority nationalities and to live in the south of China, had lower education and income, and were less likely to be smokers. Participants following the PFS pattern had higher education and income, were more likely to be smokers, and took more energy per day. Participants who followed the AB pattern had higher education and income, were less likely to be smokers, but were more likely to be drinkers (Table 1). Food intakes across different nutrient patterns are shown in Table A1. Participants following different nutrient patterns differed significantly in intakes of major food groups.

Age-adjusted means of serum lipids are shown in Table 2. Participants in the PB pattern and the PFS pattern had relatively low LDL-C and TC, and those following the AB pattern had the highest LDL-C and TC. In multivariate analyses, compared with the individuals in the PB pattern, those in the CAF pattern had higher LDL-C and TC after adjustment of covariates (Table 3). Participants in the AB pattern also had higher LDL-C and TC compared to those following the PB pattern. There was no significant difference in serum lipids between participants in the PFS pattern and participants in the PB pattern.

Discussion

The relationship of serum lipids with nutrient patterns in Chinese adult women was investigated in the present study. The present study revealed that nutrient pattern characterised by high intakes of animal fat and carbohydrate and a low intake of dietary fibre and nutrient pattern characterised by high consumption of animal protein, animal fat, cholesterol, vitamin A, vitamin B_2, niacin, vitamin C, calcium, potassium and selenium were associated with elevated serum cholesterol.

Many studies have analysed the main food patterns in Chinese populations,[24] some of which have investigated the effects that certain food patterns have on serum lipids.[14,15] In contrast, limited attention has been paid to the pattern of nutrient intake. To the best of our knowledge, the present study is the first to analyse the association between nutrient patterns and serum lipids based in a large-scale Chinese population.

The present study found four kinds of nutrient patterns in the diets of Chinese women. The first nutrient pattern was characterised by high intakes of carbohydrate, plant protein, dietary fibre, vitamin B_1, magnesium, ferrite, copper and manganese. As macronutrients in this pattern were obtained from a diet rich in plant based foods, we named it the PB pattern. From Table A1, we can see that participants in this pattern followed a diet dominated by plant foods. In other studies deriving patterns from food consumption data, this pattern has often been referred to as the 'traditional northern pattern'.[24,28] Participants in the CAF pattern had more animal fat and carbohydrate, because they consumed more animal oil and cereals than others. Previous studies suggested that nutrient patterns that were rich in carbohydrate and fat were associated with obesity[29] and might increase the risk of fractures.[30] People following the PFS pattern consumed more plant fats and sodium, but they had relatively low intakes of vitamins except for vitamin E. Presumably because they consumed too high a proportion of convenience foods, which are low in nutrients and high in calories. The characteristic foods in this pattern represented a newly emerging food pattern in China titled 'snacks'.[15,31,32] The AB pattern was characterised by high intakes of animal protein, animal fat, cholesterol, etc. People in this pattern enjoyed a higher food diversity compared to individuals in other patterns.

In the present study, we observed a significant increase in LDL-C and TC for participants in the CAF pattern compared with those in the PB pattern after adjustment for

Table 1 Baseline characteristics of participants across four nutrient patterns[(a)]

Variable	*Plant-based pattern*	*Carbohydrate and animal fat pattern*	*Plant fat and sodium pattern*	*Animal-based pattern*	*P-value*[(b)]
n	474	747	673	992	
Age (years)	50.7 ± 13.1	50.1 ± 13.3	49.6 ± 12.7	49.8 ± 13.7	0.544
BMI (kg/m^2)	23.7 ± 3.2	22.8 ± 3.3	23.8 ± 3.6	23.5 ± 3.5	<0.001
Nationality (%)					
Han	95.1	76.4	92.3	88.7	<0.001
Others	4.9	23.6	7.7	11.3	
Residential region (%)					
South	28.5	81.8	44.4	57.4	<0.001
North	71.5	18.2	55.6	42.6	
Education (%)					
Primary school and lower	55.5	58.4	46.3	41.6	<0.001
Lower middle school	29.7	29.9	28.7	28.9	
Upper middle school and higher	14.8	11.8	25.0	29.5	
Physical activity (%)					
<100 (METs-hour/week)	33.5	31.7	31.2	30.6	0.033
100–200	24.1	22.5	22.7	28.7	
≥200	42.4	45.8	46.1	40.7	
Income (%)					
≤10 000 (Yuan/year)	63.9	58.2	46.2	44.8	<0.001
10 000–20 000	25.5	29.3	33.4	33.8	
>20 000	10.6	12.5	20.4	21.4	
Smoking (%)					
Non-smoker	97.0	97.9	93.5	97.2	<0.001
Smoker	3.0	2.1	6.5	2.8	
Alcohol consumption (%)					
Non-drinker	93.7	91.4	91.8	88.2	<0.001
Drinker	6.3	8.6	8.2	11.8	
Energy intake (kcal/day)	2054.0 ± 637.8	2174.8 ± 632.1	2210.2 ± 649.6	1937.9 ± 572.7	<0.001

[(a)] Continuous variables were presented as means ± SDs, and categorical variables were presented as proportions.
[(b)] Differences across four patterns were compared using analysis of variance for continuous variables or chi-square tests for categorical variables.
METs, metabolic equivalent tasks.

Table 2 Serum lipids of Chinese women aged 18–80 years across four nutrient patterns[(a)]

Variable	*Plant-based pattern*	*Carbohydrate and animal fat pattern*	*Plant fat and sodium pattern*	*Animal-based pattern*	*P-value*[(b)]
LDL-C (mg/dL)					
Crude	115.7 ± 1.7	115.5 ± 1.3	114.2 ± 1.3	119.0 ± 1.2	0.042
Age-adjusted	115.1 ± 1.6	115.4 ± 1.3	114.5 ± 1.3	119.2 ± 1.1	0.029
HDL-C (mg/dL)					
Crude	56.6 ± 0.6	57.7 ± 0.5	56.0 ± 0.6	56.9 ± 0.4	0.142
Age-adjusted	56.6 ± 0.6	57.7 ± 0.5	56.0 ± 0.5	56.9 ± 0.4	0.142
Non-HDL-C (mg/dL)					
Crude	71.7 ± 1.0	72.7 ± 0.6	71.9 ± 0.8	72.1 ± 0.6	0.818
Age-adjusted	71.6 ± 0.9	72.6 ± 0.7	72.0 ± 0.7	72.1 ± 0.6	0.815
TC (mg/dL)					
Crude	187.4 ± 1.9	188.2 ± 1.4	186.1 ± 1.5	191.1 ± 1.3	0.065
Age-adjusted	186.7 ± 1.7	188.1 ± 1.4	186.5 ± 1.4	191.3 ± 1.2	0.043
TG (mg/dL)					
Crude	136.2 ± 5.1	129.8 ± 3.2	138.1 ± 4.1	137.5 ± 3.6	0.399
Age-adjusted	135.3 ± 4.8	129.6 ± 3.8	138.6 ± 4.0	137.7 ± 3.3	0.386

[(a)] Values are means ± SEs of serum lipid components.
[(b)]Differences across four patterns were compared using analysis of variance or analysis of covariance.
LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; non-HDL-C, non-high-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride.

Table 3 Association between nutrient patterns and serum lipids in Chinese women aged 18–80 years

			Carbohydrate and animal fat pattern		*Plant fat and sodium pattern*		*Animal-based pattern*	
Variable	*Model*	*Plant-based pattern*	β *(95% CI)*	P-*value*	β *(95% CI)*	P-*value*	β *(95% CI)*	P-*value*
LDL-C	Crude	Reference	−0.13 (−4.34, 4.08)	0.952	−1.47 (−5.77, 2.82)	0.501	3.36 (−0.64, 7.36)	0.100
	Model 1[(a)]	Reference	4.26 (−0.03, 8.55)	0.052	−0.06 (−4.17, 4.04)	0.977	5.13 (1.22, 9.04)	0.010
	Model 2[(b)]	Reference	4.57 (0.29, 8.85)	0.036	−0.22 (−4.34, 3.90)	0.916	4.91 (0.99, 8.82)	0.014
HDL-C	Crude	Reference	1.06 (−0.53, 2.65)	0.192	−0.63 (−2.26, 0.99)	0.446	0.28 (−1.23, 1.80)	0.714
	Model 1	Reference	0.26 (−1.46, 1.97)	0.770	−1.05 (−2.69, 0.59)	0.208	−0.42 (−1.98, 1.15)	0.602
	Model 2	Reference	−0.04 (−1.70, 1.63)	0.967	−0.64 (−2.24, 0.96)	0.431	−0.10 (−1.62, 1.42)	0.900
non-HDL-C	Crude	Reference	0.97 (−1.20, 3.13)	0.382	0.24 (−1.97, 2.45)	0.831	0.38 (−1.68, 2.44)	0.719
	Model 1	Reference	0.21 (−2.11, 2.53)	0.859	0.22 (−2.00, 2.44)	0.845	0.14 (−1.97, 2.25)	0.897
	Model 2	Reference	0.32 (−1.99, 2.64)	0.784	0.08 (−2.15, 2.31)	0.947	0.07 (−2.05, 2.20)	0.946
TC	Crude	Reference	0.84 (−3.69, 5.36)	0.717	−1.23 (−5.85, 3.39)	0.601	3.74 (−0.57, 8.04)	0.089
	Model 1	Reference	4.47 (−0.10, 9.04)	0.055	0.16 (−4.21, 4.53)	0.943	5.27 (1.10, 9.44)	0.013
	Model 2	Reference	4.89 (0.34, 9.44)	0.035	0.14 (−4.52, 4.23)	0.948	4.98 (0.82, 9.15)	0.019
TG[(c)]	Crude	Reference	−0.02 (−0.09, 0.05)	0.623	0.03 (−0.04, 0.09)	0.472	0.01 (−0.05, 0.08)	0.695
	Model 1	Reference	0.02 (−0.05, 0.10)	0.499	0.05 (−0.01, 0.12)	0.125	0.05 (−0.02, 0.11)	0.143
	Model 2	Reference	0.04 (−0.03, 0.11)	0.241	0.04 (−0.03, 0.10)	0.278	0.04 (−0.03, 0.10)	0.262

[(a)] Adjusted for age (years), nationality (Han, others), residential region (north/south) and education level (primary school and below, lower middle school, higher middle school and above).
[(b)] Adjusted for age (years), nationality (Han, others), residential region (north/south), education level (primary school and below, lower middle school, higher middle school and above), BMI (kg/m^2), physical activity (<100 METs-hour/week, 100–200, ≥200), tobacco smoking (smoker/non-smoker), alcohol consumption (drinker/non-drinker) and daily energy intake (log-transformed).
[(c)] Values of TG were log-transformed before analysis.
CI, confidence interval; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; non-HDL-C, non-high-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride.

covariates. Compared to individuals in the PB pattern, those in the CAF pattern consumed more animal fat but less dietary fibre and minerals. Animal fat, which has a relatively high proportion of saturated fatty acids, is positively associated with serum cholesterol.[33,34] The negative effects of saturated fatty acids on serum cholesterol could be explained by increasing the formation of LDL-C.[35] In addition, the inadequate intake of dietary fibre might also contribute to the elevated serum cholesterol of the CAF pattern. Dietary fibre has hypocholesterolaemic effects[36] and thus has long been treated as a protective factor for CVD.[37] An umbrella review of meta-analyses underlined that fibre supplementation, regardless of the type of fibre, could significantly reduce serum cholesterol.[9] The mechanisms of the beneficial effects of dietary fibre include chelating cholesterol in the small intestine, increasing the faecal excretion of bile acids, and regulating the synthesis of cholesterol.[9,38]

Participants in the AB pattern had the highest levels of LDL-C and TC in the present study. Just like participants following the CAF pattern, women in this pattern also had a high intake of animal fat, which might be associated with the elevated serum cholesterol. Besides, participants in this pattern consumed more animal protein. Even though limited studies have directly demonstrated that animal protein has negative effects on serum cholesterol, some studies suggested that there was a positive relationship between dietary animal protein and serum cholesterol levels.[33,39] More importantly, individuals in this pattern had a high intake of cholesterol. Although the effect of dietary cholesterol on CVD is still controversial, it is commonly believed that dietary cholesterol is positively associated with serum cholesterol levels.[40–42] This association was observed in both middle-aged and old Chinese women.[43–45] Considering the fact that mean daily cholesterol intake in Chinese adults is still increasing, people should pay more attention to the consumption of food containing high levels of cholesterol, such as eggs, pork, shellfish, etc.[46]

In the present study, individuals following different nutrient patterns varied significantly in residential region, income and education, indicating that socioeconomic status still greatly influences the nutritional status of the Chinese population. Women in the PB pattern were more likely to live in the north of China and had a lower level of education and income. This pattern mainly reflects the nutrient intakes of low-income people who live in the north. Participants following the CAF pattern also had a lower level of education and income; however, unlike individuals in the PB pattern, they were more likely to live in the south of China. Participants in this pattern were also more likely to belong to minority nationalities. Briefly, this pattern mainly reflects the nutrient intakes of low-income women living in the south. In contrast to nutrient patterns PB and CAF, participants in nutrient patterns AB and PFS, were not limited regionally and were almost equally distributed in the north and south of China. Individuals in these two patterns had a higher level of education and income.

The present study used a large-scale, population-based sample to explore the association between nutrient pattern and serum lipids. However, this study has several limitations. First, as this is a cross-sectional study, it does not allow inference about causality, and there might be recall bias. Second, the food composition database we could access includes only a limited number of nutrients. For example, data were unavailable for polyunsaturated fatty acid and trans-fatty acid; these variables could provide important information if they were included in the pattern analysis. In addition, information on previous dyslipidaemia diagnoses is not recorded in the survey. Patients with dyslipidaemia may change their eating habits, which might underestimate the association in the present study. Finally, as there are some mixed foods in China, sometimes it is difficult to determine precisely whether they are plant- or animal-sourced.

In conclusion, we identified four nutrient patterns among Chinese adult women. Education, income and geographical differences across different patterns could be observed. Compared to the nutrient pattern with high intakes of carbohydrate, plant protein, dietary fibre and minerals, the pattern with high intakes of CAF and a low intake of dietary fibre was associated with elevated TC and LDL-C after adjustment for covariates. The pattern that was characterised by high consumption of animal protein, animal fat and cholesterol was also positively associated with serum TC and LDL-C.

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Conflict of interest

The authors have no conflicts of interest to declare.

Authorship

JZ and YZ conceived and designed the research; JZ, ST and MW analysed the data and interpreted the results; JZ and AZ wrote the paper; PW and YZ revised the paper.

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Appendix

Food consumption across four nutrient patterns in Chinese women aged 18–80 years[(a)]

Variable	*Plant-based pattern*	*Carbohydrate and animal fat pattern*	*Plant fat and sodium pattern*	*Animal-based pattern*	*Overall mean*	*P-value*[(b)]
Cereals and their products (g)	438.8 (371.5, 511.6)	363.1 (313.4, 417.3)	327.8 (267.2, 387.5)	328.1 (266.2, 407.9)	353.3 (290.1, 427.1)	<0.001
Tubers (%)	54.4	33.7	53.6	42.7	44.9	<0.001
Fast food (%)	9.3	11.4	17.2	22.9	16.4	<0.001
Snacks (%)	9.5	9.5	14.7	17.4	13.4	<0.001
Soy and its products (g)	8.1 (0.0, 28.5)	1.3 (0.0, 14.7)	7.8 (0.0, 23.4)	9.6 (0.0, 23.2)	6.9 (0.0, 21.1)	<0.001
Beans (%)	11.2	7.0	5.6	8.5	7.9	0.004
Meat (g)	5.6 (0.0, 42.2)	62.8 (34.2, 94.3)	33.3 (0.0, 64.1)	79.4 (42.2, 120.7)	52.4 (15.7, 91.3)	<0.001
Poultry (%)	9.7	22.8	14.3	32.9	22.1	<0.001
Processed meat and organ meat (%)	3.8	8.6	8.5	20.1	11.7	<0.001
Fish (%)	18.1	33.1	33.7	52.3	37.4	<0.001
Other aquatic products (%)	6.8	5.4	4.9	16.1	9.2	<0.001
Eggs (g)	18.0 (0.0, 42.8)	12.5 (0.0, 31.0)	21.7 (0.0, 43.7)	34.8 (6.6, 67.7)	21.4 (0.0, 48.4)	<0.001
Milk and dairy products (%)	2.7	2.8	9.5	18.1	9.6	<0.001
Vegetables (g)	293.2 (199.1, 417.8)	284.8 (207.3, 383.8)	278.2 (197.0, 403.8)	327.4 (237.1, 440.4)	295.7 (213.2, 413.0)	<0.001
Fungi (%)	13.9	10.0	14.4	23.7	16.4	<0.001
Nuts (%)	9.3	8.4	12.2	14.7	11.6	<0.001
Fruits (%)	27.4	29.0	35.5	47.4	36.6	<0.001
Animal oil (%)	5.3	36.5	7.6	12.6	16.4	<0.001
Plant oil (g)	26.9 (18.0, 35.7)	22.3 (8.5, 32.9)	54.3 (43.5, 67.7)	29.2 (18.9, 40.6)	31.4 (19.4, 45.7)	<0.001

(a)For food groups with more than 50% of consumers, we used P50th (P25th, P75th) to describe average intake per day. Otherwise, we categorised food intake as non-consumers or consumers and showed the proportion of consumers. Food intakes were adjusted for total energy intake to 2000 kcal per day.
(b)For food groups with more than 50% of consumers, differences across different patterns were tested using Kruskal -Wallis tests. Otherwise, proportions of consumer across four patterns were compared with chi-square tests.