Association between Dietary Patterns and Cardiometabolic Risks among Older Adult Males in Sichuan Province, China: A Cross-sectional Study

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Received September 26, 2020; Revised October 28, 2020; Accepted November 05, 2020

Abstract Objective: This study aims to identify data-driven dietary patterns and find out the relationship of dietary patterns with different cardiometabolic risks including overweight/obesity, dyslipidemia or high blood pressure (HBP) among older adult males (aged ≥65 years old) residents (>10 years) of Sichuan, Southwestern China.

Methods: This cross-sectional study investigated the relationships of dietary patterns with cardiometabolic risks in older adult males (n =1136) aged ≥65 years old referred to the Public Hospital in Sichuan Province, China. A validated semi-quantitative food frequency questionnaire (SFFQ) was used to investigate the correlations between the animal-based and processed food dietary (pattern 1), balanced dietary (pattern 2), and Ovo-Lacto Vegetarian dietary (pattern 3) and different cardiometabolic risks. The correlations between dietary patterns and the laboratory tests were calculated. Results: The animal-based and processed food, balanced, and Ovo-Lacto Vegetarian dietary patterns accounted for 14.83%, 14.36% and 11.86% of the variance, respectively. The Chi-Square test showed the dietary patterns were associated with triglycerides (TG) (P < 0.001), total cholesterol (TC), Systolic blood pressure (SBP), and body mass index (BMI). Adjusted logistic regression analysis showed the animal-based and processed food dietary pattern was positively associated with overweight/obesity (OR: 3.25, 95% CI: 1.94, 5.46) and dyslipidemia (OR: 3.53, 95% CI: 2.00, 6.22). The balanced dietary pattern was negatively associated with overweight/obesity (OR: 0.51, 95% CI: 0.36, 0.72), dyslipidemia (OR: 0.50, 95% CI: 0.35, 0.75) and HBP (OR: 0.54, 95% CI: 0.38, 0.77). The Ovo-Lacto Vegetarian dietary pattern was negatively associated with dyslipidemia (OR: 0.56, 95% CI: 0.39, 0.81) and hyperuricemia (OR: 0.56, 95% CI: 0.39, 0.79). No statistically significant relationship was found between the three dietary patterns and impaired fasting glucose (P: 0.05). Conclusions: Elderly males in Sichuan Province with overweight/obesity, dyslipidemia and high blood pressure seem to have adopted different dietary patterns.

Keywords: dietary patterns, elderly males, semi-quantitative food frequency questionnaire (SFFQ), dietary survey


1. Introduction

The global rise of chronic non-communicable diseases such as hypertension and diabetes poses significant public health challenges worldwide [1]. The role of nutrition in the pathogenesis or as a risk factor of chronic non-communicable diseases such as cardiovascular disease (CVD) has long been debated [2,3,4]. Using natural medications and nutrients for managements of different disorders is an ancient idea as well as novel medical approach in healthcare [5,6,7]. So far many studies have focused on associations between individual nutrients, foods or food groups and prevalence of chronic non-communicable diseases [8,9]. Dietary patterns such as the Mediterranean and Dietary Approaches to Stop Hypertension (DASH), have been increasingly studied [10,11]. The traditional Mediterranean-type diet, including plant foods and an emphasis on plant protein sources, provide a well-tested healthy dietary pattern to reduce CVD [12], including its beneficial effects on blood pressure and lowering of chronic disease risk and markers such as hypertension, hypercholesterolemia, obesity, and diabetes [13]. While classic approaches are useful, they can difficulty account for the combined effects of the multiple components of a diet. In contrast, data-driven approaches, also called a posteriori approaches, generate hypothesis-free dietary
patterns that better reflect a population’s diet [14].

China is culturally diverse and its citizens enjoy a multitude of dietary choices. Traditional Sichuan cuisine is the most widely served cuisine in the country and has a dietary pattern with preferences for spicy, oily, salty and soy food, and fewer dairy products. However, with rapid economic development and urbanization of Sichuan province, the dietary structure and lifestyle of her residents have also changed. On the other hand, the prevalence of CVDs in Chengdu, the capital city of Sichuan, is over 50% [15]. The relationship between Sichuan cuisine and the prevalence of overweight, obesity, dyslipidemia and high blood pressure have not yet been fully examined.

Investigating the association of diets on the development of diseases is a complex task that requires both quality dietary information and numerous individuals who completed all the inspection items [16,17,18]. Considering these factors, we chose the target population at the hospital Medical Examination Center. Dietary data were collected by health surveys including nutrition-related questions which had been used in representative populations in Sichuan and had good reliability and validity as we reported before [19]. In this cross-sectional study, we aimed to identify data-driven dietary patterns using the semi-quantitative Simplified Food Frequency Questionnaire (SFFQ) from hospital wellness surveys, and to study the association of dietary patterns with overweight, obesity, dyslipidemia and high blood pressure in Sichuan males aged at least 65 years.

2. Methods

2.1. Study Design and Participants

This study enrolled older adult males aged ≥ 65 years old who referred to the Medical Examination Center in the Wellness Center of the Public Hospital in Sichuan Province, Southwest China between March 2017 and August 2018. A representative sample of the group was obtained by a multistage stratified cluster sampling method. The inclusion criteria were adult males aged ≥ 65 years old, living in Sichuan province for more than 10 years. Exclusion criteria included history of medications for the chronic diseases including blood pressure drugs, lipid-lowering drugs and hypoglycemic drugs. Moreover, individuals with history of stroke, coronary heart disease or other serious CVDs were excluded from the study.

The study protocol was approved by the local Human Ethics and Research Ethics committees of Sichuan Provincial People's Hospital, Sichuan, China, which were in complete accordance with the ethical standards and regulations of human studies of the Helsinki declaration (2014). All the participants provided written informed consent for the participating in the study. The flowchart of the study containing the different stages and the participants is presented in Figure 1.

![Figure 1. The CONSORT diagram of the main phases of the clinical trial](image-url)
2.2. Dietary Assessment

Diet was assessed using the SFFQ scale at the beginning of the study as per the following protocol: Participants were invited to attend a health examination in which they answered the self-administered questionnaire. The questionnaire has been validated for use in Chinese population [19] with a log-transformed correlation coefficient of 0.578 (crude 0.539) for validity. Participants were asked to provide their dietary intake in the preceding year before the study and recorded both the frequency and quantity of consumed food items in 10 food categories. Six predefined frequency categories of each food type including 1~3 times/day, 4~6 times/week, 1~3 times/week, 4~6 times/month, 1~3 times/month and never. The diet checklist comprised of food intake in the preceding year. Each food intake was recorded according to the real-life situation. An illustrated food model booklet, measuring cups, spoons, and ruler were used to assist participants in accurately estimating quantities of foods and beverages consumed. The mean daily food intake was calculated as the mean quantity per intake multiplied by the mean daily intake frequency. The 10 food categories, which have been consistently assessed across surveys, included refined rice and noodle, whole grains (brown rice/potato/oats/buckwheat, etc.), meat (pork/beef/mutton and chicken/duck/goose, etc.), aquatic products (fish/shrimp/crab/shellfish, etc.), eggs (fried eggs/steamed and chicken/duck/goose, etc.), eggs, etc.), legume products (soybean/soy milk/tofu, etc.), dairy products (milk/yogurt, and other dairy products), vegetables, fruits and nuts.

2.3. Identification of Dietary Patterns

Factor analysis was used to identify dietary patterns. Answers to the SFFQ were transformed into daily dietary doses and then normalized using the Z-score procedure. The varimax rotation procedure was used to rotate these factors. The number of determinants was established using Kaiser’s criterion (>1) and further verified through Cattell’s criterion (scree plot test). The factor loading values were calculated for each dietary factor. A food item was retained in the pattern if its factor loading value was above 0.30. The derived factors (dietary patterns) were labeled based on our data interpretation and earlier literature [20]. The subjects were categorized according to the interquartile range from Quartile 1(Q1) to Quartile 4(Q4) of each pattern. Additionally, the subject features were divided into quartile groups based on the range of dietary patterns. Further statistical analyses were done in the quartiles of each dietary factor.

2.4. Definition of Terms, Demographics and Lifestyle Data

Dyslipidemia was diagnosed if at least one of the four following criteria was met: triglycerides (TG) ≥2.26 mmol/L, total cholesterol (TC) ≥6.22 mmol/L, high-density lipoprotein cholesterol (HDL-C) <1.04 mmol/L, or low-density lipoprotein cholesterol (LDL-C) ≥4.14 mmol/L [21]. A person with a body mass index (BMI) of 24 to 28 kg/m² was considered overweight, and a person with a BMI ≥28 kg/m² was considered to be obesity [22]. Waist circumference ≥90 cm was the cutoff waist circumference for male with excess waistlines. Systolic blood pressure (SBP) ≥140 mmHg and/or diastolic pressure (DBP) ≥90 mmHg were diagnosed as high blood pressure (HBP) [22]. A person with a fasting plasma glucose (FPG) ≥6.1 mmol/L was diagnosed with impaired fasting glucose (IFG) [23]. Serum uric acid (SUA)> 420 mmol/L in men indicated hyperuricemia [24].

The following demographic and lifestyle data were assessed by questionnaires as previous described [20]: alcohol consumption (no vs. moderate drinking vs. excessive alcohol consumption), and smoking status (never vs. former vs. smoker). Excessive alcohol consumption was defined as drinking more than 25 g alcohol/day. Never smokers were defined as smoking<10 cigarettes/lifetime. Former smokers defined as abstinence from smoking for at least 15 years on the day of enrollment in the study.

2.5. Statistical Analyses

Numbers and percentages were calculated for age, smoking status, excessive alcohol consumption and the prevalence of non-communicable diseases in the quartiles of each factor (dietary pattern). The associations between structure indicators for each factor were analyzed by using the Chi-square test.

To assess the relationship between dietary patterns and the laboratory tests, a logistic regression analysis was applied and the odds ratios (OR) and 95% confidence intervals (CI) were calculated. The association was adjusted for age, smoking, excessive alcohol consumption and total energy intake. All P-values presented were 2-tailed; P< 0.05 was considered significant. Statistical analysis was carried out using the Statistical Package for the Social Science (SPSS) software, version 17.0 (IBM, Armonk, New York, NY, USA).

3. Results

3.1. Characteristics of the Study Population

The survey collected 1214 questionnaires from groups who never take medicine for chronic diseases including blood pressure drugs, lipid-lowering drugs and hypoglycemic drugs and finished wellness examination at our institution. Thirty five patients with stroke/coronary heart disease and 22 participants who were not residents or had lived in Sichuan less than 10 years were excluded. The questionnaire information of 21 patients was incomplete and was not included. Finally, 1136 subjects were included in the study. Their mean age was (72.04 ± 8.98) years and they had a mean BMI of (24.11 ± 3.02) Kg/m².

3.2. Dietary Patterns of the Study Population

The mean dietary intake of the population over the preceding year is shown in Table 1. Both the Kaiser-Meyer-Olkin index (0.672) and Bartlett’s test (P<0.001) indicated that correlation among the variables was sufficient for factor analysis. Three factors, the animal-based and processed food dietary pattern, the
balanced dietary pattern, and the Ovo-Lacto Vegetarian dietary pattern, were derived and accounted for 14.83%, 14.36% and 11.86% of the variance, respectively. The top two food groups were used to name the three patterns: refined rice and noodle/meats (Pattern 1), whole grain/vegetables (Pattern 2), and dairy products/fruits (Pattern 3). The factor-loading of all 10 food groups, in a descending order is presented in Table 2.

Pattern 1 (animal-based and processed food dietary pattern) was most strongly correlated with the consumption of refined rice and noodle, meat and aquatic products (Table 2). Pattern 2 (balanced pattern) was most strongly correlated with the whole grains, vegetables and legume products. Pattern 3 (Ovo-Lacto Vegetarian dietary pattern) was positively correlated with the dairy products, fruits and eggs.

### Table 1. The mean dietary intake of the study population over the preceding year* (n=1136, Mean ± SD)

<table>
<thead>
<tr>
<th>Food groups</th>
<th>Pattern 1</th>
<th>Pattern 2</th>
<th>Pattern 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refined rice and noodle</td>
<td>0.690</td>
<td>-0.200</td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>0.667</td>
<td>0.222</td>
<td></td>
</tr>
<tr>
<td>Aquatic products</td>
<td>0.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legume products</td>
<td>0.216</td>
<td>0.412</td>
<td></td>
</tr>
<tr>
<td>Dairy products</td>
<td></td>
<td>-0.265</td>
<td>0.771</td>
</tr>
<tr>
<td>Fruits</td>
<td></td>
<td>0.282</td>
<td>0.589</td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
<td>0.274</td>
<td>0.353</td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td>0.211</td>
<td>0.201</td>
</tr>
<tr>
<td>Percentage of variance explained (%)</td>
<td>14.83</td>
<td>14.36</td>
<td>11.86</td>
</tr>
</tbody>
</table>

*Values < 0.20 were excluded for simplicity.

### Table 2. Factor-loading matrix for major dietary patterns*

### Table 3. Dietary patterns of the study population stratified by age, smoking status and alcohol consumption, N (%)

### Table 4. Daily energy intakes of the study population stratified by age, BMI, waist circumference and dietary patterns, (Mean ± SD)

**P < 0.01 was considered statistically significant.**

**P < 0.05 was considered statistically significant.**

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*Journal of Food and Nutrition Research*
3.3. Dietary Patterns of the Study Population Stratified by Smoking Status, Alcohol Consumption and Energy Intake

Chi-Square analysis showed that smoking status correlated with dietary patterns. Age and excessive alcohol consumption did not show statistically significant association, after comparison of the distribution characteristics of the 3 dietary patterns in the population (Table 3). We also analyzed the energy intake of the population given its possible effects on the analysis. The daily energy intake of Pattern 1 (1948.93 ± 445.17 Kcal/d) was significantly higher than that of Pattern 2 (1743.52 ± 637.93 Kcal/d) and Pattern 3 (1494.93 ± 640.07 Kcal/d) (P<0.000) (Table 4). Furthermore, participants whose BMI was <18.5 or ≥24 Kg/m² had a significantly higher daily energy intake than participants whose BMI was 18.5 - 23.9 Kg/m².

3.4. Association between Dietary Patterns and Physical Indicators

The associations between dietary patterns and physical examination are presented in Table 5. The three dietary patterns showed significant association with BMI, SBP, high TG, high TC and high LDL-C (P<0.05). No correlation was observed between the dietary patterns and the excess waist, DBP, FPG and SUA.

Logistic regression analysis was carried out to determine the association between the three dietary patterns and overweight/obesity, dyslipidemia, high blood pressure (HBP), hyperuricemia and impaired fasting glucose (IFG) after adjustment for age, smoking status, excessive alcohol consumption and total energy intake. The subjects were categorized according to the interquartile range from Quartile 1 (Q1) to Quartile 4 (Q4) of each pattern based on the range of dietary patterns. Pattern 1 was positively associated with overweight/obesity and dyslipidemia after multivariable adjustment. The OR of overweight/obesity (OR: 3.25, 95% CI: 1.94, 5.46) and dyslipidemia (OR: 3.53, 95% CI: 2.00, 6.22) was significantly higher in Q4 versus Q1. There was no significant difference in the OR of HBP, IFG and hyperuricemia between Q4 and Q1 of dietary Pattern 1 (Figure 2A).

Pattern 2 showed negatively association by subjects with overweight/obesity, dyslipidemia and HBP after multivariable adjustment. The OR of overweight/obesity (OR: 0.51, 95% CI: 0.36, 0.72), dyslipidemia (OR: 0.50, 95% CI: 0.35, 0.75) and HBP (OR: 0.54, 95% CI: 0.38, 0.77) was significantly lower than those of Q4 versus Q1. No correlation was demonstrated between Q4 and Q1 of Pattern 2 in the OR of IFG and hyperuricemia (Figure 2B).

Pattern 3 was negative adopted by subjects with dyslipidemia and hyperuricemia. The OR of dyslipidemia (OR: 0.56, 95% CI: 0.39, 0.81) and hyperuricemia (OR: 0.56, 95% CI: 0.39, 0.79) was significantly lower in Q4 versus Q1. No difference in the OR of IFG, HBP and overweight/obesity was observed between the highest and the lowest quartile of this pattern (Figure 2C).

### Table 5. Correlation between dietary patterns and physical indicators in Sichuan elderly males, N (%)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pattern 1</th>
<th>Pattern 2</th>
<th>Pattern 3</th>
<th>Chi-Square</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI Kg/m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;18.5 (n=34)</td>
<td>11 (32.4)</td>
<td>15 (44.1)</td>
<td>8 (23.5)</td>
<td>89.45</td>
<td>0.000***</td>
</tr>
<tr>
<td>18.5–23.9 (n=527)</td>
<td>128 (24.3)</td>
<td>187 (35.5)</td>
<td>212 (40.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥24 (n=573)</td>
<td>291 (50.8)</td>
<td>113 (19.7)</td>
<td>169 (29.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess waist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=729)</td>
<td>271 (37.2)</td>
<td>207 (28.4)</td>
<td>251 (34.4)</td>
<td>0.59</td>
<td>0.745</td>
</tr>
<tr>
<td>No (n=405)</td>
<td>159 (39.3)</td>
<td>108 (26.7)</td>
<td>138 (34.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥140mmHg (n=417)</td>
<td>128 (30.7)</td>
<td>142 (34.1)</td>
<td>147 (35.3)</td>
<td>18.60</td>
<td>0.000***</td>
</tr>
<tr>
<td>&lt;140mmHg (n=717)</td>
<td>302 (42.1)</td>
<td>173 (24.1)</td>
<td>242 (33.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBP ≥90mmHg (n=47)</td>
<td>22 (46.8)</td>
<td>8 (17.0)</td>
<td>17 (36.2)</td>
<td>3.11</td>
<td>0.21</td>
</tr>
<tr>
<td>&lt;90mmHg (n=1087)</td>
<td>408 (37.5)</td>
<td>307 (28.2)</td>
<td>372 (34.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High TG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=252)</td>
<td>158 (62.7)</td>
<td>41 (16.3)</td>
<td>53 (21.0)</td>
<td>84.55</td>
<td>0.000***</td>
</tr>
<tr>
<td>No (n=882)</td>
<td>272 (30.8)</td>
<td>274 (31.1)</td>
<td>336 (38.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High TC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=110)</td>
<td>57 (51.8)</td>
<td>28 (25.5)</td>
<td>25 (22.7)</td>
<td>11.20</td>
<td>0.004**</td>
</tr>
<tr>
<td>No (n=1024)</td>
<td>373 (36.4)</td>
<td>287 (28.0)</td>
<td>364 (35.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High LDL-C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=47)</td>
<td>26 (55.3)</td>
<td>13 (27.7)</td>
<td>8 (17.0)</td>
<td>8.18</td>
<td>0.017*</td>
</tr>
<tr>
<td>No (n=1087)</td>
<td>404 (37.2)</td>
<td>302 (27.8)</td>
<td>381 (35.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High FPG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=159)</td>
<td>66 (41.5)</td>
<td>41 (25.8)</td>
<td>52 (32.7)</td>
<td>1.03</td>
<td>0.60</td>
</tr>
<tr>
<td>No (n=975)</td>
<td>364 (37.3)</td>
<td>274 (28.1)</td>
<td>337 (34.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High uric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (n=380)</td>
<td>132 (34.7)</td>
<td>114 (30.0)</td>
<td>134 (35.3)</td>
<td>2.70</td>
<td>0.260</td>
</tr>
<tr>
<td>No (n=754)</td>
<td>298 (39.5)</td>
<td>201 (26.7)</td>
<td>255 (33.8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: P<0.05
**: P<0.01
***: P<0.001
P<0.05 was considered statistically significant.
4. Discussion

The study demonstrated significant correlation between dietary patterns and overweight/obesity, dyslipidemia and high blood pressure. Westernized diet patterns have been associated with a higher risk of metabolic syndrome [25,26] and are characterized by a high consumption of meat or meat products, snacks, sugar-sweetened beverages, and baked desserts and are similar to Pattern 1 in our study. Our findings showed that the animal-based and processed food dietary most strongly correlated with consumption of refined rice and noodle, meat and aquatic products was related with overweight/obesity and dyslipidemia. The \( OR \) was significantly higher among elderly males in Q4 versus those in Q1 (Q4:Q1=3.25 and 3.53, respectively).

Current literature shows dyslipidemia facilitates the atherosclerotic process and increases the morbidity of the disorder. Statins are an important evidence-based treatment option to reduce low-density lipoprotein cholesterol levels and risks of CVDs [27]. However, different barriers limit the availability of statins including side effects, intolerance, and patient preference. To overcome such limitations, functional food ingredients and nutraceuticals offer interesting alternatives or adjuvants that have shown beneficial effects on vascular functions and good capacities for decreasing the risks of CVDs associated with dyslipidemia [27]. The mechanisms
of nutraceuticals and functional food ingredients on lipids and reducing dyslipidemia risks are not fully understood. However, several hypotheses have been proposed including 7α-hydroxylation reduction, reducing 3-hydroxy-3-methylglutaryl-CoA reductase mRNA levels, and increasing cholesterol fecal excretion, and decreasing very low-density lipoprotein secretion [27,28,29,30,31]. Moreover, some studies have demonstrated that nutraceuticals are capable of interacting with several biochemical pathways in lipid metabolism and therefore, they are potent agents to overcome the issue of the genetic variability of individuals which is a challenge in the current lipid-lowering treatments [32].

Studies have consistently shown that healthy dietary patterns may decrease the risk of overweight/obesity [33,34,35,36], while patterns described as unhealthy (Western) increase this risk [33,37,38]. Our study also showed an increased preference of overweight/obesity in participants with a higher adherence to the animal-based and processed food dietary. McKeown et al. [39] showed that higher intake of refined grains was associated with higher visceral adiposity, while Serra-Majem and Bautista-Castaño [40] found that increases in white bread consumption during four years of follow-up were associated with a greater growth of waist circumference (mean waist change of 1.11 cm in Q1 and 2.39 cm in Q4). However, in our study, there was no correlation between the three dietary patterns and waist circumference. Waist circumference is closely associated with total energy intake and exercise habits. As a confounding factor of waist circumference, exercise habits were not included in this analysis may be an important reason. Furthermore, racial differences and regional living habit may be another factor.

One of the aspects in using nutraceuticals and functional food ingredients for reducing CVD risk factors is possible interactions with lipid lowering drugs. Studies have demonstrated the potentials of combination therapy of nutraceuticals with different lipid-lowering drugs such as statins on reducing CVDs risks [41,42]. However, recent studies have raised some doubts about such combined treatments [43,44]. For instance, Lorgeril et al reported that omega-3 supplementation can negatively interact with statins in such ways that lead to a reduction in the final effects of the medication on dyslipidemia in the lipid-lowering treatment [43].

The DASH diet was found to be effective at reducing blood pressure [45] and other cardiovascular risk factors [46]. Some dietary components including milk, fruit juice, dairy products and eggs have been used to assess the DASH dietary pattern [47], which is similar to Pattern 3 in our study. However, the groups adoption of dietary Pattern 3 showed the OR of hyperlipidemia and hyperuricemia was lowered while that of blood pressure was not. In contrast, the balanced dietary pattern (Pattern 2) showed significant correlation with lower blood pressure, high blood lipids and overweight/obesity. Maybe, compared with the DASH diet, the balanced dietary composed of whole grains, vegetables and legume products was a dietary pattern that was more easily accepted and associated with controlled cardiovascular risk by the elderly in Sichuan.

A study has shown that a high consumption of meat, processed meat in particular, can increase the risk of type 2 diabetes [48]. A meta-analysis of epidemiological studies on meat consumption has shown that meat intake is associated with FPG and insulin concentrations in Caucasians without diabetes mellitus [49]. Both processed and unprocessed red meats were associated with a higher FPG after adjustment for potential confounders (excluding BMI). However, there was no such correlation after adjustment for BMI. In our study, although daily energy intake in the three dietary patterns was statistically different, none was a high-energy diet. The animal-based and processed food dietary pattern was not connected with HBP and abnormal glucose concentration in the participants, after adjustment for potential confounders like age, smoking status, excessive alcohol consumption and total energy intake. This may be due to the low daily energy intake or ethnic characteristics. We also observed that the BMI of this group was slightly above normal (24.11 ±3.02 Kg/cm² and the age of the objects was high (72.04 ± 8.98 years). We suspect that the relationship among blood pressure, glucose concentration and dietary patterns among elderly males who were slightly overweight, may be subtler than that in young people. Further research is needed to confirm this.

One strength of the current study is the large size of the study population, which is also ethnically homogenous. Moreover, we used the dietary patterns determined posteriori, which reflect the reality far better than the patterns determined based on previously adopted assumptions. They are closer to the real-world setting, in which food and nutrients are consumed in complex systems, while lack of preliminary assumptions makes them independent from current knowledge and views.

This study also has several limitations that could be considered when interpreting our findings. First of all, this is merely a cross-sectional study; meanwhile, the causal link between dietary patterns and overweight/obesity, dyslipidemia, high blood pressure remains unclear. It is possible that the diagnosis of even a single metabolic disorder may lead to changes in their dietary habits. The three derived patterns explained about 41.05% of the total variation. This may not explain the dietary patterns of all Sichuan elderly males thoroughly. The questionnaire of this study did not collect the daily intake of oil, salt and sugar, and the analysis of the results may have some effects. No assessment and analysis of the impact of daily activity levels are also the shortcomings of this study. Further epidemiological studies are needed to gain more comprehensive information and insight in order to develop prevention strategies and control measures.

5. Conclusions

Elderly males in Sichuan Province with overweight/obesity, dyslipidemia and high blood pressure adopted different dietary patterns. This study showed that the animal-based and processed food dietary pattern was associated with overweight/obesity and dyslipidemia in elderly males. The balanced dietary pattern was not popular in patients and associated with the lower risk of overweight/obesity, dyslipidemia and HBP. In the Ovo-Lacto Vegetarian dietary pattern we found a lower trend in those with dyslipidemia and hyperuricemia. None correlation with
IFG and the three dietary patterns was found in this group. The results of our analyses show that public health policy should pay more attention to cooperation with health managers and promote more reasonable dietary patterns to the public. It is also essential to introduce an appropriate price policy that will encourage consumers to choose food products that are beneficial to the health.

List of abbreviations:

Semi-quantitative Food Frequency Questionnaire (SFFQ); Dietary Approaches to Stop Hypertension diet (DASH diet); triglycerides (TG); high-density lipoprotein cholesterol (HDLC); low-density lipoprotein cholesterol (LDL-C); body mass index (BMI); Waist circumference (WC); Waist circumference (SBP); diastolic pressure (DBP); impaired fasting glucose (IFG); Serum uric acid (SUA); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low -density lipoprotein cholesterol (LDL-C); high -density lipoprotein cholesterol (HDL-C); triglycerides (TG); high -density lipoprotein cholesterol (HDL-C); total cholesterol (TC); low- density lipoprotein cholesterol (LDL-C); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low- density lipoprotein cholesterol (LDL-C); high- density lipoprotein cholesterol (HDL-C); triglycerides (TG); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low -density lipoprotein cholesterol (LDL-C); high -density lipoprotein cholesterol (HDL-C); triglycerides (TG); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low -density lipoprotein cholesterol (LDL-C); high -density lipoprotein cholesterol (HDL-C); triglycerides (TG); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low -density lipoprotein cholesterol (LDL-C); high -density lipoprotein cholesterol (HDL-C); triglycerides (TG); body mass index (BMI); Waist circumference (WC); total cholesterol (TC); low- density lipoprotein cholesterol (LDL-C); high-density lipoprotein cholesterol (HDL-C); triglycerides (TG). Acknowledgments

We are grateful to all study participants for their active cooperation. We acknowledge contribution of our survey team members, interviewers, leaders, and volunteers for their continuous efforts in the field survey.

References


