Dietary Predictors of Overweight and Obesity in Iranian Adolescents

Nimah Bahreini Esfahani, Neda Ganjali Dashti, Marjan Ganjali Dashti, Mohd Ismail Noor, Poh Bee Koon, Ruzita Abd Talib, Syarif Husin Lubis

1Department of Community Nutrition, Food Security Research Center, School of Nutrition and Food Science, Isfahan University of Medical Sciences, Isfahan, IR Iran
2Department of Civil Engineering, Universiti Teknologi Petronas, Perak, Malaysia
3School of Biological Science, Universiti Sains Malaysia, Penang, Malaysia
4Department of Nutrition and Dietetics, School of Healthcare Sciences, Faculty of Health Sciences, University of Kebangsaan Malaysia, Kuala Lumpur, Malaysia
5Department of Biomedical Sciences, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Received 2015 March 15; Revised 2015 April 20; Accepted 2015 May 18.

Abstract

Background: Considering both diet and energy expenditures possess some influence on weight status, research into dietary determinants of obesity is challenging but essential to rational planning of well-organized interventions to avoid obesity.

Objectives: This study aimed to determine whether dietary factors were predictive of overweight and obesity in adolescents in the Iranian population.

Patients and Methods: A total of 840 students, ages 15 - 17, from six schools were enrolled in this cross-sectional study. A diet-patterns approach often has been used to describe the eating patterns in adolescents. Height, weight, and waist circumference anthropometric indices, physical activity, waist-hip ratio, and BMI measurements were determined. Daily dietary data and weighed food records were collected in 2010 and 2011. Abdominal obesity was defined according to world health organization guidelines, and the relationship between dietary predictor variables and the measures of adiposity were determined by using linear regression. Usual dietary intakes were assessed in an experimental study of Esfahani students.

Results: In total, 38.5% of girls and 32.2% of boys had a Western dietary pattern as the more prevalent pattern. The diet quality of adolescents with the lowest score on each dietary pattern was compared with those recording the highest scores. Those with the Western dietary pattern score were less likely to exercise and had a higher prevalence of general obesity. Adolescents in the greater quartile of the Mediterranean dietary patterns had the lowest odds of being overweight (OR 0.50, 95% CI 0.27 - 0.73) and obese (OR 0.48, 95% CI 0.15 - 0.80) than those in the lower quartile, whereas those in the greater quartile of the Western dietary pattern had the highest odds of being overweight (OR 1.69, 95% CI 1.10 - 2.04) and obese (OR 1.44, 95% CI 1.05 - 1.84). Higher consumption of a Western dietary pattern and a salty-sweet dietary pattern were associated significantly with obesity (P < 0.05). Intake of a Western dietary pattern and a salty-sweet dietary pattern were associated positively with measures of adiposity, namely body mass index and waist circumference.

Conclusions: This study showed significant associations between the seven dietary patterns and overweight and obesity among adolescents. Using dietary patterns within adolescents can provide important information on dietary consumption, and this approach is clearer and much easier to follow.

Keywords: Obesity, Food Habits, Adolescent, Dietary Patterns, Predictors, Overweight

1. Introduction

Nowadays, obesity is considered a common problem (1, 2) in both developed and developing countries. The prevalence of obesity is rising dramatically in Asian countries, including Iran (3). The world health organization reported that Iran is among the first seven countries in the world with regard to high prevalence of obesity in adolescents (4, 5). Based on the reports, 31% of youths ages 6 - 19 are overweight in Iran (2, 6). Obesity is a medical condition in which excessive body fat accumulates to the extent that it has an adverse impact on health, resulting in a reduced lifespan and increased health issues (3, 7), including among both children and adolescents (8, 9). The rising prevalence of obesity reflects the strong impact of lifestyle factors, including diet, in its etiology (10). Rezaei et al. reported that, in Tehran, among subjects including 270 students selected from schools for girls, 87% had relatively good quality nutritional behaviors, and their average daily intake included cereals, bread, vegetables, and fats from the recommended range (11). Many of them had an inappropriate situation regarding body
weight, and in relation to their utilization of the major food groups, the main percentage of unhealthy food consumed was related to fat, with most of the subjects taking fatty and salty snacks on a daily basis (11).

During the last few decades, the dietary plan quality of adolescents has declined with additional energy intake from takeout, salty and sweet snacks, and soft drinks, which has reduced the trends regarding fruit and vegetable intake. Although dietary factors happen to be implicated in the creation of obesity, the connection is complex and poorly understood.

Responding to the inconsistent results found so far with conventional methods of exiling single foods or nutrients, dietary pattern analysis continues to be suggested for additional research in nutritional epidemiology because this approach may provide further insight into this complex association.

Most of the data available in this regard are from developed countries (12, 13), and few data are available from developing countries (14, 15).

2. Objectives

The aim of the current study was to assess the relation of dietary patterns identified by factor analysis of obesity among adolescents and to design a strategy for a balanced diet to avoid obesity, which may cause irreversible damage to health.

3. Patients and Methods

This cross-sectional study was conducted in a representative sample of Iranian adolescents, ages 11 - 18, selected by a multistage cluster random-sampling method, who lived in Isfahan. The ethical committee of the Isfahan University of Medical Sciences approved the study. In the second phase, 840 students, ages 15 - 17, from six schools, were enrolled. Data collection was carried out from September 2010 - 2011. We excluded students who were remaining > 7 products clear on the food frequency questionnaire (FFQ), and those that noted an overall total everyday energy intake (EI) outside of the range of 800 - 4200 kcal were excluded because it could cause bias. A signed knowledgeable consent form was acquired from each participant. Normal nutritional consumption was assessed via the 168-item semi-quantitative FFQ (10). The questionnaire was a direct interview. The FFQ contains a list of meals with standard portion sizes frequently consumed by adolescents. Individuals were asked to record their frequency of use of certain portions of each food throughout the last year on a regular (e.g., rice or bread), weekly (e.g., meat or whole grain), or monthly (e.g., seafood) basis. The reported frequency for each food object was transformed into a daily intake. Serving sizes of meals were changed into grams by utilizing family measures (16). Overall energy intake was based on summing the energy intake from all meals. Due to the large variety of food items in accordance with the quantity of individuals, we assigned each food item into one of the 31 described food teams. The basis for a food item to be placed into a food class was the likeness of nutrients. Some foods were considered independent food classes, as their nutrient profiles were unique. A prior validation study determined great correlations between dietary intakes assessed by the same method of FFQ during multiple 24-hour dietary recalls throughout a yearlong study (17) (such as coffee, tea, eggs, and margarine), or their intake was considered to reveal a definite dietary pattern (such as broth, doogh, or garlic).

Subjects for this study were recruited from schools based on the following criteria: age 15 - 17 and a healthy resident of Esfahan city. Participants were excluded if any of the following was applicable to them: under medical treatment and receiving medications, physically disabled or receiving hormone therapy, and suffering from diseases such as cardiovascular disease and diabetes. In order to exclude subjects, their past medical history was obtained through the socio-demographic section of the questionnaire.

In order to calculate the sample size, the following formula was used: $n = (pqz^2/E^2)$ where $n = sample\ size; z^2 = square\ of\ the\ confidence\ level\ in\ standard\ error\ units; p = \ estimate\ of\ the\ proportion\ of\ normal\ dietary\ pattern; q = 1 - p, or\ the\ estimated\ proportion\ of\ failures;\ and\ E^2 = square\ of\ the\ maximum\ allowance\ for\ error\ between\ the\ true\ proportion\ and\ the\ sample\ proportion.\ Assume\ the\ arbitrary\ test\ usually\ may\ display\ 60%\ of\ all\ people (p)\ and\ recognizes\ the\ normal\ dietary\ pattern.\ To\ assume\ with\ 95%\ confidence (Zs.i = 1.96) that the allowance for sampling error is not > 3.5% points (E), these values into the formulation will be:

$$n = (1.96)^2 (0.6)(0.4)/0.0352$$
$$= (3.8416)(0.24)/0.001225$$
$$= 0.922/0.001225$$
$$= 753$$

The test measurement was increased up to 15% as a result of attrition. The ultimate trial measurement was 753 + 753 × 15 / 100 = 844

3.1. Assessment of Anthropometric Measures

Weight was measured using digital scales (SECA Germany) while the participants were minimally clothed without shoes and recorded to the nearest 100 g. Height was assessed via the SECA stadiometer 206 (SECA Germany) measure while the subjects were standing, not wearing

Bahreini Esfahani N et al. 2016;18(9):e25569.
3.2. Statistical Analysis

The factor score for each pattern was considered by summing intakes of meal groups weighted by their factor loadings (19). Each adolescent obtained a factor score for each identified pattern, and we adjusted all models for BMI. All designs for BMI-categorized individuals were altered by quartile of dietary pattern scores. One of the ways of evaluation of difference with Tukey’s post hoc evaluations was executed to differentiate substantial variations (such as age, anthropometry and physical exercise) across quartile kinds of dietary pattern ratings. The division of the qualitative variable across quartile was considered by using Pearson’s chi-square tests. Age and energy were adjusted to mean values (namely, age, physical exercise, and overall EI) for overweight and obesity. First, we acquired age and gender-modified ORs, and then adjustments were made for WC and SES. We also adjusted for EI (kcal/d), physical activity, and sleeping time in the third model, and ultimately, we included BMI in the logistic regression model to study if the relationship was mediated by obesity. The Hansel chi-square test was employed to examine the tendency of the tape on the subject’s body to make sure that the tape had the proper pressure, namely, neither loose nor too tight. Even though, generally, in most individuals, the narrowest waist is simple to recognize, sometimes, measurement of the narrowest waist could not be done accurately due to a wide range of abdominal fat or serious thinness (18). In the present study, once the narrowest place of the waist was recognized (particularly in overweight participants), the measurements of the WC were taken straight under the end of the lowest rib, because generally in most individuals the narrowest waist is at the lowest rib. To reduce error, all measurements were taken by the same observer.

4. Results

Demographic data of our participants are described in Table 1. Seven major dietary patterns were extracted by using factor analysis. The Western dietary pattern was the most prevalent pattern among girls (38.5%) and boys (32.2%), whereas the Mediterranean dietary pattern was the least prevalent pattern, 3.94% among girls and 4.25% among boys. Factor-loading matrices for these dietary patterns can be found in Table 2. Partial correlation coefficients (r) for the association between dietary pattern scores and features of overweight and obesity among adolescents are presented in Table 3. The highest correlation was seen between sleeping time and low protein, which was followed by energy intake with Western, low-protein, and salty-sweet patterns (P < 0.05).

The diet quality of adolescents with the minimum score on each dietary pattern was compared with those recording maximum scores. As a result of the comparison among the participants in the lowest and highest quartiles, significant obesity trends were found among subjects presenting less physical activity. The Western dietary pattern presented a significantly higher BMI among subjects with significantly much less exercise coupled with a considerably greater incidence of obesity.

Individuals within the greater from the traditional dietary pattern had been a little more physically active, as well as significantly less probably be overweight compared to those within the minimum bracket.

Those with the Western dietary pattern score were less likely to exercise and had a higher prevalence of general obesity. Consumers of the Western dietary pattern intake had more energy and cholesterol and less fiber. In total, these factors explained 76.94% and 76.42% of the whole variance. Table 4 shows that participants in the maximum quartile of the Mediterranean dietary patterns had minimum odds of being overweight (OR 0.50, 95%; CI 0.27 - 0.73) and obese (OR 0.48, 95%; CI 0.15 - 0.80) than did those in the smallest quartile, whereas those in the uppermost quartile of the Western dietary pattern had higher odds of being overweight (OR 1.69, 95%; CI 1.10 - 2.04) and obese (OR 1.44, 95%; CI 1.05 - 1.84) than did those in the minimum quartile.

Subjects in the highest quartile of the Asian pattern (Table 5) had minimum odds of being overweight (OR 0.37, 95%; CI 0.55 - 0.92) and obese (OR 0.67, 95%; CI 0.49 - 0.85) than did those in the smallest quartile, whereas those in the highest quartile of the low-protein dietary pattern (Table 6) had maximum odds of being overweight (OR 1.05, 95%; CI 0.81, 1.30) and obese (OR 1.39, 95%; CI 1.18 - 1.60) than did those in the minimum quartile.

Table 6 illustrates that those in the uppermost quartile of the sweet dietary pattern had the highest odds of being.
Table 1. General Characteristics of Iranian Adolescents\textsuperscript{a,b}

|                   | Boys (n = 420) | Girls (n = 420) | P Value |
|-------------------|----------------|-----------------|---------|
| Age, y            | 15.0 ± 2.1     | 15.4 ± 1.7      | 0.813   |
| Weight, kg        | 51.8 ± 15.7    | 51.8 ± 10.5     | 0.472   |
| Height, cm        | 160 ± 14       | 158 ± 8         | 0.614   |
| BMI, Kg/m\textsuperscript{2} | 19.9 ± 4.0     | 20.7 ± 3.5      | 0.387   |
| WHR               | 0.7 ± 0.01     | 0.7 ± 0.01      | 0.441   |
| Energy intake, kcal/d | 2223 ± 1083   | 1903 ± 896      | 0.113   |

| Weight status %   |                 |                 |         |
|-------------------|-----------------|-----------------|---------|
| Overweight        | 16.6 ± 0.3      | 11.9 ± 0.3      | 0.638   |
| Obese             | 19.7 ± 0.4      | 15.1 ± 0.3      | 0.040   |

| Sleeping duration, h/d |     |     |         |
|------------------------|-----|-----|---------|
| Light                  | 7.8 ± 1.2 | 7.5 ± 1.1 | 0.122   |

| Physical activity, %   |     |     |         |
|------------------------|-----|-----|---------|
| Light                  | 37.2 | 44.2 | 0.091   |
| Moderate               | 46.7 | 44.5 | 0.741   |
| Vigorous               | 16.1 | 11.3 | 0.062   |

| Socioeconomic status, % |     |     |         |
|-------------------------|-----|-----|---------|
| Low                     | 32.2 | 35.6 | 0.439   |
| Middle                  | 53.8 | 52.4 | 0.850   |
| High                    | 14   | 12   | 0.735   |

\textsuperscript{a}Values are expressed as means ± SD or %.
\textsuperscript{b}1 Kcal = 4.185 kJ.

Participants in the uppermost quartile of the traditional pattern (Table 5) had lesser odds of being overweight (OR 1.00, 95%; CI 0.75 - 1.53) and obese (OR 1.37, 95%; CI 1.01 - 1.73) than those in the minimum quartile.

5. Discussion

To our understanding, this is first study of Middle Eastern countries to record the relationship associated with significant dietary patterns and obesity. Our results revealed that the Mediterranean and Asian dietary patterns were associated with lower risks of obesity, whereas the Western dietary pattern was associated with higher risks of obesity. We identified no substantial association involving the traditional diet pattern with obesity. Almost all associations were independent of various other lifestyle factors.

It is our understanding that this is the first study by which major dietary patterns have been related by factor analysis directly to obesity. Additionally, we indicated that a dietary pattern characterized by high use of legumes, vegetables, fruit, and poultry is related to a reduced threat of obesity.

In comparison, a dietary pattern with high levels of red meat, processed meat, refined grains, butter, and high-fat milk products and low levels of vegetables and fruit is connected with a greater threat of obesity. Studies that have recognized dietary patterns in developing countries are rare. The patterns extracted within our study were just like those found in earlier studies on adult populations (20). Two main dietary patterns were identified known as “prudent” (including veggies, fresh fruits, beans, whole grain products, as well as fish) and “Western” (including highly processed meats, steak, butter, high-fat milk products, eggs, and white grain).

Comparable dietary patterns were based on the nurses’ health study (21, 22), which investigated individuals with the Swedish Mammography Cohort and documented three major dietary patterns described as balanced (veg-
Table 2. Food Grouping Used in the Dietary Pattern Analyses

| Food Groups                  | Food Items                                                                 |
|------------------------------|----------------------------------------------------------------------------|
| Processed meats              | Sausages, pizza                                                           |
| Red meats, organ meats       | Beef, hamburger, lamb, beef liver                                        |
| Fish                         | Canned tuna fish, other fish                                              |
| Poultry                      | Chicken with or without skin, eggs                                        |
| Butter, margarine            | Butter, margarine                                                         |
| Low-fat dairy products       | Skins or low-fat milk, low-fat yogurt                                     |
| High-fat dairy products      | High-fat milk, whole milk, chocolate milk, high-fat yogurt, cream cheeses, ice cream |
| Tea, coffee                  | Tea, coffee                                                               |
| Fruit                        | Bananas, cantaloupe, peaches, apples, raisins or grapes, watermelon, oranges, grapefruit, limes, strawberries, peaches, nectarine, tartarines, mulberry, plums, persimmons, pomagranates, lemons, pineapple, fresh figs and dates |
| Fruit juices                 | Apple juice, orange juice, grapefruit juice, other fruit juices           |
| Cruciferous vegetables       | Cabbage, cauliflower, Brussels sprouts, kail Carrots                     |
| Tomatoes                     | Tomatoes, tomato sauce, tomato paste                                      |
| Green leafy vegetables       | Spinach, lettuce                                                         |
| Legumes                      | Beans, peas, lima beans, broad beans, lentils, soy                        |
| Garlic                       | Garlic                                                                   |
| French fries                 | French fried potatoes                                                    |
| Whole grains                 | Dark breads, barley bread, popcon, cereflakes, wheat germ, hidgear        |
| Refined grains               | White breads (farsh, baguettes), noodles, pasta, rice, toasted bread, sweet bread, white flour, starch, biscuits |
| Snacks                       | Potato chips, corn puffs, crackers, popcorn                              |
| Nuts                         | Peanuts, almonds, pistachios, hazelnuts, roasted seeds, walnuts           |
| Mayonnaise                   | Mayonnaise                                                                |
| Dried fruit                  | Dried figs, dried dates, dried mulberries, other dried fruit             |
| Olives                       | Olives                                                                   |
| Sweets and desserts          | Chocolates, cookies, cakes, confections                                  |
| Hydrogenated fats            | Hydrogenated fats, animal fats                                           |
| Vegetable oils               | Vegetable oils                                                           |
| Sugars, condiments           | Sugars, candies, gau, jam, jelly, honey                                  |
| Soft drinks, yogurt          | Soft drinks, dough (an Iranian yogurt preparation with a consistency similar to that of whole milk) |
| Breath                       | Breath                                                                   |

gies, fresh fruits, seafood, domestic fowl, tomato, grain, and low-fat dairy products), Western (processed animal meat products, various meats, processed grains, desserts, and deep-fried potatoes), and drinker (beer, wine beverages, hard liquor, and snacks).

The MD and Western patterns within this research tend to be much like the actual prudent and Western patterns described by Kim and Mueller (19), therefore, is similar to the healthy and Western patterns described by Hu et al. (20). Determining the actual relationship between dietary patterns and obesity is new. Nevertheless, it is recommended in order to see what types of dietary patterns can be found all over the world and to extend these types of patterns are based on the actual obesity epidemic. Within these studies, we identified a great opposite intimate relationship between the MD and Asian dietary pattern and the threat associated with obesity. This is in line with earlier described American (23) and European (24) studies. Various scientific studies determined that a dietary pattern seen as low-fat dairy, whole grains, and fresh fruit was involved inversely in alterations in BMI and WC in females (14, 22).

Inverse associations also have been reported between major dietary patterns characterized by whole grains, fruits, and vegetables with BMI and weight gain (25, 26). On the other hand, numerous studies have recorded no significant association (P = 0.49) between a healthy dietary pattern and BMI (27). This could be related to the self-reported weight and height within these studies. The Western dietary pattern appeared to be favorably related to the improved probability associated with common and central obesity. Both cross-sectional (28, 29) and prospective studies (30, 31) have indicated same findings previously. A fabulous “meat products” dietary pattern acquired with factor evaluation within a group of Hawaiian females was linked with a greater BMI (28). An optimistic relationship regarding the Western dietary pattern and being overweight was
Table 3. Partial Correlation Coefficients ($r$) for the Association Between Dietary Pattern Scores and Features of Overweight and Obesity Among Adolescents

| Western Pattern Score | Low Protein Score | Asian Pattern Score | Salty Pattern Score | Sweet Pattern Score | Traditional Pattern Score | Mediterranean Pattern Score |
|-----------------------|-------------------|---------------------|---------------------|---------------------|---------------------------|----------------------------|
| r                     | p                  | r                   | p                   | r                   | p                         | r                          |

**Without BMI Adjustment**

| Waist circumference   | 0.29               | 0.01               | 0.30              | 0.01               | 0.40                      | 0.02                      |
| Age/Sex               | 0.28               | 0.02               | 0.29              | 0.02               | 0.79                      | 0.01                      |
| Energy intake         | 0.47               | 0.006              | 0.34              | 0.006              | -0.53                     | 0.05                      |
| Physical activity     | 0.25               | 0.02               | 0.26              | 0.02               | -0.66                     | 0.04                      |
| Sleeping time         | 0.52               | < 0.001            | 0.51              | 0.005              | 0.43                      | 0.08                      |

**With BMI Adjustment**

| Waist circumference   | 0.08               | 0.37               | 0.19              | 0.06               | 0.008                     | 0.07                      |
| Age/Sex               | 0.00               | 0.22               | 0.29              | 0.01               | 0.007                     | 0.09                      |
| Energy intake         | 0.26               | 0.03               | 0.45              | 0.01               | 0.05                      | 0.06                      |
| Physical activity     | 0.38               | 0.01               | 0.17              | 0.05               | -0.05                     | 0.04                      |
| Sleeping time         | 0.08               | 0.04               | 0.05              | 0.03               | 0.07                      | 0.34                      |

Table 4. Multivariate Adjusted Odds Ratio (95% CIs) for Overweight and Obesity Across Quartile (Q) Categories of Mediterranean Pattern Scores

| Mediterranean Pattern | Q2               | Q4               | P Value for Trend |
|-----------------------|------------------|------------------|-------------------|
| Overweight            |                  |                  |                   |
| Model I               | 0.92 (0.64, 1.20)| 0.50 (0.27, 0.73)| < 0.01            |
| Model II              | 0.97 (0.70, 1.33)| 0.55 (0.29, 0.81)| < 0.01            |
| Model III             | 0.98 (0.71, 1.25)| 0.61 (0.31, 0.80)| < 0.01            |
| Model IV              | 0.99 (0.72, 1.22)| 0.65 (0.37, 0.93)| < 0.01            |
| Obesity               |                  |                  |                   |
| Model I               | 0.94 (0.54, 1.34)| 0.48 (0.15, 0.80)| < 0.01            |
| Model II              | 0.94 (0.59, 1.30)| 0.57 (0.20, 0.82)| < 0.01            |
| Model III             | 0.96 (0.62, 1.29)| 0.53 (0.23, 0.82)| < 0.01            |
| Model IV              | 0.97 (0.70, 1.23)| 0.56 (0.27, 0.84)| < 0.01            |

*Model I, adjusted for age and sex; model II, further adjusted for waist circumference and SES; model III, additionally adjusted for energy, physical activity, and sleeping time; model IV, additionally adjusted for BMI; overweight defined as ≥ 85th percentile; obesity defined as ≥ 95th percentile.*

documented specifically by Slattery et al. (29).

Within an eight-year prospective study among more than 50,000 adult women, the nurses’ health study (31) recorded that adoption of the Western dietary pattern is associated with greater weight gain. Higher intakes of meat and sweets, as seen within the Western pattern, were related to gaining weight on a two-year follow-up period among males and females within the European Prospective Investigation into Cancer (32, 33) and nutrition-potsdam study (30, 34). Generally, these results underscore the significance of a Westernized diet as well as a nutrition changeover within the challenging prevalence of obesity within developing countries.

The actual Iranian dietary pattern identified within this research was linked persistently with being overweight. Iranian eating habits, as they were obvious within our study, are extremely loaded with processed grains (white rice as well as bread), tea, potatoes, and hydrogenated fats. With one of these ingredients, one could assume to find an optimistic connection among this kind of dietary pattern and risk associated with obesity. Nevertheless, some food groupings such as legumes and whole fiber items have been further loaded within this dietary pattern that could interact with various food products within the
Table 5. Multivariate Adjusted Odds Ratio (95% CIs) for Overweight and Obesity Across Quartile (Q) Categories of Asian and Traditional Pattern Scores.

|                | Asian Pattern |                       | Traditional Pattern |                       | P Value for Trend | P Value for Trend |
|----------------|---------------|-----------------------|---------------------|-----------------------|-------------------|-------------------|
|                | Q2            | Q4                    | P Value for Trend   | Q2                    | Q4               |                   |
| Overweight     |               |                       |                     |                       |                   |
| Model I        | 0.76 (0.53, 0.90) | 0.77 (0.55, 0.92)      | < 0.01              | 1.01 (0.78,1.28)      | 0.95 (0.82,1.12) | < 0.05            |
| Model II       | 0.94 (0.81, 1.1) | 0.98 (0.84,1.12)       | 0.18                | 1.06 (0.82,1.20)      | 1.00 (0.89,1.07) | 0.16              |
| Model III      | 0.89 (0.71,0.98) | 0.86 (0.72,0.99)       | 0.07                | 1.08 (0.84,1.38)      | 1.01 (0.90,1.11) | 0.09              |
| Model IV       | 0.98 (0.90,1.31) | 1.2 (0.91,1.45)        | 0.11                | 1.12 (0.88,1.13)      | 1.02 (0.92,1.13) | 0.14              |
| Obesity        |               |                       |                     |                       |                   |
| Model I        | 0.61 (0.46,0.83) | 0.67 (0.49,0.85)       | < 0.03              | 0.99 (0.62,1.38)      | 1.05 (0.90,1.19) | < 0.04            |
| Model II       | 0.78 (0.60,0.91) | 0.81 (0.65,0.94)       | 0.31                | 1.02 (0.66,1.16)      | 1.09 (0.98,1.20) | 0.34              |
| Model III      | 0.50 (0.22,0.64) | 0.55 (0.25,0.66)       | 0.47                | 1.02 (0.68,1.16)      | 1.04 (0.96,1.14) | 0.5               |
| Model IV       | 0.83 (0.49,0.97) | 0.74 (0.48,0.99)       | 0.22                | 1.03 (0.70,1.12)      | 1.20 (1.04,1.49) | 0.33              |

*a Model I, adjusted for age and sex; model II, further adjusted for waist circumference and SES; model III, additionally adjusted for energy, physical activity, and sleeping time; model IV, additionally adjusted for BMI; overweight defined as ≥ 85th percentile; obesity defined as ≥ 95th percentile.

Table 6. Multivariate Adjusted Odds Ratio (95% CIs) for Overweight and Obesity Across Quartile (Q) Categories of Sweet and Low-Protein Pattern Scores.

|                | Sweet Pattern |                       | Low-Protein Pattern |                       | P Value for Trend | P Value for Trend |
|----------------|---------------|-----------------------|---------------------|----------------------|-------------------|-------------------|
|                | Q2            | Q4                    | P Value for Trend   | Q2                   | Q4               |                   |
| Overweight     |               |                       |                     |                      |                   |
| Model I        | 1.04 (0.79,1.30) | 1.00 (0.75,1.13)      | < 0.01              | 1.19 (0.99,1.32)     | 1.05 (0.81,1.30) | < 0.05            |
| Model II       | 1.06 (0.61,1.14) | 1.07 (0.67,1.49)      | < 0.01              | 1.28 (1.05,1.42)     | 1.17 (0.95,1.40) | 0.15              |
| Model III      | 1.08 (0.87,1.30) | 1.19 (0.85,1.66)      | < 0.01              | 1.70 (1.43,1.94)     | 1.61 (1.42,1.80) | 0.08              |
| Model IV       | 1.09 (0.85,1.19) | 1.30 (1.00,1.70)      | < 0.01              | 1.07 (0.86,1.28)     | 1.08 (0.87,1.13) | 0.12              |
| Obesity        |               |                       |                     |                      |                   |
| Model I        | 1.15 (0.71,1.87) | 1.37 (1.01,1.73)      | < 0.01              | 1.34 (1.16,1.58)     | 1.39 (1.18,1.6)  | < 0.05            |
| Model II       | 1.12 (0.42,1.95) | 1.4 (1.05,1.84)       | < 0.01              | 1.20 (0.94,1.46)     | 1.21 (0.95,1.5)  | 0.33              |
| Model III      | 1.25 (0.56,2.80) | 1.5 (1.04,1.90)       | < 0.01              | 1.83 (1.61,1.99)     | 1.85 (1.65,1.88) | 0.44              |
| Model IV       | 1.48 (0.61,1.59) | 1.6 (1.06,1.89)       | < 0.01              | 2.17 (1.96,2.42)     | 2.10 (1.94,2.22) | 0.27              |

*a Model I, adjusted for age and sex; model II, further adjusted for waist circumference and SES; model III, additionally adjusted for energy, physical activity, and sleeping time; model IV, additionally adjusted for BMI; overweight defined as ≥ 85th percentile; obesity defined as ≥ 95th percentile.

pattern in order to counteract their impact on obesity.

The dietary pattern approach is complementary to analyses using individual foods or nutrients, which are limited by biologic interactions and co-linearity among nutrients. The logic behind the dietary pattern approach is that foods and nutrients are not eaten separately, but are eaten in the form of specified dietary patterns. However, all statistical methods that have been used for data reduction have limitations. For example, using factor analysis for dietary data reduction has been criticized for its subjectivity in nature and for the difficulty of replicating the results in other populations (35). However, similar dietary patterns based on thorough factor analysis have been noticed in different populations. It seems that the dietary patterns identified in this Iranian populace resemble those in Western populations. This is actually unsurprising, due to the fact that, in the past several years, Iran has encountered a socioeconomic changeover paired with Westernization in eating habits as well as lifestyle (36-38).

Alizadeh et al. in a study in northern Iran, suggested that, among the six major dietary patterns, Asian-like food was the healthiest one (39). Bahreynian et al. found three important nutritional patterns in Iran: healthy, Western, and sweet-dairy (40). The study revealed that significant as-
Table 7. Multivariate Adjusted Odds Ratio (95% CIs) for Overweight and Obesity Across Quartile (Q) Categories of Western and Salty Pattern Scores

|                  | Western Pattern | Salty Pattern |                  |                  |
|------------------|-----------------|---------------|------------------|------------------|
|                  | Q2              | Q4            | P Value for Trend | Q2              | Q4            | P Value for Trend |
| **Overweight**   |                 |               |                  |                 |               |                  |
| Model I          | 1.15 (0.91, 1.40) | 1.69 (1.10, 2.04) | < 0.01           | 1.28 (0.90, 1.65) | 1.04 (0.82, 1.29) | < 0.01           |
| Model II         | 1.09 (0.85, 1.39) | 1.68 (1.08, 1.97) | < 0.01           | 1.25 (0.93, 1.57) | 1.40 (0.95, 1.81) | < 0.01           |
| Model III        | 1.08 (0.86, 1.36) | 1.67 (1.06, 1.89) | < 0.01           | 1.27 (0.94, 1.59) | 1.41 (1.32, 1.40) | < 0.01           |
| Model IV         | 1.07 (0.89, 1.32) | 1.50 (1.04, 1.90) | < 0.01           | 1.33 (0.96, 1.77) | 1.09 (0.88, 1.37) | < 0.01           |
| **Obesity**      |                 |               |                  |                 |               |                  |
| Model I          | 1.30 (0.88, 1.67) | 1.44 (1.03, 1.94) | < 0.01           | 1.44 (0.81, 1.33) | 1.34 (1.17, 1.53) | < 0.01           |
| Model II         | 1.24 (0.90, 1.55) | 1.37 (1.01, 1.73) | < 0.01           | 1.08 (0.84, 1.33) | 1.27 (0.94, 1.56) | < 0.01           |
| Model III        | 1.22 (0.91, 1.57) | 1.35 (1.00, 1.70) | < 0.01           | 1.07 (0.86, 1.35) | 1.88 (1.66, 1.89) | < 0.01           |
| Model IV         | 1.18 (0.87, 1.50) | 1.28 (0.90, 1.66) | < 0.01           | 1.01 (0.89, 1.33) | 2.01 (1.93, 2.31) | < 0.01           |

*aModel I, adjusted for age and sex; model II, further adjusted for waist circumference and SES; model III, additionally adjusted for energy, physical activity, and sleeping time; model IV, additionally adjusted for BMI; overweight defined as ≥ 85th percentile; obesity defined as ≥ 95th percentile.

Associations exist between the three dietary patterns among girls. The limitation of the sweet pattern, salty pattern, low-protein pattern, and Western pattern needs to be incorporated in a complex strategy for prevention of obesity.

There is an agreement between the findings of this study and numerous studies conducted on similar factors. Numerous limits should be regarded as within the presentation in our findings. We evaluated dietary patterns by using food consumption information only, even though the inclusion of consuming behaviors of, for instance, food as well as snack food habits within dietary pattern evaluation have been suggested (41). Furthermore, the limits of this FFQ affect dietary pattern analyses that depend on dietary information obtained with this method. One other issue in our research is its cross-sectional nature. Therefore, the actual relationship between these types of dietary patterns as well as being overweight or obese continues as being verified within prospective analyses.

5.1. Conclusions

Dietary pattern evaluation among teenagers provides essential information on dietary consumption within this populace. In addition, suggestions designed using this strategy tend to be clearer as well as much easier to follow. Longitudinal investigation can provide even further understanding of the actual aspect associated with modifying dietary patterns during teenagers’ changeover from adolescence to adulthood. Critical zones with regard to long-term investigation incorporate prospective evaluation of the connection among dietary patterns and obesity.

Acknowledgments

The authors express their deep appreciation to the Isfahan University of Medical Sciences through the fundamental research grant scheme (288259) for funding this project.

Footnote

**Authors’ Contribution:** Nimah Bahreini performed research and read final draft. Mohd Ismail Noor performed analysis and read final draft. Poh Bee Koon performed analysis and read final draft. Ruzita Abd Talib gathered data and read final draft. Syarif Husin Lubisc gathered data gathering and read final draft. Marjan Ganjali gathered data gathering and read final draft.

References

1. Haslam DW, James WPT. Obesity. *Lancet*. 2005;366(9492):1197-209. doi: 10.1016/s0140-6736(05)67483-4.
2. Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. *Epidemiol Rev*. 2007;29:62-76. doi: 10.1093/epirev/mxm003. [PubMed: 17478440].
3. Ayatollahi SM, Mostajabi F. Prevalence of obesity among schoolchildren in Iran. *Obes Rev*. 2007;8(4):289-91. doi: 10.1111/j.1467-789X.2006.00299.x. [PubMed: 17578179].
4. Popkin BM. The nutrition transition and obesity in the developing world. *J Nutr*. 2001;131(3):371S-38S. [PubMed: 11238777].
5. Popkin BM, Gordon-Larsen P. The nutrition transition: worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord*. 2004;28 Suppl 1:S2-S9. doi: 10.1038/sj.ijo.0802804. [PubMed: 15543214].
6. World Health Organization. Obesity: preventing and managing the global epidemic.; 2000.
23. Murtaugh MA, Herrick JS, Sweeney C, Baumgartner KB, Guiliano AR, Byers T, et al. Diet composition and risk of overweight and obe-
sity in women living in the southwestern United States. J Am Diet Assoc. 2007;107(8):1311-21. doi: 10.1016/j.jada.2007.05.008. [PubMed: 17659896].

24. Mendez MA, Popkin BM, Jacobsen A, Berenguer A, Tormo MJ, Sanchez MJ, et al. Adherence to a Mediterranean diet is associated with reduced 3-year incidence of obesity. J Nutr. 2006;136(1):2394-8. [PubMed: 17056825].

25. Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D, Willett WC. Prospective study of major dietary patterns and risk of coro-

nary heart disease in men. Am J Clin Nutr. 2000;72(4):921-2. [PubMed: 11009931].

26. Schulze M, Nothlings U, Hoffmann K, Bergmann MM, Boeing H. Identifi-
cation 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(5):1383-9. [PubMed: 15867301].

27. Kant AK. Dietary patterns and health outcomes. J Am Diet Assoc. 2010;110(4):645-5. doi: 10.1016/j.jada.2010.01.001. [PubMed: 20154348].

28. Maskarinec G, Novotny R, Tasaki K. Dietary patterns are asso-
ciated with body mass index in multiethnic women. J Nutr. 2000;130(12):3068-72. [PubMed: 11010871].

29. Slattery ML, Edwards SL, Boucher KM, Anderson K, Caan BJ. Lifestyle and colon cancer: an assessment of factors associated with risk. Am J Epidemiol. 1999;150(8):369-77; [PubMed: 10522658].

30. Schulz M, Kroke A, Liese AD, Hoffmann K, Bergmann MM, Boehing H. Food groups as predictors for short-term weight changes in men and women of the EPIC-Potsdam cohort. J Nutr. 2002;132(6):3335-40. [PubMed: 12042455].

31. Schulze MB, Fung TT, Manson JE, Willett WC, Hu FB. Dietary pat-
terns and changes in body weight in women. Obesity (Silver Spring). 2006;14(6):1444-53. doi: 10.1038/oby.2006.164. [PubMed: 16988088].

32. Neda GD, Rabeta MS, Ong MT. Chemical composition and anti-
proliferative properties of flowers of Clitoria Ternatea. Int Food Res J. 2013;20(1):7.

33. Rabeta MS, Chan S, Neda GD, Lam KI, Ong MT. Anticancer effect of uner-
utilized fruits. Int Food Res J. 2013;20(2):2.

34. Salleh RM, Dashii NG, Thong OM. Proximate Analysis and Anti-
proliferative Properties of Vitis negundo L. Sains Malaysiana. 2014(34)(10):3543-7.

35. Martinez ME, Marshall JR, Schlesd R. Invited commentary: Factor analysis and the search for objectivity. Am J Epidemiol. 1999;150(8):369-77; [PubMed: 10522658].

36. Galal O. Nutrition-related health patterns in the Middle East. Asia Pac J Clin Nutr. 2007;16(3):337-41. doi: 10.14150/apjcn.2007.337.

37. Ghassemi H, Harrison G, Mohammad K. An accelerated nutrition tran-

tion in Iran. Public Health Nutr. 2002;5(1):149-55.

38. Panel E. Clinical guidelines on the identification, evaluation, and treat-
ment of overweight and obesity in adults. National Heart, Lung, and Blood Institute; 1998.

39. Azadbakht L, Esmaillzadeh A. Dietary and non-dietary determi-
nants of central adiposity among Tehran women. Public Health Nutr. 2008;11(5):528-34. doi: 10.1079/phn2008000882. [PubMed: 17764804].

40. Rezaeipour A, Youssefi F, Mahmoudi M, Shakeri M. Relationship
between Adolescents’ Nutritional and Physical Activity Behaviors with their Perceptions about Parents’ Lifestyle Behaviors. Hayat. 2007;13(3):17-25.

41. Fung TT, Rimm EB, Spiegelman D, Rifai N, Tofler GH, Willett WC, et al. Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. Am J Clin Nutr. 2001;73(3):687-7.

42. Kim JA, Kim SM, Lee J, Oh HJ, Han JH, Song Y, et al. Dietary patterns and the metabolic syndrome in Korean adolescents: 2002 Korean Na-
tional Health and Nutrition Survey. Diabetes Care. 2007;30(7):1904-5. doi: 10.2337/dc07-0259. [PubMed: 17416789].

43. Esmaillzadeh A, Mirrnan P, Azizi F. Whole-grain intake and the prevalence of hypertension in a cohort of urban adults in Tehran. J Am Coll Nutr. 2005;24(1):55-63. [PubMed: 15940460].

44. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

45. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.

46. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

47. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.

48. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

49. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.

50. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

51. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.

52. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

53. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.

54. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heysmfield SB, et al. Comparisons of waist circumference measures at 4 sites. Am J Clin Nutr. 2003;77(2):579-84. [PubMed: 12450397].

55. Kim JO, Muller CW. Factor analysis: Statistical methods and practical issues. 14. Sage; 1978.