Original articles

Major Dietary patterns among female adolescents with eating disorders: A factor analysis approach

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Summary *Aim:* Present study was conducted to determine major dietary patterns among female students as major factors in preventing eating disorders. *Methods and Material:* In this cross-sectional study, 515 samples were detected through 2766 female students who were selected by a multistage random sampling from 5 distinct of Tehran and assessed for having eating disorders. A two-stage procedure including screening using Eating Attitude Test-26 questionnaire and a semi structured questionnaire based on Diagnostic & Statistical Manual of Mental disorders, 4th ed. diagnostic criteria was used to diagnose eating disorders. All participants fulfilled a modified version of the Body Shape Satisfaction Scale and a qualitative food frequency questionnaire. Dietary patterns were defined using factor analysis and three interpretable factors were obtained. Then, people were categorized based on their dietary patterns' scores quartiles. To identify the association between dietary patterns and eating disorders, logistic regression was used in three models. *Findings:* Using factor analysis, three major dietary patterns were obtained: High carbohydrate- High fat pattern, High Proteins- High fat pattern and High Fibre-Low fat pattern. Findings showed that the Odds ratio of eating disorder reduced in high protein- high fat pattern and after adjustment of confounding factors, this reduction is still remained significant. Odds ratio of eating disorder is increased in high fibre- low fat dietary pattern significantly in all models. *Conclusions:* It seems that odds of eating disorders is higher in adolescents who follow a high fibre – low fat (vegetarian) dietary pattern and lower in adherence to "high protein-High fat" dietary pattern.

Key words: eating disorders, major dietary pattern, factor analysis, female, adolescent

Introduction

Eating disorders are a group of food and nutrition related diseases in which dramatic changes occur in eating behaviours and predominantly during adolescence for the first time, mostly in girls. The symptoms of eating disorders are mainly due to pathological fear of being overweight or obese and their diagnostic criteria are based on psychological, behavioural and physiological characteristics (1-4). Epidemiological studies reported the prevalence of partial syndrome of eating disorders among adolescent from 0.8-14% (5). Prevalence of bulimia nervosa and partial syndrome among Iranian female adolescents has been reported 2.1% and 6.5%, respectively(6).

In these patients, weight preoccupation cause a range of misbehaviours includes severe restriction of energy intake on voluntary, self starving and unusual eating patterns. This may result in inappropriate intake of nutrients and malnutrition that could affect adolescents' health status via different mechanism (7, 8). The results of the studies have shown menstrual disorders, decreased bone mineral density, reduced height growth, delayed puberty in addition to Calcium, Iron,

Zinc, Copper, Magnesium, and C , A, D, E, B_1, B_2, B_6, B_9 and B_{12} Vitamins deficiencies in these patients resulting from limiting food and calorie intake(2, 5, 9).

Only a few data is available about the intake pattern of patients with eating disorders and limited conducted studies just assessed their nutrient intake. This traditional approach won't be able to identify the relation between food intake and disease, because of ignoring the interactions of foods and nutrients and confounding effect eating habits. So this approach is substituted nowadays by "dietary pattern analysis" method that was provided in 1986 by Jacobson and et .al (10). In this method, food items are put in a "factor" based on the degree of their correlation while factors are totally independent to each other; then, using leaner combination of variables (food items) for each factor, each people is given a "food score" which can be used in logistic regression analysis to examine the relation of disease with dietary patterns. Actually, dietary patterns make it possible to identify the whole diet and not its ingredients. So, it will be easier to design and implement nutritional intervention in the form of changes in dietary patterns and will be more successful (11-12).

Studies on "dietary pattern" around the world as well as Iran have been focused mainly on adults and a few studies assessed dietary pattern of children and adolescents(13). Up to date, no study has been investigated the dietary patterns among patients with eating disorders, so the present study was conducted to determine the major dietary pattern of adolescent girls with eating disorders in Tehran, Iran as a basic step to design appropriate nutritional intervention to prevent eating disorders.

Material and Methods

In this descriptive cross-sectional study, 2766 female high school students were selected with a stratified random sampling from 5 distinct of Tehran regarding to pupils population in each distinct. Then, a two-stage approach were used to diagnose eating disorders among them and 515 individuals, all diagnosed eating disorders(n=231) and 284 healthy, were entered study.

In this study 25 food groups were considered for factor analysis and while it requires at least 10 samples for each variable (food groups), at least 250 samples was needed. According to the 515 samples analyzed in this study, sample size was adequate for factor analysis.

This study was approved by "The ethics committee of National Nutrition and Food Technology Research Institute".

Data collection tools

In present study, a demographic questionnaire were used to gathering data about number of family members, parents' job, education and their marital status and students' date of birth, parity and their age at menarche.

In addition, for screening and identification of suspected samples, Farsi translation of EAT-26 questionnaire was used that its reliability and validity have been verified by Dezhkam and colleagues (14). Responses of EAT question are classified based on the Likert scale and for each statement, always, usually and often, gets 3, 2 and 1 point respectively. Three remaining options were "sometimes", "rarely" and "never" are zero-rated. Thus, EAT-26 scores can be from zero to 78 and score of 20 or higher indicates a possible eating disorder.

Also a semi structured questionnaire that was prepared and validated by Dezhkam and colleagues based on DSM-IV diagnostic criteria was used to diagnose eating disorders(14). On the basis of DSM-IV criteria, anorexia nervosa is defined by «Refusal to maintain body weight at or above a minimally normal weight for age and height, intense fear of gaining weight or becoming fat, disturbance in the way one›s body weight or shape is experienced, in postmenarcheal females, amenorrhea, i.e., the absence of at least 3 consecutive menstrual cycles»(15). Bulimia nervosa is defined by «recurrent episodes of binge eating characterized by eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances with a sense of lack of control over eating during the episode, in addition to recurrent inappropriate compensatory

behaviour to prevent weight gain, such as self-induced vomiting, misuse of laxatives, diuretics, enemas, or other medications, fasting, or excessive exercise. The binge eating and inappropriate compensatory behaviour both occur, on average, at least twice a week for 3 months»(15). Eating disorder not otherwise specified includes disorders of eating that do not meet the criteria for the above two eating disorder diagnoses. Examples include: «For female patients, all of the criteria for Anorexia Nervosa are met except that the patient has regular menses or despite significant weight loss, the patient›s current weight is in the normal range or all of the criteria for Bulimia Nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur less than twice a week or for less than 3 months or the patient has normal body weight and regularly uses inappropriate compensatory behaviour after eating small amounts of food»(15).

To determine body satisfaction, a modified version of the Body Shape Satisfaction Scale was used in which satisfaction with ten different body parts (height, weight, body shape, waist, hips, thighs, stomach, face, body build, shoulders) were administered and scored with a five Likert scale, ranging from one point for "very dissatisfied" to five points for "very satisfied" and classified as weak, medium and good based on tertiles of obtained scores (16-17). To investigate physical activity level, a valid questionnaire for adolescent that includes four questions was used(18). Responses are classified based on the Likert scale as the most active choice scored 4 and less active scored 1 in each question. The tertiles of total score were considered as high, medium and low physical activity. To investigate usual dietary intake, a valid (19), semi-quantitative FFQ included 168 food items was used but because of time limitation for fulfilling questionnaires at school and special characteristics of eating disorders, according to other studies on food consumption in this age group, mentioned questionnaire merged and modified to a qualitative FFQ questionnaire including 70 items. Content validity of this new questionnaire confirmed by group of experts and Cronbach's Alpha was used to determine its reliability (r=0.68).

Study procedure

To implement study, all the students completed Demographic and EAT 26 questionnares in first phase. Then screening questionnaire were rated and samples with high risk of eating disorders were defiened (n=578). In the second phase, all these high risk samples fullfiled the diagnostic questionnaire of eating disorders which was supplemented with a short interview by a trained expert to ensure the correction of answers. Thus, no case of anorexia nervousa, 59 cases of bulimia nervosa and 178 cases of eating disorders not otherwise specified (EDNOS), totally 237 preson were diagnosed with eating disorder which Food Frequency Questionnaire (FFQ) questionnaire was completed for 231 of them with interview by an expert. 293 students with screening score less than 15 selected randomly and after the completion of diagnostic questionnaire to ensure lack of eating disorders, were selected and 284 of them fullfiled FFQ questionnaire in same method. The Procedure is shown in Figure 1.

Anthropometric measurments

Weight and height of selected samples were measured using standard methods by a trained expert. Weight was measured with a portable digital scale (Seca), with an accuracy of 10 g and height was meas-
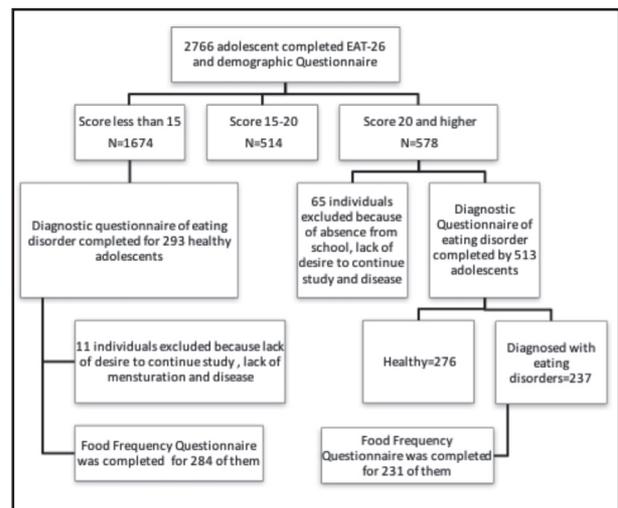
Figure 1. Procedure of screening and diagnosis of eating disorders among female students of Tehran, Iran

ured with a non-elastic tape measure with a precision of 0.1 cm. Then BMI was calculated and underweight (≥5th), overweight (85th-95th) and obesity (≥95th) were defined compared to BMI for age of CDC2000 for adolescents (20-21).

Data analysis:

Data were analyzed using SPSS (Version 18) and dietary patterns were defined using factor analysis. In order to perform factor analysis, due to the large number of food items in the food frequency questionnaire, food items were categorized to 25 "Food Groups" (Table 1) based on the similarity of their nutrients content or their culinary usage and according to previous studies(11). If a food item had a unique nutrient profile or its consumption indicated a distinct food pattern, considered individually as a food group. Principal Component Analysis (PCA) with Varimax rotation was used to extract independent dietary patterns and based on Eigen value more than 1.6 and using Scree test, three interpretable factors were retained. Loading factor equal or more than 0.3 was considered to determine items of each dietary pattern according to previous studies and scores of each people were calculated based on loading factors and food items in each factor (12, 22). Then, people were categorized based on their dietary patterns' scores quartiles. To identify the association between dietary patterns and eating disorders, the data of both groups (with and without eating disorders) were analyzed together and logistic regression was used in three models: in first model, effect of age, age at menarche and weight status, in second model previous variables in addition to body satisfaction and physical activity and in third model, effect of all variables including age, age at menarche and weight status, body satisfaction, Physical activity, parity, parents marital status, parents job and education were modified. First quartile of dietary patterns' score was determined as reference in all models (11, 23). Demographic characteristics were defined as mean and standard deviation for quantitative variables and percent for qualitative ones. One way ANOVA were used to compare means between groups of quantitative variables and Chi square and fisher exact test were used to compare the frequency of qualitative variables. Data normality was checked using Kolmogorov–Smirnov test before

analyzing. Anthropometric data were analyzed using Epi-info.

Results

General charactersistics

Result showed that Mean±SD of age was 15.63±0.91 and age at menarch was 12.61±1.21 years among studied population. Also the Mean±SD of their weight, height and body mass index was 60.54±12.02 (Kg), 160.92±6.07 (Cm) and 23.37±4.42 (Kg/m²), respectively. No significant difference was observed between these groups (Bulimia, EDNOS and Normal) regarding these variables.

Body mass index status of samples has been shown in chart 1, and no significant difference observed between groups in this regard.

Chart1- Frequency of Body mass index distribution among 515 female students

The most frequent parity was "first" (45.5%), and most of them (48.8%) were belonged to "four members" families. Majority of their parents were living together (80.1%). Assessing their parents hob showed that the most frequency of their father job was self-employee and Majority of mothers was housewives. The most frequent level of parents' education was high school Diploma, 51.1% and 39.23% in fathers and mothers, respectively. Using Qi-square, no statistical significance was observed between eating disorders and these variables.

Assessing their body satisfaction revealed that 12.8% of them had low satisfaction, 53% medium satisfaction, and 34.2% were well satisfied with their bodies.

Major Dietary Patterns

Using factor analysis among studied population, three major dietary patterns were identified and named
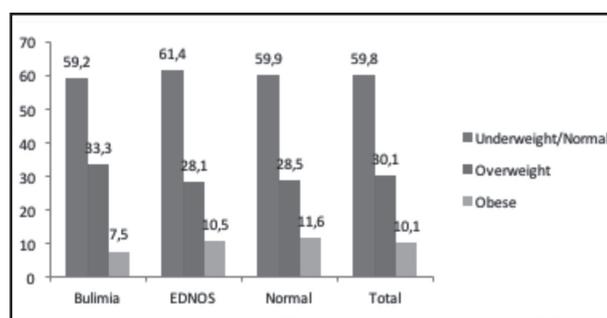
Figure 2.

based on their dominant macro nutrients as:

- High carbohydrate-high fat pattern including high consumption of rice, corn, French fries, salty snacks, confectionary products, mayonnaise, fast food.
- High protein-high fat pattern including high consumption of Other cereals, red meat, fish, egg, organ meat, dairy products, nuts, olive and olive oil, saturated fat.
- High fiber-low fat pattern including avoidance

of rice and high consumption of vegetables, sour snacks, fruits, nuts and dried fruits.

Table 1 is showing the "factor loading" of food items in each of patterns. These three patterns totally represent %26.4 of the variance explained. Indeed, some other dietary patterns were identified too, but due to the low variance explained by these models were not considered in other analyzes. As the dietary patterns defined by factor analysis are formed on the basis of association between

Table 1.   Loading factor of food groups in extracted dietary patterns

Food Groups	High carbohydrate, High fat	High Protein, High fat	High fibre, Low fat
Salted snacks	0.683	-0.042	0.090
Fast foods	0.646	-0.063	-0.038
Mayonnaise	0.620	0.157	0.001
French fries	0.509	0.112	-0.050
Confectionary Products	0.447	0.008	0.035
Boiled corn	0.353	0.287	0.080
Hydrogenated fat	0.353	0.458	-0.148
Rice	0.303	0.200	-0.373
Dairy products(Regular and low-fat)	-0.153	0.580	0.087
Red meats	0.025	0.517	0.006
Cereals	0.258	0.457	-0.157
Olive and olive oil	-0.216	0.386	0.297
Fish	0.098	0.385	0.176
Egg	0.001	0.370	0.004
Organ meats	0.198	0.359	0.009
Nuts	0.242	0.315	0.419
Dried fruits	0.173	-0.064	0.705
Sour snacks	0.249	-0.166	0.624
Vegetables	-0.079	0.230	0.521
Fruit and fruit juice	0.091	0.258	0.382
Potato(boiled or grilled)	-0.037	0.252	0.212
Legumes	0.003	0.273	0.218
High fat dairy products	0.227	0.030	0.041
Poultry	0.157	0.055	0.124
Tea	0.206	0.043	0.073
% Variance	12.06	7.89	6.48

Factor loading values greater than 0.3 is considered

food items (rather than similarity between dietary patterns of individuals), so all the subjects are present in all patterns with different scores.

As it is shown in Table 2, odds ratio of eating disorders is different in quartiles of High carbohydrate- high fat pattern, as it is decreased in the second quartile to the first. In 3rd and 4th quartiles, although there is a slight increase in odds ratio compares to the second quartile, odds ratios are still lower than first quartile. The same pattern is observed in odds ratio values in all models and after adjusting the effect of confounding variables.

Odds ratio of eating disorders is decreased in high protein- high fat pattern. Although after adjusting for confounding variables, odds ratio in second quartile was not significant, but a significant decreasing trend is observed in all other quartiles of all models.

Odds ratio of eating disorders is increased significantly in quartiles of high fibre- low fat pattern and although the odds ratio is not significant in second quartile of any of these models, but its trend of increasing is significant.

Discussion

In the present study, using factor analysis, three major dietary patterns were identified among the population: "**high carbohydrate and high fat**" pattern include salty snacks, fast food, mayonnaise, French-fries, confectionary products, corn and rice, "**high protein, high fat**" pattern includes saturated fat, other grains, low-fat or regular dairy products, red meat, olives and olive oil, fish, eggs, organ meats and nuts and "**high fibre and low fat** " pattern which includes rice (negative relationship), nuts, dried fruits, sour snacks, vegetables and fruits. All three models showed a significant relationship with eating disorders after adjusting for confounding variables.

In the most of studies which have examined dietary patterns, food items are classified in patterns under titles like «unhealthy or western» versus «healthy or traditional» patterns which include items like olives, nuts, and fish (24-27). Dietary patterns obtained in present study do not exactly follow this classification,

Table 2. Linear regression analysis of the association between dietary patterns and eating disorders

Quartiles of Dietary Patterns					P-Value Trend
	First	Second	Third	Forth	
High carbohydrate, High fat					
Crude	1	0.43(0.26-0.73)	0.50 (0.3-0.85)	0.59(0.35-0.98)	0.007
Model 1	1	0.44(0.25-0.77)	0.53(0.31-0.92)	0.62(0.36-1.07)	0.009
Model 2	1	0.46(0.26-0.81)	0.53(0.30-0.93)	0.67(0.38-1.18)	0.039
Model 3	1	0.39(0.21-0.71)	0.50(0.28-0.91)	0.60(0.33-1.08)	0.017
High Protein, High fat					
Crude	1	0.61(0.36-1.01)	0.40(0.24-0.68)	0.34(0.20-0.57)	<0.0001
Model 1	1	0.54(0.31-0.94)	0.38(0.22-0.66)	0.32(0.19-0.57)	<0.0001
Model 2	1	0.60(0.34-1.04)	0.37(0.20-0.66)	0.35(0.19-0.62)	0.001
Model 3	1	0.59(0.33-1.06)	0.38(0.21-0.70)	0.35(0.19-0.64)	0.002
High Fibre, Low fat					
Crude	1	1.67(0.98-2.85)	2.48(1.45-4.24)	3.18(1.86-5.44)	<0.0001
Model 1	1	1.61(0.91-2.84)	2.38(1.35-4.17)	3.19 (1.8-5.66)	<0.0001
Model 2	1	1.70(0.94-3.06)	2.24(1.25-4.01)	2.78(1.53-5.05)	0.005
Model 3	1	1.72(0.93-3.19)	2.53(1.37-4.65)	2.74 (1.47-5.1)	0.005

Model 1: Justified for weight status, age and age at monarch; Model 2: Justified for weight status, age, age at monarch, body satisfaction and Physical activity; Model 3: Justified for weight status, age, age at monarch, body satisfaction, physical activity, family size, parity, parents' marital status, parents' job and education

as it›s «high-carbohydrate, high-fat» patterns is some how similar to «unhealthy» pattern because of food items such as mayonnaise, French-fries, confectionery products, corn and rice in the form of refined grains. But «high protein-high fat» pattern is a mixture of both «unhealthy» and «healthy» patterns because of including food items such as red meat, eggs, organ meats along with olives, cheese, milk, nuts, and fish; and in the third pattern, «high fibre, low fat», although it is some how similar to «healthy» pattern in other studies because of including fruits, vegetables and nuts, but it lacks some basic food items mentioned in these models, such as dairy, poultry or legumes.

In fact, «high fibre, low fat» resemble to «vegetarian» pattern because of lacking animal foods or could called «snack» pattern as it›s food items (fruit, dried fruit, nuts) are mainly consuming as snacks.

While using factor analysis, numbers of variables enter analysis and the number and name of factors are determined by researchers, so dietary patterns are not iterative and comparison between studies are difficult, especially among communities with different diets.

This difference between patterns also may be due to the different nature of eating disorders. This means that people with eating disorders have a two-dimensional attitude regarding foods and as they have fear of obesity, according to their own perception of «fattening», categorize foods to «good or bad» and «permitted or prohibited» and select their food in this way rather than noticing the effects of food on their health(28-29). In other words, they think about content of macronutrients in their diet rather than fibre content or using suitable oils which result in formation of different dietary patterns.

In the present study, «high-carbohydrate, high-fat» pattern showed an inverse relationship with eating disorders. «Food avoidance» pattern in female with eating disorders was first described in 1965 as «carbohydrate Phobia». Studies showed that restrictive anorectic female have symptoms of «carbohydrate starvation» and their carbohydrate consumption is low or non existent. These patients expressed strong hatred of all fattening foods; especially avoided starch, sweets and desserts(28). However, strict avoidance of sugar and starch is not the constant characteristics of eating disorders. In being eating episodes, anorectic and bulimic peoples consume different types of snacks and desserts(28). This may be

the reason that not any specific «trend» was observed in quartiles of «high carbohydrate» food pattern in present study. Similar to these findings, the attitude of «getting fat by consuming carbohydrates» in Greek society has also been reported by Yannakoulia and colleagues, as with increasing the risk of eating disorders, less energy was supplied by carbohydrates(30).

In present study, an inverse relationship was observed between eating disorders and «high protein-high fat» pattern. Findings of other studies indicate fat aversion among people with eating disorders (28, 31-34). Vaz and colleagues compared food aversions of people with eating disorder with a control group and showed that aversion of foods with high quality protein content (meat, fish, milk and eggs) was characteristic of patients with eating disorders(35). In another study, da Costa and colleagues reported lower intake of protein and calcium among adolescent with eating disorder in compare to control group(36).

A significant relationship was observed in present study between «high fibre-low fat» pattern which was free of confectionery products, fats and starchy carbohydrates and eating disorder. Specially, low consumption of rice in this pattern is considerable. Although studies that have conducted in recent years, mention that the total calorie intake and not macronutrient composition is effective in weight control (37-40), but the Iranian society widely accepted the old belief that restricting carbohydrate intake, especially rice is an effective way to lose weight(41) and it is clearly visible in this pattern.

«High fibre-Low fat» dietary pattern in present study is also similar to vegetarian diet. In a study that was conducted on female adolescents, Chang and colleagues reported lower intake of energy, protein, carbohydrate, zinc, vitamin B6 and vitamin B12 and higher intake of raw and dietary fiber in adolescent with disordered eating patterns(42). Micali and colleagues assessed dietary intake, food frequency and dietary pattern of pregnant women with life time eating disorder in a longitudinal study. Their results showed that in compare with control group, women with eating disorder had higher score in «vegetarian» dietary pattern. They consumed less amount of meat that was compensated by soy products(43). So far there is no proof for the causal relationship that why people with eating disorders often eliminate meat from their diet (32, 44-45).

Present study had some limitations: first of all, samples were restricted to females. Second, in this study, dietary patterns were evaluated only on the basis of dietary intake; whereas some researchers believe that nutritional behaviour, such as pattern, time and number of snacks and meals should also be considered. In addition, in assessing dietary intake using the food frequency questionnaire, errors such as measurement error on the total number of food items or some of them may be exist. Therefore, it is recommended that the relationship between food consumption and eating disorders evaluate in prospective studies with larger sample size including both male and females and in different subtypes of disorder.

In conclusion, it seems that following high fibre and low fat dietary pattern (with avoidance of rice and high consumption of vegetables) increase the odds of eating disorders among adolescents and they are more likely to involve unhealthy weight control behaviours. In contrast, adherence to dietary pattern high in protein (e.g. dairy, meat, fish products) and fat (e.g. nuts, olive and olive oil) might be associated with reduced odds eating disorders among this group. Further studies are required to confirm our findings.

Acknowledgement

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