Gender Difference on the Association between Dietary Patterns and Obesity in Chinese Middle-Aged and Elderly Populations

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Abstract: Dietary patterns are linked to obesity, but the gender difference in the association between dietary patterns and obesity remains unclear. We explored this gender difference in a middle-aged and elderly populations in Shanghai. Residents (n = 2046; aged ≥45 years; 968 men and 1078 women) who participated in the Shanghai Food Consumption Survey were studied. Factor analysis of data from four periods of 24-h dietary recalls (across 2012–2014) identified dietary patterns. Height, body weight, and waist circumference were measured to calculate the body mass index. A log binominal model examined the association between dietary patterns and obesity, stratified by gender. Four dietary patterns were identified for both genders: rice staple, wheat staple, snacks, and prudent patterns. The rice staple pattern was associated positively with abdominal obesity in men (prevalence ratio (PR) = 1.358; 95% confidence interval (CI) 1.132–1.639; p = 0.001), but was associated negatively with general obesity in women (PR = 0.745; 95% CI: 0.673–0.807; p = 0.031). Men in the highest quartile of the wheat staple pattern had significantly greater risk of central obesity (PR = 1.331; 95% CI: 1.094–1.627; p = 0.005). There may be gender differences in the association between dietary patterns and obesity in middle-aged and elderly populations in Shanghai, China.

Keywords: dietary patterns; obesity; gender difference; factor analysis; middle-aged and elderly Chinese people

1. Introduction

Obesity is defined as abnormal or excessive fat accumulation, which is a major risk factor for various metabolic disorders, such as hypertension, impaired glucose tolerance, dyslipidemia, and pro-inflammatory status. Obesity and obesity-related diseases are increasing dramatically and have become a massive burden on the world economy and global health. Worldwide, the prevalence of being overweight increased from 24.6% in 1980 to 34.4% in 2008, and the prevalence of obesity nearly doubled from 6.4% to 12.0% during the same 28-year period [1]. On the basis of World Health Organization (WHO) statistics, 39% of adults aged 18 years and over were overweight in 2014, and 13% were obese [2]. In China, the prevalence of overweight and obesity were 16.4% and 3.6% in 1992 [3], and 22.8% and 7.1% in 2002 [4], respectively. According to the China National Diabetes and Metabolic Disorders Study, 31.4% and 12.2% (approximately 299.5 and 116.2 million, respectively) of Chinese adults were overweight and obese in 2012 [5]. As a consequence, overweight and obesity have been estimated to cause 3.4 million deaths, with 4% of years of life lost and 4% of disability-adjusted life-years worldwide in 2010 [6].

China has entered into an aging society and will continue to age rapidly in the future. By the end of 2013, the population aged 60 and over accounted for 14% of the total population. It is predicted...
that 25% of the population will be aged 60 years and over by 2035 [7]. As the first city to enter into
an aging society in China, Shanghai, had an aging population 20 years earlier than the rest of the
country. In Shanghai, the proportion of the population aged 60 years and over increased from 10.7%
in 1979 to 25.7% in 2012, and by the end of 2015, the ratio reached 30% [8]. The emergence of an
aging population in China will significantly increase the prevalence of chronic non-communicable
diseases, including diabetes, cancers, chronic respiratory diseases, and cardiovascular diseases [9].
The middle-aged population (aged 45–60 years) is more sensitive to the health risk factors and more
likely to be influenced by the non-communicable chronic diseases because of the apparent hormonal
changes they experience. Therefore, obesity in the middle-aged and elderly population has been a
serious concern for China, and the mechanism by which it develops requires deeper exploration.

Obesity is a complicated multifactorial chronic disease, which may be caused by the interaction
between genetic predisposition, the environment and human behavior [10]. Dietary structure has been
demonstrated as a determinant factor to obesity; however, the association is inconsistent in different
populations and is poorly understood [11]. Compared with traditional dietary analysis, which simply
focused on the relationship between individual nutrients or foods, the analysis of dietary patterns
has emerged as a holistic and comprehensive approach [12]. A dietary pattern can take advantage of
the intricate dietary data, and take account of total dietary consumption and the potential interaction
between many nutrients and foods [13–15]. These advantages have led to the analysis of dietary
patterns being used widely to determine the association between diet and related chronic diseases in
nutritional epidemiology in recent decades [16–20].

Dietary patterns vary according to age, ethnicity, culture and other lifestyle factors [21]. Previous
studies have reported an association of dietary patterns with obesity in Chinese middle-aged and
elderly people [22,23]. A recent study in Japan reported a gender difference in the relationship between
dietary patterns and type 2 diabetes [20]. However, to the best of our knowledge, no study has explored
the effect of gender difference on the associations between dietary patterns and obesity in Chinese
middle-aged and elderly people. Therefore, this study identified the major dietary patterns among
a Chinese population aged 45 years and over, and examined the effect of gender difference on the
associations of these patterns with obesity.

2. Study Population

The Shanghai Food Consumption Survey (SHFCS) was launched during September 2012 through
August 2014. This cross-sectional study was designed to acquire knowledge of the dietary structure
and nutritional status of adults in Shanghai, China. A multi-stage cluster random sampling method
was used to draw the study sample from nine of 18 districts or counties in Shanghai, including the
eight districts of Huangpu, Xuhui, Putuo, Hongkou, Jinshan, Pudong, Qingpu, and Baoshan, and the
county of Chongming (Figure 1). One to six residential communities were selected randomly from
each district or county, according to the population density. The project was conducted four times
across two years (autumn 2012, spring and winter 2013, and summer 2014). A total of 2291 participants
aged over 45 years attended at least one survey session. After exclusion of 106 participants because of
their incomplete anthropometric information, as well as 139 participants who had missing information
on their food consumption (29) or health related factors (110), 2046 participants aged 45 years and
over were ultimately enrolled. Among them 690 participants completed all four surveys. The present
analysis was based on the SHFCS, which included 968 men and 1078 women aged 45 years and
over with completely demographic, anthropometric, and dietary data. All subjects submitted written
informed consent before their participation in the survey. The study was approved by the local
authorities and the Ethics Committee of the School of Public Health at Fudan University.
Figure 1. Multi-stage cluster random sampling of the Shanghai Food Consumption Survey.

3. Dietary Assessment

Dietary intake was measured four times using one-day 24-h dietary recalls (once a season) during the SHFCS. Valid forms were used by experienced interviewers to administer the 24-h dietary recalls via a household interview. Each participant was asked to report the types and amount of all foods (measured in g) that they consumed both at home and away from home during the previous 24 h. The average intake of the four recalls was used for each individual. A total of 408 kinds of food items were collected in the survey. The 408 varieties of food items were divided into 25 food groups, based on a combination of nutritional characteristics of each food mentioned in the Chinese Food Composition 2002 [24] and recommendations about food classification in related studies [11,25]. The 25 food groups were rice; wheat; deep-fried wheat; instant noodles; coarse grains; starchy roots and tubers; vegetables; fruits; pork; poultry; other livestock meats; organ meats; processed meats; fresh water fish and seafood; dairy; legumes; eggs; seeds and nuts; fungi and algae; western fast food; cakes and pastries; candy and chocolates; soft drinks; alcoholic beverages; and tea. The typical foods in each food group are represented in Table 1.
Table 1. Food groups in the factor analysis.

| Food Groups          | Examples of Food Items                                                                 |
|----------------------|----------------------------------------------------------------------------------------|
| Rice                 | Long-grained rice, round-grained rice, glutinous rice and products                     |
| Wheat                | Wheat noodles, wheat buns and other wheat flour products                                |
| Deep fried wheat     | Deep-fried dough sticks, deep-fried dough cakes                                        |
| Instant noodles      | Instant noodles                                                                      |
| Coarse grains        | Corn, oats, barley, sorghum foxtail millet                                             |
| Starchy roots and tubers | Potatoes, taros, yams, lotus roots, sweet potatoes cassavas                        |
| Vegetables           | Cabbage, spinach, tomatoes, cucumbers, zucchinis and products                         |
| Fruits               | Fresh fruits and products                                                             |
| Pork                 | Pork                                                                                    |
| Poultry              | Chickens, ducks, geese                                                                |
| Other livestock meats | Beef, lamb and other livestock meats                                                  |
| Organ meats          | Livers, kidneys, large intestines, blood                                               |
| Processed meats      | Ham, luncheon meats, sausages, smoked meats, dried meats                              |
| Fresh water fish and seafood | Freshwater fish, saltwater fish, shrimp, crab and shellfish                      |
| Dairy                | Animal-based milk, cheese, yogurt                                                     |
| Legumes              | Soybeans, peas, mung beans, azuki beans and products                                   |
| Eggs                 | Whole eggs, yolks, whites, preserved eggs                                             |
| Seeds and nuts       | Sesame seeds, peanuts, walnuts, almonds, cashews, pistachios                           |
| Fungi and algae      | Mushroom, kelp and laver                                                              |
| Western fast food    | Sandwiches, hamburgers, hotdogs, pizzas                                                |
| Cakes and pastries   | Cakes, cookies, moon cakes, pies and pastries                                         |
| Candy and chocolates | Honey, sugar, candies, chocolate, Jelly                                               |
| Soft drinks          | Carbonated drinks, fruit juices and vegetable juices                                  |
| Alcoholic beverages  | Liquors, wine, beer vodka, cocktails, whiskey                                        |
| Tea                  | Black tea, green tea, oolong tea                                                     |

4. Anthropometric Measurements

Trained investigators measured anthropometric variables based on a standard protocol. Height was measured to the nearest 0.1 cm with subjects standing without shoes. Weight in relatively light clothes was measured to the nearest 0.1 kg using a calibrated digital scale. Waist circumference (WC) was measured half way between the lower rib edge and the upper iliac crest using a metric measure with an accuracy of 0.1 cm. Body mass index (BMI) values were divided into four categorical levels according to the recommendation of the Working Group on Obesity in China, which are underweight, BMI < 18.5 kg/m\(^2\); normal, BMI 18.5–23.9 kg/m\(^2\); overweight, BMI 24.0–27.9 kg/m\(^2\), and general obesity, BMI ≥ 28 kg/m\(^2\) [26]. Abdominal obesity was defined as WC ≥ 85 cm for men and ≥80 cm for women in a Chinese population [27].

5. Other Health Related Variables

Other health-related variables were collected by skilled interviewers using a general questionnaire. Education level was divided into binary variables (lower and higher) from five initial education categories: illiteracy, primary school, junior middle school, high middle school, bachelor’s degree and above. Marital status was allocated as married or other marital status. Occupation was categorized as retired or other. Information on smoking status included three categories of never smokers, former smokers, and current smokers (at least one cigarette per day now). Physical activity was identified as metabolic equivalents in hours per week (MET-h/week), and was divided into three levels: light, moderate, and vigorous. Housework status was allocated to two categories (Yes/No), based on the question “did you do the house work in your daily life?” Total energy intake was calculated according to the China Food Composition 2002 [26], expressed in kilocalories per day (kcal/day).
6. Statistical Analysis

Exploratory factor analysis (principle components) was used to identify dietary patterns on the basis of the 25 food groups mentioned above. Data adequacy for factor analysis has been assessed by the Kaiser-Meyer-Olkin Measure of Sample Adequacy and the Bartlett Test of Sphericity. Factors were rotated by orthogonal transformation (varimax rotation) to minimize the correlation among them and to improve their interpretability. After evaluating the Eigen values, scree plot, factor interpretability, and variance explained, four factor solutions were selected. Food groups were considered to contribute to the pattern significantly if they had an absolute correlation (factor loading) \( \geq 0.20 \) with that pattern. The factor scores for every dietary pattern were calculated for each participant by summing intakes of food groups weighted by their factor loadings. The labeling of dietary patterns was done on the basis of interpretation of major food groups with high factor loadings in each dietary pattern. Participants were categorized into quartiles according to factor scores of each pattern. Quartile 1 represents a lower consumption of this food pattern, while quartile 4 represented a higher one. Data are expressed as the mean \( \pm \) standard deviation (SD) for continuous variables and as percentages for categorical variables. A chi-squared test for categorical variables and analysis of variance (ANOVA) for continuous variables were used to evaluate the association between health-related factors and dietary patterns. A log binomial model was used to estimate the prevalence ratios (PR) and 95% confidence interval (95% CI) for general obesity and abdominal obesity across the quartile categories of dietary pattern scores. Model 1 was adjusted for age (continuous). Model 2 was additionally adjusted for education level (lower, higher), marital status (married, others), smoking status (never, former, current, but not included in women), occupation (retired, others), physical activity (light, moderate, and vigorous), and housework status (yes/no). Model 3 was further adjusted for total energy intake (continuous). The statistical analysis was performed using SPSS software package version 22.0 for windows (SPSS Inc., Chicago, IL, USA) and SAS software version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA). Two-side \( p \)-values < 0.05 were considered statistically significant.

7. Results

Selected individual characteristics of the study sample are displayed in Table 2, stratified by gender. Men made up 47.3% of the sample and had a similar age distribution to the women. The prevalence of overweight and general obesity were 47.8% for men and 43.9% for women; likewise, compared with women (42.7%), men had a higher prevalence of abdominal obesity (52.9%). Most participants in both genders were married (91.1%). Men (33.3%) reported a higher education level than women (27.1%); however, more women were retired (66.4% vs. 59.1%) and did more housework (92.5% vs. 67.9%) compared with men. In terms of smoking status, the majority of male participants were never smokers (42.9%) and current smokers (51.8), while almost all of the female participants were non-smokers. No significant difference was found in the level of physical activity between men and women.

Factor analysis revealed four independent dietary patterns, which explained 26.85% of the variance in total food consumption for men, and 26.22% for women (Table 3). Both genders shared comparable, but not completely consistent, dietary patterns. The rice staple pattern was loaded heavily on rice, vegetables, pork, poultry, fungi, and algae for both genders; however, men ate more starchy roots/tubers, organ meats, processed meats, and seeds/nuts, and women ate more seafood and eggs. The wheat staple pattern was characterized by a high intake of wheat, deep-fried wheat, dairy, instant noodles, legumes and tea, with less rice and starchy roots/tubers for men. In women, this pattern was characterized by a high intake of wheat, coarse grain, fruits, dairy, legumes, seeds/nuts, fungi/algae, soft drinks, and tea, and less rice and processed meats. The snacks pattern was characterized by high consumption of starchy roots/tubers, fruits, cakes/pastries, soft drinks, alcoholic beverages and tea, but less rice, vegetables, pork and eggs for men; in women, this pattern was represented by high intake of starchy roots/tubers, fruits, seed/nuts and cakes/pastries, but less intake of pork. The last factor was labeled the prudent pattern because of its high intake of coarse grains, fruits, dairy, and tea for men; and coarse grains, fruits, processed meats, and seafood for women. The absolute amount of the
25 food groups across quartiles of dietary pattern scores are displayed in Table 1, which matches with the results of factor analysis in Table 3.

Characteristics of the participants in our study across the quartile categories of dietary scores are shown in Table 4. Subjects of both genders in the top quartile of the rice staple pattern were more likely to be significantly younger and married. Furthermore, men with higher scores for this pattern are more likely to be working and had a higher prevalence of general and abdominal obesity, while women following this pattern are more likely to be a house worker and have a lower prevalence of abdominal obesity compared with those in the lowest quartile. Both genders in the highest quartile of the wheat staple pattern were more likely to have higher education level, to be working and to take more physical exercise; however, men had a higher prevalence of general obesity. Compared with those in the lowest quartile, men and women with higher scores for the snacks pattern were more likely to be older, working, and have a higher level of education. Meanwhile, men in the top quartile of this pattern were more likely to participate in more physical exercise, and women were less likely to be married. In addition, both genders in the top quartile of the prudent pattern were more likely to have a higher level of education, be working, and to participate in more physical exercise. In particular, men with high scores for this pattern were likely to be older, smoke less, and do housework.

Table 2. Characteristics of the study participants.

| Variable                  | Total       | Men          | Women        | p Value |
|---------------------------|-------------|--------------|--------------|---------|
| No. (%)                   | 2046        | 968 (47.3%)  | 1078 (52.7%) |         |
| Age in years (%)          | 60.1 ± 10.8 | 60.0 ± 10.7  | 60.2 ± 10.9  | 0.340   |
| 45–59                     | 1031        | 477 (49.3)   | 554 (51.4)   |         |
| 60–                        | 1015        | 491 (50.7)   | 524 (48.6)   |         |
| BMI (%)                   |             |              |              |         |
| under weight              | 72 (3.5)    | 30 (3.0)     | 42 (3.9)     |         |
| normal                    | 1039 (50.8) | 476 (49.2)   | 563 (52.2)   | 0.017   |
| overweight                | 745 (36.4)  | 384 (39.7)   | 361 (33.5)   |         |
| general obesity           | 190 (9.3)   | 78 (8.1)     | 112 (10.4)   |         |
| abdominal obesity (%)     | 972 (47.5)  | 512 (52.9)   | 460 (42.7)   | <0.001  |
| education level (%)       |             |              |              |         |
| Lower                     | 1432 (70.0) | 646 (66.7)   | 786 (72.9)   | 0.002   |
| Higher                    | 614 (30.0)  | 322 (33.3)   | 292 (27.1)   |         |
| marital status 2 (%)      |             |              |              |         |
| married                   | 1864 (91.1) | 912 (94.2)   | 952 (88.3)   | <0.001  |
| other marital status      | 182 (8.9)   | 56 (5.8)     | 126 (11.7)   |         |
| smoking status (%)        |             |              |              |         |
| never                     | 1485 (72.6) | 415 (42.9)   | 1070 (99.3)  | <0.001  |
| former                    | 52 (2.5)    | 52 (5.4)     | 0 (0.0)      |         |
| current                   | 509 (24.9)  | 501 (51.8)   | 8 (0.7)      |         |
| occupation (%)            |             |              |              |         |
| retired                   | 1228 (63)   | 572 (59.1)   | 716 (66.4)   | <0.001  |
| others                    | 758 (37)    | 396 (40.9)   | 362 (33.6)   |         |
| physical activity (%)     |             |              |              |         |
| light                     | 1105 (54)   | 550 (56.8)   | 555 (51.5)   |         |
| moderate                  | 370 (18.1)  | 164 (16.9)   | 206 (19.1)   | 0.054   |
| vigorous                  | 571 (27.9)  | 254 (26.2)   | 317 (29.4)   |         |
| housework status (%)      |             |              |              |         |
| yes                       | 1654 (80.8) | 657 (67.9)   | 997 (92.5)   | <0.001  |
| no                        | 392 (19.2)  | 311 (32.1)   | 81 (7.5)     |         |
Table 3. Factor-loading matrix for dietary patterns among 2046 Shanghai residents aged over 45 years.

| Food Groups                  | Men (n = 968) | Women (n = 1078) |
|------------------------------|--------------|------------------|
|                              | Rice Staple  | Wheat Staple     | Snacks | Prudent | Rice Staple | Wheat Staple | Snacks | Prudent |
| Rice                         | 0.413        | -0.503           | -0.462  | 0.415    | -0.565      | 0.575       |        |         |
| Wheat                        | 0.619        |                  |         |          |             |             |        |         |
| Deep fried wheat             | 0.213        |                  |         |          |             |             |        |         |
| Instant noodles              | -0.221       | 0.213            | 0.966   | 0.278    |             | 0.929       |        |         |
| Coarse grains                |              |                  | 0.929   | 0.428    |             |             |        |         |
| Starchy roots and tubers     | 0.295        | -0.439           | 0.352   |          | 0.684       | 0.280       | 0.464  | 0.928   |
| Vegetables                   | 0.580        | -0.370           | 0.966   | 0.280    | 0.267       |            | -0.279 |         |
| Fruits                       |              |                  |         |          |             |             |        |         |
| Pork                         | 0.244        | -0.216           | -0.202  | 0.267    | -0.279      |            |        |         |
| Poultry                      | 0.571        |                  |         |          | 0.319       |             |        |         |
| Other livestock meats        |              |                  |         |          |             |             |        |         |
| Organ meats                  | 0.226        | 0.466            | -0.355  | 0.274    |             |             |        |         |
| Processed meats              |              |                  |         |          |             |             |        |         |
| Fresh water fish and seafood |              |                  |         |          |             |             |        |         |
| Dairy                        | -0.447       | 0.383            | 0.317   | 0.591    |             |             |        |         |
| Legumes                      | 0.370        |                  |         |          |             |             |        |         |
| Eggs                         |              |                  | -0.446  | 0.464    | 0.201       | 0.669       |        |         |
| Seeds and nuts               | 0.288        | 0.312            | 0.474   | 0.200    |             |             |        |         |
| Fungi and algae              |              |                  |         |          |             |             |        |         |
| Western fast food            |              |                  |         |          |             |             |        |         |
| Cakes and pastries           |              |                  |         |          |             |             |        |         |
| Candy and chocolates         |              |                  |         |          |             |             |        |         |
| Soft drinks                  |              |                  |         |          |             |             |        |         |
| Alcoholic beverages          |              |                  |         |          |             |             |        |         |
| Tea                          | 0.344        | 0.201            | 0.220   | 0.236    |             |             |        |         |
### Nutrients

**Table 4. Characteristics of participants by quartiles (Q) of dietary pattern scores**

|               | Rice Staple | Wheat Staple | Snacks | Prudent |
|---------------|-------------|--------------|--------|---------|
|               | Q1 (Low)    | Q4 (High)    | p      | Q1 (Low) | Q4 (High) | p    | Q1 (Low) | Q4 (High) | p    | Q1 (Low) | Q4 (High) | p    |
| **Men No.**   | 242         | 242          |        | 242      | 242       |       | 242      | 242       |       | 242      | 242       |       |
| Age in year   | 61.0 ± 11.0 | 58.8 ± 10.8  | 0.024  | 59.4 ± 9.9 | 60.1 ± 11.0 | 0.460 | 58.5 ± 9.8 | 61.0 ± 11.7 | 0.011 | 58.1 ± 9.8 | 62.1 ± 11.6 | <0.001 |
| BMI (kg/m²)   | 23.5 ± 3.2  | 24.1 ± 3.4   | 0.059  | 23.7 ± 3.5 | 23.9 ± 2.8  | 0.495 | 23.8 ± 3.3 | 23.6 ± 3.1  | 0.471 | 23.9 ± 3.3 | 23.8 ± 3.3  | 0.510 |
| WC (cm)       | 84.5 ± 9.2  | 86.4 ± 8.5   | 0.021  | 84.5 ± 8.9 | 86.6 ± 8.6  | 0.010 | 85.1 ± 8.9 | 86.0 ± 9.5  | 0.292 | 86.1 ± 9.9 | 86.0 ± 9.5  | 0.950 |
| General obesity (%) | 16 (6.6) | 30 (12.4) | 0.030 | 23 (9.5) | 13 (5.4) | 0.083 | 19 (7.9) | 14 (5.8) | 0.367 | 18 (7.4) | 23 (9.5) | 0.441 |
| Abdominal obesity (%) | 103 (42.6) | 138 (57.0) | 0.001 | 105 (43.4) | 142 (58.7) | 0.001 | 122 (50.4) | 125 (51.7) | 0.785 | 126 (52.1) | 133 (55.0) | 0.524 |
| Smoking status (%) | 99 (40.9) | 111 (45.9) | 0.102 | 110 (45.5) | 102 (42.1) | 0.111 | 115 (45.9) | 104 (43.0) | 0.097 | 81 (33.5) | 121 (50.0) | <0.001 |
| WC (cm)       | 61.0 ± 11.0 | 58.8 ± 10.8  | 0.024  | 59.4 ± 9.9 | 60.1 ± 11.0 | 0.460 | 58.5 ± 9.8 | 61.0 ± 11.7 | 0.011 | 58.1 ± 9.8 | 62.1 ± 11.6 | <0.001 |
| Education (%)  | 41 (17.8)  | 72 (29.8)    | 0.143  | 46 (19.0) | 41 (16.9) | 0.001 | 45 (18.6) | 44 (18.2) | 0.002 | 29 (12.0) | 54 (22.3) | <0.001 |
| Occupation (%) | 154 (63.6) | 126 (52.1)   | 0.010  | 120 (49.6) | 158 (65.3) | <0.001 | 130 (53.7) | 154 (63.6) | 0.027 | 125 (51.7) | 176 (72.7) | <0.001 |
| Physical activity | 146 (60.3) | 131 (54.1)  | 0.158  | 158 (65.3) | 108 (44.6) | 0.001 | 154 (63.6) | 122 (50.4) | 0.000 | 180 (74.4) | 104 (43.0) | <0.001 |
| Vigorous (%)   | 53 (21.9)  | 72 (29.8)    | 0.143  | 46 (19.0) | 41 (16.9) | 0.001 | 45 (18.6) | 44 (18.2) | 0.002 | 29 (12.0) | 54 (22.3) | <0.001 |
| Former (%)     | 157 (64.9) | 170 (70.2)   | 0.207  | 163 (67.4) | 166 (68.6) | 0.770 | 164 (67.8) | 168 (69.4) | 0.695 | 139 (57.4) | 182 (75.2) | <0.001 |
| Total energy intake (Kcal/day) | 1580.30 ± 589.63 | 1661.78 ± 557.47 | 0.119 | 1583.66 ± 614.50 | 1646.20 ± 534.41 | 0.233 | 1611.21 ± 602.33 | 1642.67 ± 588.04 | 0.561 | 1574.59 ± 614.65 | 1639.56 ± 518.05 | 0.209 |

| **Women No.**  | 269         | 269          |        | 269      | 269       |       | 269      | 269       |       | 269      | 269       |       |
| Age in year    | 63.0 ± 12.4 | 58.9 ± 9.5   | <0.001 | 59.6 ± 10.7 | 61.0 ± 10.9 | 0.123 | 58.2 ± 9.6 | 61.2 ± 10.5 | 0.001 | 60.4 ± 11.1 | 59.6 ± 10.9 | 0.397 |
| BMI (kg/m²)    | 23.6 ± 3.8  | 23.8 ± 3.1   | 0.068  | 23.9 ± 3.6 | 23.4 ± 3.0  | 0.056 | 23.8 ± 3.5 | 24.1 ± 3.4  | 0.339 | 23.7 ± 3.4 | 23.7 ± 3.5  | 0.858 |
| WC (cm)        | 80.7 ± 9.1  | 79.6 ± 8.4   | 0.149  | 80.1 ± 8.4 | 79.2 ± 8.7  | 0.246 | 79.8 ± 8.6 | 80.2 ± 8.7  | 0.588 | 80.5 ± 9.1 | 78.9 ± 8.7  | 0.042 |
| General obesity (%) | 38 (14.1) | 24 (8.9) | 0.059 | 26 (9.7) | 20 (7.4) | 0.355 | 33 (12.3) | 30 (11.2) | 0.688 | 32 (11.9) | 25 (9.3) | 0.327 |
| Abdominal obesity (%) | 132 (49.2) | 105 (39.9) | 0.019 | 116 (43.1) | 112 (41.6) | 0.727 | 111 (41.3) | 122 (45.4) | 0.339 | 120 (44.6) | 106 (39.4) | 0.221 |
| Education (%)   | 204 (75.8) | 196 (72.9)   | 0.430  | 25 (9.3) | 133 (49.4) | <0.001 | 60 (22.3) | 83 (30.9) | 0.025 | 36 (13.4) | 106 (39.4) | <0.001 |
| Former (%)      | 144 (55.4) | 183 (68.0)   | 0.781  | 140 (52.0) | 207 (77.0) | <0.001 | 164 (61.0) | 191 (71.0) | 0.014 | 162 (60.2) | 208 (77.3) | <0.001 |
| Total energy intake (Kcal/day) | 1510.02 ± 672.77 | 1634.41 ± 744.62 | 0.043 | 1540.94 ± 656.87 | 1627.23 ± 690.34 | 0.138 | 1611.21 ± 706.96 | 1705.35 ± 866.22 | 0.168 | 1603.25 ± 736.61 | 1631.64 ± 606.10 | 0.626 |
The relationship between general and abdominal obesity and dietary patterns, as assessed by log binomial model is displayed in Table 5. After adjustments for all confounders (age, education level, married status, occupation, smoking status, physical exercise, housework status and energy intake), men in the highest quartile of the rice staple pattern had a significant risk of abdominal obesity (PR = 1.358; 95% CI: 1.132–1.639; p = 0.001). By contrast, women with higher scores for this pattern were less likely to have general obesity (PR = 0.745; 95% CI: 0.673–0.807; p = 0.031). Meanwhile, the wheat staple pattern for men was also positively associated with abdominal obesity (PR = 1.331; 95% CI: 1.094–1.627; p = 0.005). Nevertheless, the snacks and prudent patterns showed no association with the risk of general and abdominal obesity in either gender.

Table 5. Association of dietary patterns with general obesity and abdominal obesity across quartiles of dietary pattern scores.

| Gender | Dietary Patterns | General Obesity | Abdominal Obesity |
|--------|------------------|----------------|------------------|
|        | Q1       | Q4 | p | Q1 | Q4 | p |
| Men    | Rice staple | Model 1. 1 1.873 (1.062, 3.441) 0.035 1 1.383 (1.153, 1.668) 0.001 | Model 2. 1 1.836 (1.031, 3.399) 0.044 1 1.358 (1.132, 1.639) 0.001 | Model 3. 1 1.800 (0.998, 3.226) 0.054 1 1.358 (1.132, 1.639) 0.001 |
|        | Wheat staple | Model 1. 1 0.566 (0.285, 1.074) 0.089 1 1.349 (1.131, 1.619) 0.001 | Model 2. 1 0.631 (0.297, 1.290) 0.216 1 1.331 (1.094, 1.627) 0.005 | Model 3. 1 0.621 (0.294, 1.260) 0.196 1 1.331 (1.094, 1.627) 0.005 |
|        | Snacks     | Model 1. 1 0.830 (0.519, 1.619) 0.362 1 1.006 (0.844, 1.201) 0.942 | Model 2. 1 0.891 (0.545, 1.083) 0.587 1 1.022 (0.854, 1.224) 0.809 | Model 3. 1 0.887 (0.541, 1.078) 0.574 1 1.023 (0.856, 1.225) 0.797 |
|        | Prudent    | Model 1. 1 1.236 (0.896, 1.270) 0.362 1 1.031 (0.872, 1.221) 0.719 | Model 2. 1 1.022 (0.939, 1.245) 0.799 1 0.996 (0.816, 1.216) 0.967 | Model 3. 1 1.022 (0.939, 1.245) 0.770 1 0.997 (0.817, 1.217) 0.978 |

| Women  | Rice staple | Model 1. 1 0.863 (0.613, 1.136) 0.076 1 0.826 (0.676, 1.001) 0.068 | Model 2. 1 0.749 (0.626, 0.912) 0.038 1 0.839 (0.687, 1.018) 0.079 | Model 3. 1 0.745 (0.675, 0.807) 0.031 1 0.832 (0.681, 1.011) 0.067 |
|        | Wheat staple | Model 1. 1 0.857 (0.583, 1.157) 0.375 1 0.948 (0.781, 1.150) 0.586 | Model 2. 1 1.008 (0.706, 1.207) 0.950 1 1.000 (0.802, 1.244) 0.997 | Model 3. 1 1.014 (0.694, 1.028) 0.903 1 1.000 (0.802, 1.244) 0.997 |
|        | Snacks     | Model 1. 1 0.941 (0.697, 1.201) 0.660 1 1.066 (0.883, 1.291) 0.507 | Model 2. 1 0.976 (0.711, 1.359) 0.865 1 1.100 (0.905, 1.339) 0.337 | Model 3. 1 0.972 (0.849, 1.180) 0.823 1 1.100 (0.904, 1.340) 0.340 |
|        | Prudent    | Model 1. 1 0.863 (0.613, 1.136) 0.345 1 0.916 (0.751, 1.113) 0.380 | Model 2. 1 0.915 (0.672, 1.085) 0.544 1 0.961 (0.777, 1.183) 0.710 | Model 3. 1 0.915 (0.784, 1.083) 0.545 1 0.959 (0.776, 1.179) 0.682 |

Model 1: adjusted for age (continuous). Model 2: model 1 additionally adjusted for education level (lower, higher), marital status (married, others), smoking status (never, former, current but not included in women), occupation (retired, others), physical activity (light, moderate and vigorous), and housework status (yes/no). Model 3: model 2 further adjusted for total energy intake (continuous).

8. Discussion

The present study extracted four distinct dietary patterns for a middle-aged and elderly population in Shanghai: the rice staple pattern, wheat staple pattern, snacks, and prudent pattern. Our findings revealed that men who followed a rice staple pattern had a greater risk of general and abdominal obesity. Meanwhile, the same pattern showed a protective effect against general obesity in women. Additionally, the wheat staple pattern was found to have a positive association with abdominal obesity only in men. The effect of gender difference on the relationship between diet and relative health outcomes has been analyzed. Studies in Japan [20] and South Korea [28] reported the effects of gender difference on the association between dietary patterns and type 2 diabetes and metabolic syndrome, respectively. To the best of our knowledge, this is the first study to analyze the effect of gender difference on the relationship between dietary patterns and obesity in middle-aged and elderly Chinese.
The rice staple pattern represents a classical, comprehensive diet structure in South China. The pattern for men was found to have a positive association with general and abdominal obesity. This result was consistent with a study from Zhejiang province China [22], which reported a similar animal food pattern, mainly comprising rice, mushroom, red meat, and fat/oils. Compared with men, women who followed this pattern had a decreased risk of general obesity, which was comparable to a study in Chinese young women that reported a diet resembling the traditional southern pattern (high intake of rice, tubers, vegetables, and pork), which was associated positively with a decreased risk of general and abdominal obesity. Although both genders shared the same label, discrepancies in food composition of this pattern between men and women was the primary cause that led to a significant gender difference on the association between the pattern and obesity. Proteins providing food in the rice staple pattern for men were pork, poultry, organ meats, processed meats, and were pork, poultry, seafood, and eggs for women. Obviously, high consumption of various livestock and poultry meats is the most important factor contributing to obesity. Known as an energy-dense food that contains abundant saturated fat and cholesterol, the association between excess meat consumption and obesity has been confirmed through studies across different populations. The EPIC-PANACEA study found that excess consumption of red meat, poultry, and processed meat might contribute to an increased risk of obesity [29]. In addition, a systematic review and meta-analysis reviewed that red and processed meat intake is directly associated with the risk of obesity and higher BMI and WC [30]. Furthermore, a study in a Chinese population also concluded that greater intake of fatty fresh red meat is significantly associated with a higher WC (men only) and risk of abdominal obesity [31]. Instead of organ and processed meat, women eat more fish and eggs. Fish was indicated to have a protective role against obesity because of its rich content of omega-3 polyunsaturated fatty acid (omega-3PUFA) [32]. Eggs are lower in fat than meat, and those present are mostly the healthy unsaturated fats. Rice is one of the most essential staple foods in China, especially in South China. In general, rice is considered to have a protective effect against obesity because of its lower energy density. However, the relationship between rice and obesity is inconsonant in various populations. Two studies from Jiangsu [33] and Zhejiang province [22] in China both indicated that intake of rice was inversely associated with being overweight. However, this was inconsistent with a study in Korean adults, which showed that the rice-kimchi pattern, characterized by a higher intake of white rice, kimchi, and vegetables, was positively associated with obesity [34]. In our study, rice showed a protective role in the rice staple pattern only for women but not for men. These discrepancies could be attributed to the differences in the population, rice varieties, cooking methods and study design. However, the present study suggests that the comprehensive influence of other foods remaining in a pattern could be another logical explanation. Another food item that showed a different effect between men and women, but in the same pattern are vegetables. Vegetables are considered healthy constituents in the diet, and prevent weight gain through their low energy density and high dietary fiber content. However, in this study, vegetables showed a protective effect only for women, but not for men, which could be attributed to the high smoking prevalence in men. A study of Europeans reported that for persons who stop smoking, high vegetable intakes might be recommended to reduce the risk of overweight [35]. A similar study also concluded that in a large population, higher baseline vegetable intakes did not substantially influence midterm weight change overall but could help to reduce risk of weight gain in persons who stop smoking [36]. In our study, the prevalence of current smoker for men is 51.8%, but very few women smoked. Therefore, smoking might reduce the beneficial impact of vegetables on obesity in men.

The wheat staple pattern was the second dietary pattern in our study, which consisted of different food items, and showed inconsistent associations with obesity between men and women. Men with this pattern consumed high levels of wheat flour, deep fried wheat, instant noodles, dairy, legumes, and tea, and were discovered to have an increased risk of abdominal obesity. One primary characteristic of this pattern for men is high carbohydrate intake. Studies based on other populations suggested that a high carbohydrate diet had positive association with general and abdominal obesity [37,38].
A potential explanation for the mechanism underlying the increased carbohydrate-related risk for obesity is that carbohydrate intake might alter lipid profiles, such as an increase in triglycerides and/or a decrease in high-density lipoprotein cholesterol, leading to increased obesity [39]. In addition, an animal experiment study reported that wheat gluten promotes weight gain in animals on both a high-fat and control-standard diet, partly by reducing the thermogenic capacity of adipose tissues. Moreover, compared with rice, wheat flour absorbs less water when cooked, so the energy density of wheat may be higher than rice. Another characteristic of the wheat staple pattern for men is the unhealthy cooking method, deep-frying. Typical Chinese fast foods, such as deep-fried wheat foods (deep-fried dough sticks and deep-fried dough cakes) and instant noodles, are very popular in China for their tastiness and convenience. However, the deep-fried cooking method of these foods has been a serious concern. A study of three US cohorts suggested that consumption of fried food could interact with genetic background in relation to obesity [40]. The SUN project in a Mediterranean cohort concluded that a more frequent consumption of fried foods at baseline was associated with a higher risk of subsequently becoming overweight/obese during follow-up [40]. Therefore, high carbohydrate and/or wheat intake, and the deep-fried cooking method, might be the two determinant factors that contributed to the increased risk of obesity associated with the wheat staple dietary in men. By contrast, the wheat staple pattern for women was found to have no relationship with obesity. Compared with men, the pattern for women was more diverse in its food composition and comprised a combination of adverse and protective components. Apart from wheat flour (which women consumed much less of), soft drinks, especially sugar-sweetened drinks, were considered as adverse factors for obesity because of their low nutrients density and high-energy contents. Nevertheless, only coarse grains and fruits in the wheat staple pattern for women played a protective role against obesity. A high intake of coarse grains, which contain lower energy than rice and wheat flour, is recommended by The Chinese Dietary Guidelines because of their high contents of various vitamins and dietary fiber. Additionally, high intake of fruit also has a beneficial influence on the management of bodyweight. A recent study drew a similar conclusion that the greater baseline intake of fruit, but not vegetables or fiber, is associated with a lower risk of becoming overweight or obese in middle-aged and older women [41]. Therefore, under the comprehensive interaction of protective and adverse factors, the wheat staple pattern for women did not indicate a positive association with obesity.

Snacking patterns in our study shared similar food components for both genders, which were starchy roots/tubers, fruits, seeds/nuts, cakes/pastries, and soft drinks. In the stratified analyses, we found no association of the snacks pattern with general or abdominal obesity in both men and women. This non-significant relationship could be explained by the interaction of healthy and unhealthy food constituents in the snack pattern. On the one hand, the adverse food items, such as cakes/pastries and soft drinks were recognized to be associated with a higher risk of obesity because of their excess content of sugar and energy contents. On the other hand, fruits, seeds, and nuts, considered the healthy constituent in the pattern, would counteract the unhealthy effect on obesity. The linkage between snacking behavior and obesity is inconsistent among populations of different genders, age groups, regions, and income levels [16,42–45]. However, we believe that the diverse food composition of the snacks pattern in the different studies is the fundamental reason behind this discrepancy. Snack patterns mainly consist of high energy density and low-nutrient-content foods, which would increase the risk of obesity. Conversely, snacks patterns comprising nuts, seeds, and fruits will have a protective effect on weight management. As a dietary ingredient, snacking behavior has been dramatically increasing in China since 2004, and the Chinese snacking composition is shifting from an unhealthy one to a healthy one [46]. Additionally, a marked transition from a traditional two or three meals per day toward meals combined with smacks is underway. Further research is needed to develop a better understanding of the relationship between snack patterns and obesity.

The prudent pattern in the present study was relatively healthy from the perspective of food composition for both genders. Men and women following this pattern consumed high amounts of coarse grains and fruits. In addition, dairy, tea, seafood, and processed meat were consumed
appropriately by men and, particularly, by women. Obviously, apart from processed meats, the other food groups in prudent pattern will all play protective roles against obesity. The effects of coarse grains, fruits, and seafood have been discussed above. Dairy is indicated to play an important role in both prevention and treatment of obesity. The high dietary calcium present in dairy products plays a pivotal role in the regulation of energy metabolism, because high-calcium diets attenuate adipocyte lipid accretion and weight gain during the overconsumption of an energy-dense diet, and increase lipolysis and preserve thermogenesis during caloric restriction, which thereby markedly accelerates weight loss [47]. Additionally, epidemiological evidence and experimental studies have demonstrated that drinking tea is associated with a lower risk of general obesity and other metabolism syndromes. The beneficial effects of tea have been attributed to the presence of phenolic compounds that are powerful anti-oxidants and free iron scavengers [48]. Moreover, both men and women with high scores for the prudent pattern were more likely to have a healthy lifestyle. They had a higher education level, participated in more physical activity, smoked less (men) and did more housework. However, unlike other studies with a similar prudent pattern [49–51], we did not find a relationship between this pattern and obesity, which was probably because the sample size was not large enough to discover a statistically significant association. Therefore, further research with a larger sample size is necessary to examine the protective effects of the prudent dietary pattern in China.

Several limitations in this study should be mentioned. Firstly, the sample size was small. Although we detected statistically significant results for two patterns, further studies with larger sample sizes are needed to confirm this conclusion and for deeper exploration. Secondly, the conclusions cannot be extrapolated to the entire Chinese population, because the study participants are restricted to a middle-aged and elderly population in Shanghai. Thirdly, this study cannot show the resultant relationship between dietary patterns and obesity given the cross-sectional design. Finally, some subjective and arbitrary decisions, including determining the number of factors to retain, choosing the method of rotation of the initial factors, and labeling the dietary patterns, should be considered. In spite of these limitations, this is the first study to reveal the effect of gender difference on the association between dietary patterns and obesity in a middle-aged and elderly Chinese population. Furthermore, the use of the four periods of one-day recall method by a face-to-face interview and the adjustment for potential confounders, including age, education level, married status, occupation, smoking status, physical activity, and energy intake, ensured the validity and reliability of this study.

9. Conclusions

Our study identified four distinct dietary patterns for both genders of a middle-aged and elderly populations in Shanghai: the rice staple pattern, wheat staple pattern, snacks pattern, and prudent pattern. Our findings indicated that the rice staple pattern was associated positively with abdominal obesity in men, but was associated negatively with general obesity in women. A significant association between wheat staple pattern and men was observed, but not for women. Further prospective and larger sample size studies are needed to explore the gender difference in the association between dietary patterns and obesity.

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Conflicts of Interest: The authors declare no conflict of interest.
### Table 1. Absolute amount of food groups by quartiles (Q) of dietary pattern scores.

| Rice Staple | Wheat Staple | Snacks | Prudent |
|-------------|--------------|--------|---------|
| **Men/Women (g)** | **Men/Women (g)** | **Men/Women (g)** | **Men/Women (g)** |
| Rice | 217.4/194.8 | 250.0/270.4 | 201.0/161.8 | 136.1/122.7 |
| Wheat | 72.0/81.3 | 63.1/85.2 | 61.9/85.2 | 69.8/62.1 |
| Deep fried wheat | 0.2/1.6 | 0.1/1.2 | 0.1/1.2 | 0.3/0.2 |
| Instant noodles | 2.3/0.8 | 0.0/0.0 | 0.0/0.0 | 1.0/0.0 |
| Coarse grains | 128.5/147.4 | 129.9/156.2 | 133.1/157.8 | 5.1/3.7 |
| Starchy roots and tubers | 8.9/17.0 | 12.1/5.8 | 11.8/17.9 | 25.7/37.4 |
| Vegetables | 3.0/14.5 | 2.4/17.0 | 9.4/14.5 | 25.7/37.4 |
| Fruits | 128.9/149.7 | 131.6/157.8 | 131.6/157.8 | 5.2/25.2 |
| Pork | 57.0/45.2 | 68.4/74.5 | 68.7/74.5 | 8.3/5.3 |
| Poultry | 3.6/1.6 | 7.0/7.1 | 7.0/7.1 | 3.0/3.0 |
| Processed meats | 0.4/1.4 | 4.0/2.3 | 4.0/2.3 | 3.4/0.3 |
| Fresh water fish and seafood | 85.5/33.8 | 78.6/81.9 | 78.6/81.9 | 52.2/43.8 |
| Dairy | 49.7/48.8 | 44.3/49.1 | 44.3/49.1 | 52.2/43.8 |
| Legumes | 35.3/18.7 | 37.7/39.9 | 37.7/39.9 | 52.2/43.8 |
| Eggs | 33.5/3.5 | 665.6/99.9 | 665.6/99.9 | 52.2/43.8 |
| Seeds and nuts | 1.5/5.1 | 8.4/11.5 | 8.4/11.5 | 3.0/3.0 |
| Fungi and algae | 3.0/3.1 | 11.7/16.2 | 11.7/16.2 | 8.3/6.8 |
| Western fast food | 3.0/0.5 | 0.0/0.0 | 0.0/0.0 | 0.0/0.0 |
| Cakes and pastries | 3.4/12.7 | 10.6/13.2 | 10.6/13.2 | 3.0/0.5 |
| Candy and chocolates | 5.7/9.6 | 8.0/3.5 | 8.0/3.5 | 3.0/0.5 |
| Soft drinks | 11.1/28.5 | 11.1/48.8 | 11.1/48.8 | 3.0/0.5 |
| Alcoholic beverages | 26.8/0.1 | 25.2/25.2 | 25.2/25.2 | 3.0/0.5 |
| Tea | 271.1/270.0 | 506.2/294.9 | 506.2/294.9 | 162.7/341.1 |

**Note:** The table continues with more food groups and their absolute amounts by quartiles of dietary pattern scores.
References

1. Stevens, G.A.; Singh, G.M.; Lu, Y.; Danaei, G.; Lin, J.K.; Finucane, M.M.; Bahalim, A.N.; McIntire, R.K.; Gutierrez, H.R.; Cowan, M.; et al. National, regional, and global trends in adult overweight and obesity prevalences. *Popul. Health Metr.* 2012, 10, 22. [CrossRef] [PubMed]

2. World Health Organization. *WHO Global Status Report 2014*; World Health Organization: Geneva, Switzerland, 2015.

3. Ge, K. Dietary pattern and physical development in China—Based on the 1992 national nutrition survey. *Asia Pac. J. Clin. Nutr.* 1995, 4 (Suppl. S1), 19–23. [PubMed]

4. Li, L.M.; Rao, K.Q.; Kong, L.Z.; Yao, C.H.; Xiang, H.D.; Zhai, F.Y.; Ma, G.S.; Yang, X.G. A description on the Chinese national nutrition and health survey in 2002. *Zhonghua Liu Xing Bing Xue Za Zhi* 2005, 26, 478–484. [PubMed]

5. Hou, X.; Lu, J.; Weng, J.; Ji, L.; Shan, Z.; Liu, J.; Tian, H.; Ji, Q.; Zhu, D.; Ge, J.; et al. Impact of waist circumference and body mass index on risk of cardiometabolic disorder and cardiovascular disease in Chinese adults: A national diabetes and metabolic disorders survey. *PLoS ONE* 2013, 8, e57319. [CrossRef] [PubMed]

6. Lim, S.S.; Vos, T.; Flaxman, A.D.; Danaei, G.; Shibuya, K.; Adair-Rohani, H.; Amann, M.; Anderson, H.R.; Andrews, K.G.; Aryee, M.; et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012, 380, 2224–2260. [CrossRef] [PubMed]

7. Wang, H.; Zhao, S.X.; Zeng, E.K.; Ma, C.W.; Wang, J.Y.; Duan, L. The Social Development and the Coping Strategies for China’s Aging Population. *Chin. J. Soc. Med.* 2014, 2, 75–77. (In Chinese)

8. Wang, B. Characteristics, thinking and solution of the aging society in Shanghai. *Chin. J. Gerontol.* 2015, 2, 532–534. (In Chinese)

9. Smith, J.P.; Strauss, J.; Zhao, Y. Healthy Aging in China. *J. Econ. ageing* 2014, 4, 37–43. [CrossRef] [PubMed]

10. Nguyen, D.M.; El-Serag, H.B. The epidemiology of obesity. *Gastroenterol. Clin. N. Am.* 2010, 39, 1–7. [CrossRef] [PubMed]

11. Popkin, B.M.; Adair, L.S.; Ng, S.W. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr. Rev.* 2010, 68, 389–408. [CrossRef] [PubMed]

12. Van Horn, L. Eating pattern analyses: The whole is more than the sum of its parts. *J. Am. Diet. Assoc.* 2011, 111, 203. [CrossRef] [PubMed]

13. Hu, F.B. Dietary pattern analysis: A new direction in nutritional epidemiology. *Curr. Opin. Lipidol.* 2002, 13, 3–9. [CrossRef] [PubMed]

14. Tucker, K.L. Dietary patterns, approaches, and multicultural perspective. *Appl. Physiol. Nutr. Metab.* 2010, 35, 211–218. [CrossRef] [PubMed]

15. Kant, A.K. Dietary patterns and health outcomes. *J. Am. Diet. Assoc.* 2004, 104, 615–635. [CrossRef] [PubMed]

16. Randi, G.; Edefonti, V.; Ferraroni, M.; La Vecchia, C.; Decarli, A. Dietary patterns and the risk of colorectal cancer and adenomas. *Nutr. Rev.* 2010, 68, 389–408. [CrossRef] [PubMed]

17. Li, Y.; He, Y.; Lai, J.; Wang, D.; Zhang, J.; Fu, P.; Yang, X.; Qi, L. Dietary patterns are associated with stroke in Chinese adults. *J. Nutr.* 2011, 141, 1834–1839. [CrossRef] [PubMed]

18. Wang, D.; He, Y.; Li, Y.; Luan, D.; Yang, X.; Zhai, F.; Ma, G. Dietary patterns and hypertension among Chinese adults: A nationally representative cross-sectional study. *BMC Public Health* 2011, 11, 925. [CrossRef] [PubMed]

19. Sun, J.; Buys, N.; Shen, S. Dietary patterns and cardiovascular disease-related risks in Chinese older adults. *Front. Public Health* 2013, 1, 48. [CrossRef] [PubMed]

20. Nanri, A.; Shimazu, T.; Takachi, R.; Ishihara, J.; Mizoue, T.; Noda, M.; Inoue, M.; Tsugane, S. Dietary patterns and type 2 diabetes in Japanese men and women: The Japan Public Health Center-based Prospective Study. *Eur. J. Clin. Nutr.* 2013, 67, 18–24. [CrossRef] [PubMed]

21. Park, S.Y.; Murphy, S.P.; Wilkens, L.R.; Yamamoto, J.F.; Sharma, S.; Hankin, J.H.; Henderson, B.E.; Kolonel, L.N. Dietary patterns using the Food Guide Pyramid groups are associated with sociodemographic and lifestyle factors: The multiethnic cohort study. *J. Nutr.* 2005, 135, 843–849. [PubMed]
22. Shu, L.; Zheng, P.F.; Zhang, X.Y.; Si, C.J.; Yu, X.L.; Gao, W.; Zhang, L.; Liao, D. Association between Dietary Patterns and the Indicators of Obesity among Chinese: A Cross-Sectional Study. *Nutrients* **2015**, *7*, 7995–8009. [CrossRef] [PubMed]

23. Xu, X.; Hall, J.; Byles, J.; Shi, Z. Dietary Pattern Is Associated with Obesity in Older People in China: Data from China Health and Nutrition Survey (CHNS). *Nutrients* **2015**, *7*, 8170–8188. [CrossRef] [PubMed]

24. Ward, J.; Friche, A.A.; Caiaffa, W.T.; Proietti, F.A.; Xavier, C.C.; Diez, R.A. Association of socioeconomic factors with body mass index, obesity, physical activity, and dietary factors in Belo Horizonte, Minas Gerais State, Brazil: The BH Health Study. *CAD Saude Publica* **2015**, *31* (Suppl. 51), 182–194. [CrossRef] [PubMed]

25. Zhai, F.Y.; Du, S.F.; Wang, Z.H.; Zhang, J.G.; Du, W.W.; Popkin, B.M. Dynamics of the Chinese diet and the role of urbanicity, 1991–2011. *Obes. Rev.* **2014**, *15* (Suppl. 1), 16–26. [CrossRef] [PubMed]

26. Zhou, B.F. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults—Study on optimal cut-off points of body mass index and waist circumference in Chinese adults. *Biomed. Environ. Sci.* **2002**, *15*, 83–96. [PubMed]

27. Wang, H.J.; Wang, Z.H.; Yu, W.T.; Zhang, B.; Zhai, F.Y. Changes of waist circumference distribution and the prevalence of abdominal adiposity among Chinese adults from 1993 to 2006. *Zhonghua Liu Xing Bing Xue Za Zhi* **2008**, *29*, 953–958. (In Chinese) [PubMed]

28. Kang, Y.; Kim, J. Gender difference on the association between dietary patterns and metabolic syndrome in Korean population. *Eur. J. Nutr.* **2015**. [CrossRef] [PubMed]

29. Vergnaud, A.C.; Norat, T.; Romaguera, D.; Mouw, T.; May, A.M.; Travier, N.; Luan, J.; Wareham, N.; Slimani, N.; Rinaldi, S.; et al. Meat consumption and prospective weight change in participants of the EPIC-PANACEA study. *Am. J. Clin. Nutr.* **2010**, *92*, 398–407. [CrossRef] [PubMed]

30. Rouhani, M.H.; Salehi-Abargouei, A.; Surkan, P.J.; Azadbakht, L. Is there a relationship between red or processed meat intake and obesity? A systematic review and meta-analysis of observational studies. *Obes. Rev.* **2014**, *15*, 740–748. [CrossRef] [PubMed]

31. Wang, Z.; Zhang, B.; Zhai, F.; Wang, H.; Zhang, J.; Du, W.; Su, C.; Zhang, J.; Jiang, H.; Popkin, B.M. Fatty and lean red meat consumption in China: Differential association with Chinese abdominal obesity. *Nutr. Metab. Cardiovasc. Dis.* **2014**, *24*, 869–876. [CrossRef] [PubMed]

32. Lorente-Cebrian, S.; Costa, A.G.; Navas-Carretero, S.; Zabala, M.; Martinez, J.A.; Moreno-Aliaga, M.J. Role of omega-3 fatty acids in obesity, metabolic syndrome, and cardiovascular diseases: A review of the evidence. *J. Physiol. Biochem.* **2013**, *69*, 633–651. [CrossRef] [PubMed]

33. Shi, Z.; Taylor, A.W.; Hu, G.; Gill, T.; Wittert, G.A. Rice intake, weight change and risk of the metabolic syndrome development among Chinese adults: The Jiangsu Nutrition Study (JIN). *Asia Pac. J. Clin. Nutr.* **2012**, *21*, 35–43. [PubMed]

34. Kim, J.-J.; Jo, I.; Joung, H. A rice-based traditional dietary pattern is associated with obesity in Korean adults. *J. Acad. Nutr. Diet.* **2012**, *112*, 246–253. [CrossRef] [PubMed]

35. Buijsse, B.; Feskens, E.J.; Schulze, M.B.; Forouhi, N.G.; Wareham, N.J.; Sharp, S.; Palli, D.; Tognon, G.; Halkjaer, J.; Tjonneland, A.; et al. Fruit and vegetable intakes and subsequent changes in body weight in European populations: Results from the project on Diet, Obesity, and Genes (DiOGenes). *Am. J. Clin. Nutr.* **2009**, *90*, 202–209. [CrossRef] [PubMed]

36. Vergnaud, A.C.; Norat, T.; Romaguera, D.; Mouw, T.; May, A.M.; Romieu, I.; Freising, H.; Slimani, N.; Boutron-Ruault, M.C.; Clavel-Chapelon, F.; et al. Fruit and vegetable consumption and prospective weight change in participants of the European Prospective Investigation into Cancer and Nutrition-Physical Activity, Nutrition, Alcohol, Cessation of Smoking, Eating Out of Home, and Obesity study. *Am. J. Clin. Nutr.* **2010**, *90*, 3651–3657. [PubMed]

37. Park, S.H.; Lee, K.S.; Park, H.Y. Dietary carbohydrate intake is associated with cardiovascular disease risk in Korean: Analysis of the third Korea National Health and Nutrition Examination Survey (KNHANES III). *Int. J. Cardiol.* **2010**, *139*, 234–240. [CrossRef] [PubMed]

38. Lin, H.; Bermudez, O.I.; Tucker, K.L. Dietary patterns of Hispanic elders are associated with acculturation and obesity. *J. Nutr.* **2003**, *133*, 3651–3657. [PubMed]

39. Mittendorfer, B.; Sidossis, L.S. Mechanism for the increase in plasma triacylglycerol concentrations after consumption of short-term, high-carbohydrate diets. *Am. J. Clin. Nutr.* **2001**, *73*, 892–899. [PubMed]
40. Sayon-Orea, C.; Bes-Rastrollo, M.; Basterra-Gortari, F.J.; Beunza, J.J.; Guallar-Castillon, P.; de la Fuente-Arrillaga, C.; Martinez-Gonzalez, M.A. Consumption of fried foods and weight gain in a Mediterranean cohort: The SUN project. *Nutr. Metab. Cardiovasc. Dis.* 2013, 23, 144–150. [CrossRef] [PubMed]

41. Rautiainen, S.; Wang, L.; Lee, I.M.; Manson, J.E.; Buring, J.E.; Sesso, H.D. Higher Intake of Fruit, but Not Vegetables or Fiber, at Baseline Is Associated with Lower Risk of Becoming Overweight or Obese in Middle-Aged and Older Women of Normal BMI at Baseline. *J. Nutr.* 2015, 145, 960–968. [CrossRef] [PubMed]

42. Berg, C.; Lappas, G.; Wolk, A.; Strandhagen, E.; Toren, K.; Rosengren, A.; Thelle, D.; Lissner, L. Eating patterns and portion size associated with obesity in a Swedish population. *Appetite* 2009, 52, 21–26. [CrossRef] [PubMed]

43. Bes-Rastrollo, M.; Sanchez-Villegas, A.; Basterra-Gortari, F.J.; Nunez-Cordoba, J.M.; Toledo, E.; Serrano-Martinez, M. Prospective study of self-reported usual snacking and weight gain in a Mediterranean cohort: The SUN project. *Clin. Nutr.* 2010, 29, 323–330. [CrossRef] [PubMed]

44. Zizza, C.A.; Tayie, F.A.; Lino, M. Benefits of snacking in older Americans. *J. Am. Diet. Assoc.* 2007, 107, 800–806. [CrossRef] [PubMed]

45. Keast, D.R.; Nicklas, T.A.; O’Neil, C.E. Snacking is associated with reduced risk of overweight and reduced abdominal obesity in adolescents: National Health and Nutrition Examination Survey (NHANES) 1999–2004. *Am. J. Clin. Nutr.* 2010, 92, 428–435. [CrossRef] [PubMed]

46. Wang, Z.; Zhai, F.; Zhang, B.; Popkin, B.M. Trends in Chinese snacking behaviors and patterns and the social-demographic role between 1991 and 2009. *Asia Pac. J. Clin. Nutr.* 2012, 21, 253–262. [PubMed]

47. Zemel, M.B. Role of calcium and dairy products in energy partitioning and weight management. *Am. J. Clin. Nutr.* 2004, 79, 907S–912S. [PubMed]

48. Thielecke, F.; Boschmann, M. The potential role of green tea catechins in the prevention of the metabolic syndrome—A review. *Phytochemistry* 2009, 70, 11–24. [CrossRef] [PubMed]

49. Tucker, L.A.; Tucker, J.M.; Bailey, B.W.; Le Cheyninant, J.D. Dietary patterns as predictors of body fat and BMI in women: A factor analytic study. *Am. J. Health Promot.* 2015, 29, e136–e146. [CrossRef] [PubMed]

50. Haidari, F.; Shirbeigi, E.; Cheraghpour, M.; Mohammadshahi, M. Association of dietary patterns with body mass index, waist circumference, and blood pressure in an adult population in Ahvaz, Iran. *Saudi Med. J.* 2014, 35, 967–974. [PubMed]

51. Paradis, A.M.; Perusse, L.; Vohl, M.C. Dietary patterns and associated lifestyles in individuals with and without familial history of obesity: A cross-sectional study. *Int. J. Behav. Nutr. Phys. Act.* 2006, 3, 38. [CrossRef] [PubMed]

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