# Association of dietary patterns with body mass index, waist circumference, and blood pressure in an adult population in Ahvaz, Iran

*Fatemeh Haidari, PhD, Esmat Shirbeigi, MSc, Makan Cheraghpour, MSc, Majid Mohammadshahi, PhD.*


## ABSTRACT

**الأهداف**: تقييم العلاقة بين العادات الغذائية والسمنة المركزية وضغط الدم.

**الطريقة**: أجريت دراسة مقطعية لتقييم قياسات الجسم وضغط الدم وكمية الغذاء المعتاد ل 243 رجل يتراوح أعمارهم من 30– 50 عام ويعيشون في منطقة الأهواز، إيران ويعملون في نظام التعليم والثقافة خلال الفترة من اكتوبر 2011م حتى مارس 2012م باستخدام استبيان الأكل المعتاد.

**النتائج**: باستخدام تحليل العامل قمنا باستخلاص 3 أنماط غذائية أساسية وهي: النمط المتزن، عالي الدهون، وعالي البروتين، وبعد التحكم على العوامل المشوشة (الطاقة والنشاط البدني). ارتبط النمط الغذائي المتوازن بشكل سلبي مع كتلة الجسم، محيط الخصر، نسبة الخصر إلى الورك، وضغط الدم الانبساطي والانقباضي. بينما ارتبط كلا من النمط الغذائي عالي الدهون وعالي البروتين بشكل إيجابي مع مؤشرات السمنة وارتفاع ضغط الدم $p>0.05$.

**الخاتمة**: ارتبط النمط الغذائي المعتمد على الخضروات، والفواكه، والدواجن، والأسماك، ومنتجات الألبان قليلة الدهون، والحبوب الكاملة، والمكسرات، وزيت الزيتون بانخفاض خطورة الإصابة بالسمنة وارتفاع ضغط الدم بينما ارتبطت الأنماط الغذائية المعتمدة على استهلاك كميات كبيرة من اللحوم، والبيض والزبدة ومنتجات الألبان قليلة الدسم والدهون المهدرجة، والبيتزا، والمشروبات الغازية بارتفاع الإصابة بهذه الأعراض لدى سكان الأهواز، إيران.

**Objectives:** To assess the association between dietary patterns, central obesity, and blood pressure (BP).

**Methods:** In this cross-sectional study, we evaluated anthropometric measurements, BP, and usual dietary intakes of 243 men, aged 30-50 years old, working at the Education and Culture Systems in Ahvaz, Iran, between October 2011 and March 2012 using the Food Frequency Questionnaire (FFQ).

**Results:** Using the factor analysis, we extracted 3 major dietary patterns: "prudent", "high protein" and "high fat". After controlling for confounders (energy and physical activity), "prudent" pattern scores were negatively associated with body mass index, waist circumference, waist-to-hip ratio, systolic and diastolic BP ($p<0.05$). Scores of "high protein" and "high fat" patterns were positively related to obesity and hypertension indices ($p<0.05$).

**Conclusion:** A dietary pattern characterized by high consumption of vegetables, fruits, poultry, fish, low-fat dairy products, whole grains, nuts, and olives are associated with lower risk of central obesity and hypertension, while dietary patterns with high amounts of red meat, egg, butter, high fat dairy products, hydrogenated fats, pizza, and soft drinks are associated with increased risk of these conditions in Ahvaz, Iran.


*Saudi Med J 2014; Vol. 35 (9): 967-974*

*From the Nutrition and Metabolic Diseases Research Center (Haidari), the Student Research Committee (Shirbeigi, Cheraghpour), the Hyperlipidemia Research Center (Mohammadshahi), Department of Nutrition, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*

*Received 3rd December 2013. Accepted 29th June 2014.*

*Address correspondence and reprint request to: Dr. Majid Mohammadshahi, Hyperlipidemia Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. Tel. +986 (11) 3738253. Fax. +986 (11) 3737330. E-mail: shahi334@gmail.com*

**Disclosure**. This study was financially supported by Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

One of the most important precursors of disease and fitness is dietary patterns.[1] Recent developments in chronic diseases have heightened the need for evaluating dietary patterns as predicting factors in obesity, diabetes, cardiovascular diseases, and some types of cancer.[2] Several literature have emerged contradictory findings regarding individual foods or nutrients in describing the relation of diet to health and disease, as neither one nutrient, nor one food adequately describes dietary behavior.[3] Identification of a good or bad food or nutrient is less realistic than describing healthy dietary patterns, which aid people to understand the entirety of diet, while selecting foods that meet their tastes and lifestyle. A factor analysis method has been used to identify dietary patterns in similar studies.[1-4] In this approach, the mixed diet was classified into few important foods, which describe dietary behaviors.[5] Factor analysis has been shown to have good reliability and validity.[3] In the present study, we identified dietary patterns using factor analysis in an ethnically mixed population of the Education and Culture System's staff in Ahvaz, South of Iran. As a result of the population mix living in Ahvaz (Arabic, Persian, and Bakhtiari origin), a great variety of consuming foods have been existing in this area. For example, Falafel (spicy fried pea) and Samosa (spicy fried bread, tomato, and ketchup) consumption is popular among Arabic ethnic and Kebob (charbroiled or en brochette small pieces of meat, chicken, or sea foods) consumed specially in the Bakhtiari food culture. Regarding the variety of different foods eaten by multi-ethnic population in Ahvaz, a special interest exists to study the dietary patterns in this population. Moreover, according to the previous study in Ahvaz, obesity and overweight are highly prevalent in women working in administrative jobs. Rapid nutritional transition to a more sedentary lifestyle and unhealthy dietary practices seems to be the main reasons of weight gain in this population.[6] Consequently, the prevalence of obesity is strongly related to chronic metabolic diseases, such as hypertension (HTN), diabetes, and cardiovascular diseases in developing countries such as Iran.[3,7,8] Limited information, however, exists on obesity prevalence and dietary patterns in different ethnicities in Ahvaz. This study was conducted to determine the dietary patterns among the adult population of multi-ethnic men living in Ahvaz, and to investigate the relation of those patterns with abdominal obesity parameters and blood pressure (BP).

## Methods.

*Study population.* This cross-sectional study was conducted among a representative sample of Ahvazi male employees, aged 30-50 years old, working at the Education and Culture System, Ahvaz, Iran from October 2011 to March 2012. Subjects were selected by a multistage cluster random sampling method. A random sample of 315 multi-ethnic employees was invited to participate in this study, and 273 persons agreed. Participants with a prior history of cardiovascular disease, diabetes, and stroke were excluded because of possible changes in diet. We also excluded participants taking medications that would affect BP. After these exclusions, 243 healthy active persons remained for the present analysis. This study was approved by the ethical committee of Ahvaz Jundishapur University of Medical Sciences, and the study was conducted according to the principles of the Helsinki declaration. An informed written consent was also obtained from each participant.

*Dietary assessment.* All study participants completed a semi-quantitative Food Frequency Questionnaire (FFQ) specially designed for a multi-ethnic population. The FFQ was self-administered, and included 124 food items that met the diversity of consumed foods in the multi-ethnic population (Arabic, Persian, Bakhtiari) in Ahvaz. To assist in quantifying, a booklet of portion size was provided with the FFQ. Participants were asked to report their frequency of consumption of each food item during the previous year on a daily (for example, bread), weekly (egg), or monthly (sea foods) basis. The reported frequency of each food item was then converted to g/day and Nutritionist4 (N4) software was used to estimate dietary intake of the participants. All food items from FFQ were also classified into 39 food groups based on the nutrient profiles of each food item (**Table 1**). Foods that did not fit into any of the groups were left as separate food groups (tea, coffee, garlic).

*Anthropometric and demographic assessments.* Anthropometric assessments were carried out by standardized procedures. Briefly, weight and height were measured for each subject, and body mass index (BMI) was calculated from these values. Waist circumferences (WCs) were measured with an inelastic tape used at the narrowest point below the ribs, or halfway between the lowest ribs and the iliac crests. Hip circumferences were measured at the level of the anterior superior iliac spine, otherwise, at the broad circumference below the waist and waist-to-hip ratio (WHR) was calculated from these values.[9] Body fat mass (kg) and fat percentage were assessed using the Body Fat Analyzer (Omron BF 306, Kyoto, Japan). Physical activity, smoking status, ethnicity, and education level were determined by questionnaire.

*The BP measurement.* Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were

measured under constant temperature (19-21°C) and standardized conditions (supine position) using a manual sphygmomanometer (ALPK 2) by expert nurses. The recorded values were the mean of 3 readings at 20-minute intervals. An adjustable BP cuff was used to correct errors due to variations in arm circumference.[10] Hypertension was defined as SBP ≥140 mm Hg, or DBP ≥90 mm Hg as recommended in the Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of high BP.[11]

**Table 1 -** Food groups used in the dietary pattern analysis in this study.

| No. | Food category | Foods from the Food Frequency Questionnaire* |
|---|---|---|
| 1 | Processed meats | Hot dog, sausage, kielbasa |
| 2 | Red meats | Beef, hamburger, lamb, mincemeat |
| 3 | Organ meat | Beef liver, beef kidney |
| 4 | Fish and other sea food | Shrimp, clams, oysters, canned tuna fish and all types of fish |
| 5 | Poultry | Chicken with or without skin |
| 6 | Egg | Scrambled, fried (all types) |
| 7 | Butter | Butter |
| 8 | Margarines | Margarines |
| 9 | Low-fat dairy product | Skim or low-fat milk, low-fat yogurt, feta and cheddar cheeses |
| 10 | High fat dairy product | Chocolate milk, whole milk, ice cream, milk shakes, high fat yogurt (3% or more), butter fat, and pizza, parmesan, and creamy cheeses |
| 11 | Fruit | Oranges, grape fruit, cantaloupe, honey dew, water melon, peaches, nectarines, apricots, mango, apples, bananas, pears, apricots, berries, grapes, and strawberries, etc. |
| 12 | Fruit juices | Orange, grapefruit, mango, grape, apple, cranberry juice, etc. |
| 13 | Cruciferous vegetables | Broccoli, cauliflower, kale, Brussel sprouts and cabbage |
| 14 | Green leafy vegetables | Spinach, lettuce, greens |
| 15 | Yellow vegetables | All types of carrot |
| 16 | Tomatoes | Tomatoes including fresh and stewed tomatoes, tomato juice, and tomato sauce |
| 17 | Other vegetables | Hot red chili peppers, peppers (green, red, and yellow), green beans, corn, peas, mushrooms, cucumber, squash, eggplant, celery, onion, turnip and zucchini |
| 18 | Legumes | Beans, lentils, kidney, chickpea, vetch, pinto, refried, black, and baked |
| 19 | Garlic | Garlic |
| 20 | Potato | Potato chip, boiled, roasted, and grilled potato |
| 21 | Whole grains | Dark breads (Sangak, Barbari, Taftoon), barely bread, cornflakes, wheat germ, bulgur, whole wheat, barley, grits, and rye |
| 22 | Refined grains | White breads (Lavash, baguette), noodles, pasta, rice, toasted bread, sweet bread, white flour, starch, biscuits |
| 23 | Pizza | Pizza, Samoset, Falafel |
| 24 | Snacks | Potato chips, puffs, crackers, popcorn |
| 25 | Nuts | Peanuts, almonds, pistachios, walnuts, hazelnuts, roasted seeds |
| 26 | Mayonnaise | Mayonnaise |
| 27 | Dried fruits | Dried dates, dried mulberries, dried figs, etc. |
| 28 | Olive | Olives, olive oils |
| 29 | Sweets and desserts | Chocolates, cookies, cakes, confections |
| 30 | Hydrogenated fats | Animal fats, hydrogenated fats |
| 31 | Vegetable oils | Corn oil, canola oil, sunflower oil, soy oil |
| 32 | Sugars | Sugars, candies, all kinds of confectionery |
| 33 | Condiments | Jam, honey, jelly |
| 34 | Tea | Tea |
| 35 | Coffee | Coffee |
| 36 | Soda pop | All types of carbonated, flavored and sweetened soft drinks |
| 37 | Dugh‡ | Dugh, kefir (all types) |
| 38 | Salt | Salt |
| 39 | Pickles | Pickles |

Foods consumed by study participants were categorized into 39 food groups. *food intake data were collected using a 124-item semi-quantitative Food Frequency Questionnaire, ‡type of drink consisting of yogurt and water

***Statistical analysis.*** To identify dietary patterns, we applied factor analysis to data from the FFQ. The principal components program for factor analysis of Statistical Package for Social Sciences (SPSS) software with Varimax rotation to the 39 food groups was used. Factor analysis aggregates correlated variables. The obtained factors are linear combinations of the included variables, explaining as much of the variation in the original variables as possible. Finally, 3 factors based on the Eigen value of the factors were retained, and these patterns labeled as the "prudent" pattern, the "high protein" pattern, and the "high fat" pattern (**Table 2**). The pattern score for each participant was determined from the intake of the food items in each dietary pattern. These scores ranked participants according to the degree, to which they adapted to each dietary pattern.[2,3] Cut-points for tertile of dietary pattern scores were calculated, and participants were categorized based on tertile cut-points. One-way ANOVA with Tukey post hoc test was used to compare quantitative variables across tertile categories of dietary pattern scores. After adjusting for confounders, the association of 3 dietary patterns with quantitative variables was assessed by multiple linear regression analysis. A $p<0.05$ was considered significant. All statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA) program version 17 for Windows.

**Table 2 -** Factor-loading matrix of major dietary patterns according to this study.*

| Food groups | Dietary patterns | | |
|---|---|---|---|
| | Prudent | High protein | High fat |
| Processed meats | - | - | 0.23 |
| Red meats | - | 0.67 | 0.22 |
| Organ meat | - | 0.32 | 0.42 |
| Fish and other sea food | 0.43 | 0.45 | - |
| Poultry | 0.52 | 0.37 | - |
| Egg | - | 0.42 | - |
| Butter | -0.24 | - | 0.56 |
| Margarines | - | - | - |
| Low-fat dairy products | 0.37 | 0.23 | 0.28 |
| High fat dairy products | -0.40 | _ | 0.42 |
| Fruit | 0.48 | 0.25 | -0.21 |
| Fruit juices | 0.21 | 0.27 | - |
| Cruciferous vegetables | 0.76 | - | - |
| Green leafy vegetables | 0.48 | - | - |
| Yellow vegetables | 0.55 | - | - |
| Tomatoes | 0.65 | 0.21 | - |
| Other vegetables | 0.66 | - | - |
| Legumes | 0.22 | 0.31 | - |
| Garlic | - | - | - |
| Potato | 0.43 | - | - |
| Whole grains | 0.38 | - | - |
| Refined grains | - | 0.33 | - |
| Pizza | - | 0.36 | 0.40 |
| Snacks | 0.31 | 0.38 | - |
| Nuts | 0.39 | 0.38 | 0.23 |
| Mayonnaise | - | - | 0.38 |
| Dried fruits | - | - | - |
| Olive | 0.33 | _ | _ |
| Sweets and desserts | - | 0.44 | - |
| Hydrogenated fats | -0.28 | - | 0.38 |
| Vegetable oils | - | - | 0.29 |
| Sugars | - | - | - |
| Condiments | - | - | 0.22 |
| Tea | 0.23 | 0.27 | - |
| Coffee | - | 0.37 | - |
| Soda pop | - | 0.36 | 0.33 |
| Dugh | 0.35 | - | - |
| Salt | - | - | - |
| Pickles | - | 0.37 | 0.27 |

*Values <0.20 were excluded for simplicity

**Results.** In this study, 3 major dietary patterns using factor analysis were identified (**Table 2**): the "prudent "dietary pattern (high in vegetables, fruits, tomatoes, poultry, fish, low-fat dairy products, potatoes, whole grains, nuts, olives, and doogh or dugh - a savory yogurt-based beverage); the "high protein" dietary pattern (high in red meat, poultry, fish, eggs, nuts, pizza, sweets and desserts, refined grains, legumes, and soft drinks); and the "high fat" dietary pattern (high in butter, mayonnaise, organ meats, dairy products, hydrogenated fats, pizza, and soft drinks). These factors explained 20.3% of the variance. Demographic and anthropometric characteristics of participations by tertile categories of dietary patterns scores are shown in **Table 3**. As it is obvious, subjects with higher "prudent" pattern scores had a lower WC, SBP and DBP, and were more physically active. Subjects with higher "high protein" and "high fat" pattern scores generally had a higher BMI, body fat mass, and triceps skin fold thickness (TSF), and a lower level of physical activity. Higher "high fat" pattern scores were also associated with a higher DBP. **Table 4** shows the dietary intake of the study sample according to the tertile of dietary pattern scores. On average, higher "prudent" pattern scores were associated with lower intakes of total fat and higher intakes of dietary fiber, calcium, zinc, vitamin A, vitamin C, and folic acid. Higher "high protein" pattern scores were associated with higher intakes of total fat, protein, cholesterol, iron, vitamin A, and

**Table 3 -** Characteristics of study participants by tertile categories of dietary pattern scores in this study.

| Characteristics | Tertile of prudent pattern score | | | | Tertile of high protein pattern score | | | | Tertile of high fat pattern score | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | *P*-value | 1 | 2 | 3 | *P*-value | 1 | 2 | 3 | *P*-value |
| N | 81 | 81 | 81 | - | 81 | 81 | 81 | - | 81 | 81 | 81 | - |
| Age, years | 40.7±7.8 | 40.7±8.5 | 40.5±7.5 | 0.86 | 40.11±7.9 | 40.5±8.2 | 40.7±7.7 | 0.88 | 39.4±8.8 | 39.8±7.9 | 41.8±6.8 | 0.12 |
| Weight, kg | 88.5±18.5 | 83.3±16.5 | 78.6±18.2 | 0.025 | 80.3±13.5 | 81.8±17.9 | 88.4±20.1 | 0.047 | 80.2±15.8 | 82.1±17.7 | 85.4±16.1 | 0.084 |
| Body fat mass (%) | 26.8±6.1 | 25.9±4.7 | 24.6±3.9 | 0.09 | 23.4±4.1 | 25.7±4.3 | 28.2±5.9 | 0.045 | 24.3±4.0 | 25.2±5.1 | 27.7±5.5 | 0.048 |
| TSF (cm) | 17.8±6.9 | 17.9±7.3 | 17.4±5.2 | 0.143 | 16.6±7.0 | 17.4±6.1 | 19.3±6.3 | 0.01 | 17.2±6.4 | 17.4±5.8 | 18.5±5.2 | 0.049 |
| BMI (kg/m$^2$) | 28.9±3.9 | 27.3±4.2 | 26.2±3.7 | 0.08 | 26.3±5.1 | 27.1±6 | 29.1±4.2 | 0.01 | 26.4±3.6 | 27.2±3.1 | 28.9±4.7 | 0.01 |
| WC (cm) | 28.9±3.9 | 27.3±4.2 | 26.2±3.7 | 0.08 | 26.3±5.1 | 27.1±6 | 29.1±4.2 | 0.01 | 26.4±3.6 | 27.2±3.1 | 28.9±4.7 | 0.01 |
| HC (cm) | 104.9±17.2 | 104.4±16.3 | 103.1±16.4 | 0.217 | 103.7±13.2 | 103.5±14.8 | 105.3±16.2 | 0.131 | 103.4±17.3 | 103.6±16.4 | 105.4±16.8 | 0.101 |
| WHR | 0.95±0.03 | 0.95±0.04 | 0.94±0.04 | 0.06 | 0.95±0.05 | 0.94±0.06 | 0.95±0.070 | 0.117 | 0.94±0.06 | 0.94±0.04 | 0.96±0.04 | 0.09 |
| SB (mm Hg) | 128.2±23.0 | 122.7±24.0 | 119.1±21.0 | 0.01 | 123.4±25.0 | 125.9±21.0 | 126.7±19.0 | 0.09 | 124.3±18.0 | 125.2±18.0 | 126.5±23.0 | 0.13 |
| DBP (mm Hg) | 87.2±9.3 | 85.9±8.2 | 76.7±9.1 | 0.01 | 82.5±10.2 | 83.1±9.5 | 84.2±10.7 | 0.09 | 80.4±9.7 | 84.3±8.8 | 85.1±8.4 | 0.01 |
| Physical activity (MET-hour/week) | 4.3±4.1 | 6.7±3.9 | 8.2±5.1 | 0.042 | 8.1±3.4 | 6.2±3.1 | 5.1±3.2 | 0.049 | 8.2±3.6 | 5.7±4.1 | 5.2±4.1 | 0.044 |
| ***Education, n (%)*** | | | | 0.162 | | | | 0.277 | | | | 0.118 |
| No high school | 4 (4.9) | 2 (2.5) | 1 (1.2) | | 1 (1.2) | 6 (7.4) | 0 (0) | | 3 (3.7) | 2 (2.5) | 2 (2.5) | |
| High school | 14 (17.3) | 17 (20.9) | 19 (23.4) | | 22 (27.4) | 7 (8.6) | 21 (25.9) | | 24 (29.6) | 14 (17.3) | 12 (14.8) | |
| College degree | 47 (57.9) | 48 (59.2) | 43 (53.1) | | 51 (62.9) | 48 (59.2) | 39 (48.1) | | 39 (48.1) | 48 (59.2) | 51 (62.9) | |
| Graduate degree | 16 (19.7) | 14 (17.3) | 18 (22.2) | | 7 (8.6) | 20 (24.7) | 21 (25.2) | | 15 (18.5) | 17 (20.9) | 16 (19.7) | |
| ***Race-ethnicity, n (%)*** | | | | 0.098 | | | | 0.042 | | | | 0.085 |
| Arab | 33 (40.7) | 42 (51.8) | 15 (18.5) | | 27 (33.3) | 42 (51.8) | 21 (25.9) | | 17 (20.9) | 34 (41.9) | 39 (48.1) | |
| Persian | 17 (20.9) | 18 (22.2) | 36 (44.4) | | 40 (49.4) | 14 (17.3) | 18 (22.2) | | 30 (37.0) | 17 (20.9) | 24 (29.6) | |
| Bakhtiari | 20 (24.7) | 21 (25.9) | 23 (28.4) | | 7 (8.6) | 17 (20.9) | 40 (49.4) | | 24 (29.6) | 28 (34.6) | 12 (14.8) | |
| Other | 11 (13.6) | 0 (0) | 7 (8.6) | | 7 (8.6) | 8 (9.9) | 2 (2.5) | | 10 (12.3) | 2 (2.5) | 6 (7.4) | |

TSF - triceps skin fold thickness, BMI - body mass index, WC - waist circumference, HC - hip circumference,
WHR - waist-to-hip ratio, SBP - systolic blood pressure, DBP - diastolic blood pressure, MET - metabolic equivalent

**Table 4 -** Dietary intakes* of study participants by tertile categories of dietary pattern scores as found in this study.

| Variables | Tertile of prudent pattern score | | | | Tertile of high protein pattern score | | | | Tertile of high fat pattern score | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | *P*-value | 1 | 2 | 3 | *P*-value | 1 | 2 | 3 | *P*-value |
| Total energy (kcal/d) | 2794±217 | 2514±290 | 2317±194 | 0.04 | 2415±314 | 2590±251 | 2620±347 | 0.04 | 2296±264 | 2492±310 | 2837±371 | 0.03 |
| Energy from fat (%) | 36.7±6.2 | 29.6±5.4 | 26.2±5.3 | 0.03 | 29.3±5.8 | 29.6±6.5 | 33.8±7.2 | 0.04 | 22.9±8.8 | 31.4±7.1 | 38.2±6.3 | 0.000 |
| Energy from protein (%) | 14.7±3.4 | 16.2±4.7 | 15.9±6.2 | 0.16 | 12.2±5.1 | 15.4±4.3 | 19.2±6.1 | 0.01 | 17.0±4.5 | 15.7±5.2 | 14.1±4.7 | 0.01 |
| SFA (g/d) | 24.5±3.3 | 24.8±4.7 | 22.7±3.9 | 0.143 | 23.1±4.9 | 24.2±5.3 | 24.7±6.9 | 0.20 | 22.9±6.2 | 23.0±5.9 | 26.1±7.3 | 0.049 |
| MUFA (g/d) | 22.2±6.3 | 21.8±5.9 | 27.7±4.8 | 0.311 | 24.2±4.6 | 24.4±4.2 | 25.1±3.9 | 0.41 | 24.4±6.1 | 24.4±7.3 | 24.9±6.6 | 0.34 |
| PUFA (g/d) | 26.4±4.2 | 27.3±6.1 | 27.1±5.9 | 0.40 | 25.9±5.5 | 26.7±5.2 | 28.2±4.7 | 0.14 | 26.7±6.1 | 26.8±5.7 | 26.9±5.3 | 0.41 |
| Cholesterol (mg/d) | 287±33 | 254±47 | 232±35 | 0.10 | 232±42 | 265±81 | 288±65 | 0.00 | 201±34 | 263±61 | 321±58 | 0.000 |
| Dietary fiber (g/d) | 11.1±3.2 | 17.7±4.7 | 18.2±4.1 | 0.01 | 16.4±3.7 | 15.5±4.2 | 14.3±4.0 | 0.21 | 16.1±4.5 | 15.0±4.3 | 14.6±3.9 | 0.16 |
| Iron (mg/d) | 17.3±2.7 | 17.4±3.5 | 17.6±4.2 | 0.32 | 14.9±3.7 | 16.7±4.3 | 19.8±3.6 | 0.03 | 15.7±3.2 | 15.3±3.6 | 14.7±4.1 | 0.17 |
| Calcium (mg/d) | 720±48 | 864±63 | 965±58 | 0.03 | 849±62 | 855±59 | 846±60 | 0.42 | 860±41 | 850±54 | 839±67 | 0.27 |
| Zinc (mg/d) | 15.3±4.9 | 17.2±3.7 | 19.7±6.3 | 0.03 | 17.1±3.4 | 16.4±4.4 | 18.2±5.2 | 0.10 | 15.2±7.2 | 15.8±6.1 | 15.3±5.8 | 0.49 |
| Vitamin A (µg/d) | 515.7±72.1 | 517.5±85.3 | 560.7±88.2 | 0.02 | 520.4±84.5 | 525.5±85.2 | 547.6±88.3 | 0.04 | 529.7±91.1 | 520.4±83.1 | 521.3±81.7 | 0.21 |
| Vitamin D (µg/d) | 0.42±0.11 | 0.42±0.09 | 0.45±0.12 | 0.165 | 0.39±0.11 | 0.38±0.12 | 0.42±0.01 | 0.106 | 0.47±0.10 | 0.41±0.13 | 0.40±0.08 | 0.096 |
| Folic acid (µg/d) | 2.0±1.05 | 2.5±1.12 | 3.0±1.17 | 0.04 | 2.1±1.01 | 2.2±0.93 | 2.5±1.14 | 0.266 | 2.4±1.07 | 2.4±1.01 | 2.7±0.98 | 0.16 |
| Vitamin B12 (µg/d) | 3.2±0.92 | 3.4±0.85 | 3.9±0.97 | 0.194 | 3.0±0.97 | 3.5±0.97 | 4.0±1.07 | 0.034 | 3.3±0.93 | 3.3±0.99 | 3.2±1.02 | 0.317 |
| Vitamin C (mg/d) | 74.6±17.2 | 78.6±13.4 | 88.4±18.5 | 0.04 | 82.7±27.1 | 81.5±21.6 | 77.4±19.20 | 0.097 | 83.5±17.24 | 80.3±18.8 | 74.8±21.2 | 0.072 |
| Caffeine (mg/d) | 99.1±24.2 | 97.8±21.7 | 97.8±20.4 | 0.10 | 91.2±25.2 | 100.5±26.4 | 103.0±20.2 | 0.05 | 92.9±21.9 | 97.5±27.2 | 104.3±23.4 | 0.20 |

*Dietary intakes (energy, macro- and micro- nutrients) were determined using Nutritionist 4 (N4) software.
SFA - saturated fatty acid, MUFA - monounsaturated fatty acid, PUFA - poly-unsaturated fatty acid

**Table 5 -** Association of dietary pattern score with anthropometric indices and blood pressure according to the results in this study.

| Variables | Prudent pattern score | | High protein pattern score | | High fat pattern score | |
|---|---|---|---|---|---|---|
| | β | *P*-value | β | *P*-value | β | *P*-value |
| BMI | -0.215 | 0.001 | 0.289 | 0.000 | 0.179 | 0.006 |
| WC | -0.421 | 0.000 | 0.336 | 0.000 | 0.324 | 0.000 |
| HC | -0.270 | 0.009 | 0.301 | 0.000 | 0.214 | 0.001 |
| WHR | -0.297 | 0.000 | 0.008 | 0.897 | 0.072 | 0.272 |
| TSF | -0.145 | 0.193 | 0.328 | 0.000 | 0.081 | 0.216 |
| Body fat mass | -0.198 | 0.145 | 0.293 | 0.016 | 0.262 | 0.029 |
| SBP | -0.224 | 0.017 | 0.155 | 0.017 | 0.141 | 0.062 |
| DBP | -0.326 | 0.000 | 0.281 | 0.005 | 0.189 | 0.072 |

All regression models were adjusted for energy intake and physical activity. BMI - body mass index, WC - waist circumference, HC - hip circumference, WHR - waist-to-hip ratio, TSF - triceps skin fold thickness, SBP - systolic blood pressure, DBP - diastolic blood pressure

vitamin B12. Subjects in the highest tertile of the "high fat" pattern score had high mean intakes of total fat, protein, saturated fat, and cholesterol. Furthermore, the highest tertile of each dietary pattern score in this study was associated with higher intakes of total energy. Multivariate regression for relation between dietary pattern scores and anthropometric parameters and BP are provided in **Table 5**. After controlling for confounders (dietary intakes and physical activity levels), "prudent" pattern scores were negatively associated with BMI, WC, WHR, SBP, and DBP ($p<0.05$). Against, "high protein" pattern scores were positively related to BMI, WC, hip circumference, TSF, body fat mass, SBP, and DBP ($p<0.05$). The association between "high fat" pattern scores and BMI, WC, hip circumference, and body fat mass were also significantly positive ($p<0.05$).

**Discussion.** In the present study, 3 major dietary patterns using factor analysis were extracted. Then, the scores of dietary patterns were adjusted for confounders; and finally, the associations between dietary pattern scores and anthropometric parameters and BP were assessed. The results of the present study showed that the "prudent" pattern scores were inversely related to central obesity parameters and BP. This means that the higher "prudent" dietary pattern scores, the lower BMI, WC, WHR, SBP, and DBP. Conversely, other 2 dietary patterns ("high protein" and "high fat") were positively associated with central obesity measurements and BP. Other rare studies identified dietary patterns in developing countries.[3,7] The patterns extracted on adult populations in this study were comparable to earlier studies.[2,3,12]

In Esmaillzadeh and Azadbakht's study,[12] 3 major dietary patterns were identified, and named: healthy dietary pattern (including fruits, vegetables, tomatoes, poultry, legumes, cruciferous and green leafy vegetables, tea, fruit juices, and whole grains); western dietary pattern (including refined grains, red meat, butter, processed meat, high fat dairy products, sweets and desserts, pizza, potatoes, eggs, hydrogenated fats, and soft drinks); and Iranian dietary pattern (including refined grains, potato, tea, whole grains, hydrogenated fats, legumes, and broth). These investigators also found similar results in their other study among Iranian women.[2] The "prudent" and "high fat" patterns in the present study are very similar to the healthy and western patterns as reported by Esmaillzadeh et al.[2,12] In the Korean Health and Genome Study, Kim et al[13] reported 4 major dietary patterns labeled: "animal food" (greater intake of meats and fish); "rice-vegetable" (greater intake of steamed rice, tofu, kimchi, vegetables, dried anchovy, and seaweeds); "bread-dairy" (greater intake of bread, eggs, milk, and dairy products); and "noodle" (greater intake of ramyun, noodles, and Chajangmyeon). In the study of Kim et al,[13] the "animal food" and "bread-dairy" patterns were selected by younger people with higher education levels, and were associated with an increased risk of central obesity. The "high protein" dietary pattern in our study is relatively comparable to the "animal food" and "bread-dairy" patterns reported by Kim et al.[13]

Identifying the association between dietary patterns and indicators of metabolic syndrome, such as central obesity and HTN is not a new matter. However, it is unclear what kind of dietary patterns exists in different

parts of the world, and to what extent these patterns are related to these factors. In the present study, an inverse association between a "prudent" dietary pattern and risk of central obesity was found. Individuals in the upper tertile of "prudent" dietary pattern score were less likely to be centrally obese and more physically active, compared with those in the lowest tertile. Newby et al[14] found that a dietary pattern characterized by low-fat dairy products, grains, and fruit were inversely related to changes in BMI and WC in women. Schulz et al's[15] study has also reported inverse associations between major dietary patterns characterized by whole grains, fruits, and vegetables with BMI and weight gain. However, Van Dam et al[16] have implied no significant relationship between prudent dietary pattern and central obesity parameters. Indeed, this might be attributed to the self-reported weight and height in their study.

A "high protein" dietary pattern, obtained by factor analysis in this study was positively associated with BMI, WC, hip circumference, body fat mass, TSF, SBP, and DBP. A "meats" dietary pattern, which was obtained by factor analysis in a group of Hawaiian women was associated with higher BMI.[17] A positive association between the western dietary pattern and obesity has also been reported by Esmailzadeh and Azadbakht.[12] Similar results were also obtained by Kim et al.[13] Overall, higher intakes of meats, eggs, pizza, snacks, nuts, sweets and desserts, as seen in our "high protein" dietary pattern were associated with central obesity and HTN. These findings confirm the role of nutrition transition (from healthy to western pattern) in the rising prevalence of obesity in developing countries, such as Iran.[18] The "high fat" dietary pattern identified in our study was also significantly associated with obesity, and subjects in the highest tertile of "high fat" pattern had greater BMI, TSF, body fat mass, and were likely less active. The "high fat" dietary pattern, as shown in **Table 2**, is rich in organ meat, butter, high fat dairy products, pizza, mayonnaise, and hydrogenated fats. Therefore, a positive association between this dietary pattern and risk of obesity is expected with these components. However, coexistence of higher waist and hip circumference in subjects consuming this dietary pattern might counteract its effect on central obesity (regarding WHR). Moreover, it is possible that certain anthropometric patterns could have led to changes in diet in the hope of changing these measures. Consequently, these changes would confound the association between dietary patterns and central obesity; such residual confounding effects would tend to attenuate the risk estimates.[12] The "high fat" dietary pattern we defined in this study was not consistently associated with SBP and DBP. Regarding the huge effects of various factors on BP (such as genetics, ethnicity, age, gender, and medication intake),[19] this inconsistent result is also expected. A larger sample size is required to ascertain the relationship between dietary patterns and HTN. It should be also noted that in the current study only FFQ was used for assessing dietary intakes. This seems weak to present some conclusions.

In addition, in the present study, we studied an ethnically mixed population. As a result of the population mix living in Ahvaz (Arabic, Persian, and Bakhtiari origin), a great variety of consuming foods have been existing in this area. This is one of the most important strengths of such studies that investigate dietary patterns by factor analysis.

In conclusion, our findings suggest that a dietary pattern characterized by high consumption of vegetables, fruits, poultry, fish, low-fat dairy products, whole grains, nuts, olives and doogh that is mainly consumed by Persian ethnicity is associated with lower risk of central obesity and HTN; while dietary patterns with high amounts of red meat, organ meats, eggs, butter, mayonnaise, high fat dairy products, hydrogenated fats, refined grains, pizza, soft drinks, sweets and desserts, which are usually consumed by Arabic and Bakhtiari ethnicities are associated with increased risk of these conditions. Future studies should extend these findings by investigating potential mechanisms underlying these relations, and by examining whether prevention of other metabolic diseases (diabetes, atherosclerosis, and metabolic syndrome) is mediated through improvements in the dietary patterns. Nutritional education to improve dietary pattern is also recommended.

**Acknowledgment.** *The authors gratefully acknowledge Mr. Alipour M. for helping us in collecting data. We also thank all of the personnel who work in the Education and Culture System, Ahvaz, Iran.*

## References

1. Paradis AM, Godin G, Perusse L, Vohl MC. Associations between dietary patterns and obesity phenotypes. ***Int J Obes (Lond)*** 2009; 33: 1419-1426.
2. Esmaillzadeh A, Kimiagar M, Mehrabi Y, Azadbakht L, Hu FB, Willett WC. Dietary patterns and markers of systemic inflammation among Iranian women. ***J Nutr*** 2007; 137: 992-998.
3. Esmaillzadeh A, Azadbakht L. Food intake patterns may explain the high prevalence of cardiovascular risk factors among Iranian women. ***J Nutr*** 2008; 138: 1469-1475.
4. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. ***Am J Clin Nutr*** 2003; 77: 1417-1425.

5. Ambrosini GL, Fritschi L, de Klerk NH, Mackerras D, Leavy J. Dietary patterns identified using factor analysis and prostate cancer risk: a case control study in Western Australia. ***Ann Epidemiol*** 2008; 18: 364-370.
6. Amani R. Obesity prevalence and its nutritional related lifestyle pattern in Jundi-Shapour university female staff, Ahvaz, Iran. ***Int J Endocrinol Metab*** 2007; 3: 135-140.
7. Gupta N, Shah P, Nayyar S, Misra A. Childhood obesity and the metabolic syndrome in developing countries. ***Indian J Pediatr*** 2013; 80 Suppl 1: S28-S37.
8. Gomes PM, Andrade RC, Figueiredo RC, Pace AE, Dal Fabbro AL, Franco LJ, et al. Cardiovascular risk in Japanese-Brazilian subjects. ***Arq Bras Endocrinol Metabol*** 2012; 56: 608-613.
9. Wang Z, Hoy WE. Waist circumference, body mass index, hip circumference and waist-to-hip ratio as predictors of cardiovascular disease in Aboriginal people. ***Eur J Clin Nutr*** 2004; 58: 888-893.
10. Ostchega Y, Dillon C, Prineas RJ, McDowell M, Carroll M. Tables for the selection of correct blood pressure cuff size based on self-reported height and weight and estimating equations for mid-arm circumference: data from the U.S. National Health and Nutrition Examination Survey. ***J Hum Hypertens*** 2006; 20: 15-22.
11. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. ***Hypertension*** 2003; 42: 1206-11252.
12. Esmaillzadeh A, Azadbakht L. Major dietary patterns in relation to general obesity and central adiposity among Iranian women. ***J Nutr*** 2008; 138: 358-363.
13. Kim JH, Lee JE, Jung IK. Dietary pattern classifications and the association with general obesity and abdominal obesity in Korean women. ***J Acad Nutr Diet*** 2012; 112: 1550-1559.
14. Newby PK, Muller D, Hallfrisch J, Andres R, Tucker KL. Food patterns measured by factor analysis and anthropometric changes in adults. ***Am J Clin Nutr*** 2004; 80: 504-513.
15. Schulz M, Nothlings U, Hoffmann K, Bergmann MM, Boeing H. Identification of a food pattern characterized by high-fiber and low-fat food choices associated with low prospective weight change in the EPIC-Potsdam cohort. ***J Nutr*** 2005; 135: 1183-1189.
16. Van Dam RM, Grievink L, Ocke MC, Feskens EJ. Patterns of food consumption and risk factors for cardiovascular disease in the general Dutch population. ***Am J Clin Nutr*** 2003; 77: 1156-1163.
17. Paradis AM, Godin G, Perusse L, Vohl MC. Associations between dietary patterns and obesity phenotypes. ***Int J Obes (Lond)*** 2009; 33: 1419-1426.
18. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. ***Nutr Rev*** 2012; 70: 3-21.
19. Juhola J, Oikonen M, Magnussen CG, Mikkilä V, Siitonen N, Jokinen E, et al. Childhood physical, environmental, and genetic predictors of adult hypertension: the cardiovascular risk in young Finns study. ***Circulation*** 2012; 126: 402-409.


## Related Articles


Horaib GB, Al-Khashan HI, Mishriky AM, Selim MA, AlNowaiser N, BinSaeed AA, et al. Prevalence of obesity among military personnel in Saudi Arabia and associated risk factors. ***Saudi Med J*** 2013; 34: 401-407.

Abdel-Megeid FY, Abdelkarem HM, El-Fetouh A. Unhealthy nutritional habits in university students are a risk factor for cardiovascular diseases. ***Saudi Med J*** 2011; 32: 621-627.

Al-Hazzaa HM, Musaiger AO, Arab Teens Lifestyle Study Research Group. Physical activity patterns and eating habits of adolescents living in major Arab cities. *The Arab Teens Lifestyle Study.* ***Saudi Med J*** 2010; 31: 210-211.