Factor analysis – Eating patterns among khat chewers

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ABSTRACT

Objectives: Khat is a green leafy plant that grows in many countries, including in the southwest of Saudi Arabia. It is estimated that one third of the people in Jazan chew khat, and the majority are males. The objective of this study was to identify the dietary patterns among khat-chewing students of Jazan University. Methods: A cross-sectional descriptive analytical study was conducted at Jazan University. A total of 620 khat-chewing students participated in the study. Food intakes were collected through a food frequency questionnaire (FFQ). Dietary patterns were assessed by exploratory factor analysis based on the intake of the 17 food groups. A principal component analysis for factor extraction followed by varimax rotation was used. Results: Based on the Kaiser criterion and the scree plot, factor analysis identified three patterns that accounted for 70.2% of the variability within the sample. The first factor (starch) was characterized by rice, bread, pizza, potato, traditional food, burger, snacks, and hot drinks. The second factor (meat products/fruit) included meat products, poultry, fish, cool drinks, and fruit. The third factor (dairy products/vegetables) included dairy, low-fat and fat-free dairy, fat, and vegetables. Conclusion: The present study identified dietary patterns among khat-chewing students via factor analysis. It is now important to identify a correlation between specific patterns and health status to implement dietary interventions.

Keywords: Dietary patterns, factor analysis, food frequency questionnaire, kaiser criterion, khat, scree plot

Introduction

A diet is composed of a mixture of foods with complex nutritional combinations that are likely to interact. Dietary patterns can be derived using proper statistical approaches to assess the combined influence of food intakes and capture total diet. Identification of dietary patterns provides a comprehensive method to explore eating habits, which allows researchers to study the link between dietary patterns and nutrition-related diseases to develop well-balanced dietary guidelines. Khat (Catha edulis) is a green leafy plant native to the Arabian Peninsula’s southwest corner, as well as eastern and southern Africa. Khat consumers are numerous in Ethiopia, Yemen, Somalia, Afghanistan, Israel, and the southern part of Saudi Arabia. Khat chewers prefer to eat its fresh leaves, swallow the fluid and remove the rest in every sitting. They chew 100–500 gm of khat per session for an average of 3–4 h/day. The proportion of male khat chewers is higher than the female in Jazan region of Saudi Arabia. Use of Khat is associated with an increased risk of multiple health issues. Among khat chewers stress, anxiety, and depression were very common. Khat was not only found to boost the chewer’s mood, but it also caused alertness, hypertension, tachycardia, and decreased appetite. In fact, Khat farmers use harmful chemicals and pesticides, which can cause cancer and endocrine disturbances, suppression of the immune system, and gastrointestinal diseases. The most common diseases in the Jazan region are hypertension, bronchial asthma, diabetes, and joint diseases. The majority of these diseases can be prevented by following healthy dietary patterns. Primary care
physicians play crucial roles to alleviate those health-related problems caused by chewing khat. In addition, khat chewers think that high-calorie foods must be consumed to keep their satiety for an extended period of time. Because they chew khat for at least 5 h/session, this procedure is utilized to keep their satiety for a long time while they chew it.\[15\] The people in Jazan, who interact with a lot of khat chewers, have noticed that they consume a lot of high-calorie foods right before chewing khat. As a result, assessing the dietary patterns of khat chewers is essential to avoid nutrition-related disorders. To identify the dietary patterns, studies have used two general approaches: first, food variables were grouped based on prior knowledge or theory of a healthy diet.\[16,17\] Second, dietary patterns were obtained via statistical modeling of dietary data allowing for hypothesis-generating analyses. A widely used posterior method for identifying dietary patterns is factor analysis. This approach accounts for the entire variance of the correlation matrix. The aim of this method was used to transform a major set of related variables into a minor set of non-correlated variables, which are called principal components or factors.\[18\] To sum up the data, factor analysis originates the scopes that, when interpreted, it will clearly illustrate the data into a smaller number of items than with individuals.\[19,20\] The objective of the present study was to identify the dietary patterns in khat-chewing students using factor analysis.

**Subjects and Methods**

This is a cross-sectional descriptive analytical study, where a validated food frequency questionnaire (FFQ)\[21\] was distributed among khat-chewing students at Jazan University, between September and November 2019. Male and female students were included. There were no exclusion criteria in this research except those who do not chew khat. The study was approved by the university committee for ethics in research and financially supported by the Deanship of Scientific Research, Jazan University, KSA.

**Dietary data**

Dietary intake data was collected using a validated FFQ.\[21\] The FFQ list contained 85 food items and food groups. Each subject in the study was asked to provide their food intake for every item of the FFQ. The frequencies of individual food items of the FFQ were converted into a quantity of servings per week (_servings/week).\[22,23\] The frequency value “6+ times daily” was converted to “49 times/week,” “5–6 times daily” was converted to “42 times/week,” “2–4 times daily” was converted to “28 times/week,” “once daily” was converted to “7 times/week,” “5–6 times/week” was converted to “6 times/week,” “2–4 times/week” was converted to “4 times/week,” “once weekly” was converted to “1/week,” and “1–3 times/month” was converted to “0.75 times/week.”

**Statistical analysis**

The dietary patterns were assessed by exploratory factor analysis of the 17 food groups. Factor analysis is a common term for multivariate statistical analysis that is applied to identify the factors in a set of measurements. This technique considers all variables at the same time. Initially, Cronbach’s alpha index was obtained to assess the reliability/internal consistency of the data. The correlation structure for the food groups with the lower diagonal coefficients was prepared to assess the relationship between the food groups. To verify the suitability of using factor analysis, the sample’s homogeneity was determined by looking at the distribution of the variables in a loading plot, comparing the observed values to those predicted by a normal distribution. A component extraction method with varimax rotation was applied to reduce the data components in principal component analysis. The data adjustment was confirmed by a Kaiser–Meyer–Olkin (KMO) measurement of sample adequacy and Bartlett’s Test of Sphericity (BTS), which determines whether there are any correlations between the variables.\[28\] Principal item analysis was applied for factor extraction. This approach investigates the spatial distribution of the objects to classify the groupings and the relationships between them. The extracted first factor will explain the greatest potential variance in the data set. Independently, the second factor accounts for the maximum potential share of the remaining ones, with no correlations between the factors.\[20,24\] The Kaiser criterion considers the optimal number of factors. It is also called the eigenvalue rule or scree plot, which shows the total variance related to each factor. The correlations between the obtained independent factors and the food groups were examined after orthogonal rotation using the varimax method.\[25,26\] Factor loadings of >1.1 were chosen as significant. The negative loadings suggested an inverse relationship between the food group and the factor. In contrast, the positive value suggested a direct relationship. The factor loadings plot enabled the interpretation by observing the food groups in a system of coordinates formed by the factors. The analysis was implemented using Statistical Package for Social Science (SPSS). P value <0.05 was considered as statistically significant.

**Results**

Six hundred and twenty khat-chewing students agreed to answer the questionnaire, of whom 504 (81.3%) were in the age group 20–29 years, 96 (15.5%) were ≥30 years, and only 20 (3.2%) of the students were <20 years. In terms of gender, 496 (80.0%) of the students were males, while only 124 (20.0%) female students participated in the study. The most frequently consumed food and beverages items were bread (4.58 servings), cold drinks (4.35 servings), traditional foods (Massoub/Aseeda) (4.19 servings), dairy products (3.92 servings), rice/macaroni/corn (3.69 servings), hot drinks (3.56 servings), poultry (3.53 servings), burgers (3.46 servings), snacks (3.43 servings), pizza and pastries (3.41 servings), low-fat dairy (3.15 servings), vegetables (3.10 servings), potatoes (2.89 servings), fruits (2.83 servings), fish (2.81 servings), fat (2.61 servings), and meat products (2.21 servings). Among the meat products, meat with broth was more frequently consumed than kabsa, grilled meat, kebab meat, camel meat, and beef. Simple sugar sources, such as bread, cold drinks, traditional
foods, or rice/macaroni/corn were among the most consumed food and beverage items. Figure 1 shows the mean number of consumed food items/week.

**Dietary components**

The observed KMO test value was 0.874, which meant that the sample was revealed to be sufficient for factor analysis. Three factors were found through factor analysis, based on both the Kaiser Criterion and scree plot [Figure 2]. These three factors accounted for >70% of the variability within the sample. The first factor, which represented 29% of total variance, was named Starch. Rice, bread, pizza, potato, traditional food, burger, snacks, and hot drinks were characterized as a Starch factor. The second factor, which represented 23% of the total variance, was named meat products/fruit. Meat product, poultry, fish, cool drinks, and fruit were characterized as the second factor. The third factor, which represented 18% of the total variance, was named dairy/vegetables. Dairy, low-fat and fat-free dairy products, fat, and vegetables were characterized as the third factor. Table 1 shows the factor loadings acquired after Varimax rotation. Figure 3 shows the principal component analysis with derived factors. The food groupings and their relationships with the factors can be perceived.

### Discussion

The present study was conducted to explore the dietary patterns among khat-chewing students of Jazan University, Kingdom of Saudi Arabia, using factor analysis. Three patterns, RC1 (starch), RC2 (meat products/fruit) and RC3 (dairy products/vegetables) were identified, which explained 70% of the variance of the sample. The first factor, RC1 (starch), was described by the presence of rice, bread, pizza, potato, traditional foods, burger, snacks, and hot drinks. These foods represented the typical traditional Saudi diet and were the highest contribution among the factors. A study in Rio de Janeiro also observed a food pattern that described the prevalent consumption of rice and beans, which is considered traditional Brazilian diet. The second factor, RC2 (meat products/fruit), was characterized by the presence of meat products, poultry, fish, cold drinks, and fruit. Similarly, Yagin et al. studied the correlations of the dietary

| Food Group          | RC1   | RC2 Meat products/fruit | RC3 Dairy products/vegetables |
|---------------------|-------|-------------------------|-------------------------------|
| Meat Products       | 0.212 | 0.863                   | 0.107                         |
| Poultry             | 0.075 | 0.793                   | 0.043                         |
| Fish                | 0.209 | 0.782                   | 0.188                         |
| Rice/Macaroni/Corn  | 0.657 | 0.353                   | 0.384                         |
| Bread               | 0.668 | 0.321                   | 0.271                         |
| Pizza/Pastries      | 0.792 | 0.339                   | 0.191                         |
| Potatoes            | 0.815 | -0.022                  | 0.227                         |
| Traditional Foods   | 0.759 | 0.164                   | 0.082                         |
| Burgers             | 0.809 | 0.162                   | 0.254                         |
| Dairy               | 0.344 | 0.013                   | 0.858                         |
| Low-Fat/Fat-Free Dairy | 0.321 | 0.073                   | 0.868                         |
| Fat                 | 0.196 | 0.129                   | 0.887                         |
| Snacks              | 0.702 | 0.459                   | 0.345                         |
| Hot Drinks          | 0.643 | 0.364                   | 0.126                         |
| Cold Drinks         | 0.372 | 0.707                   | -0.025                        |
| Fruit               | 0.391 | 0.650                   | 0.123                         |
| Vegetables          | 0.048 | 0.455                   | 0.498                         |

*Extraction Method: Principal Component Analysis

| % Explained Variance | % Cumulative Variance |
|----------------------|-----------------------|
| 29.1                 | 22.8                  |
| 29.1                 | 51.9                  |
| 70.2                 | 70.2                  |

*Figure 1: Mean weekly consumption of foods and beverages of khat chewers

*Figure 2: Scree plot showing eigenvalues for each component, in factor extraction of data obtained from a FFQ answered by 620 students
patterns in overweight and obese women and described that tea, fish, poultry, and sugar were characterized by the Iranian traditional food pattern. The third factor RC3 (dairy products/vegetables) was characterized by the presence of dairy, low-fat and fat-free dairy products, fat, and vegetables. Likewise, Yagin et al.[28] considered a healthy Iranian pattern as characterized by the presence of vegetables, low-fat dairy, and red meat. Sichieri described the dairy products group as a Western dietary pattern.[27] Dietary studies are hampered by the vast number of highly correlated variables, and traditional classification methods could result in inaccurate estimates. The multivariate method is a viable option to evaluate the individual variables,[29] because identifying patterns helps researchers to look at the overall influence of the diet and describe the correlations with diseases that are not covered by specific nutrients. Identified patterns could be used as co-variables to observe whether the effect of a given food is independent of dietary patterns.[30‑32] It is also worth remembering that people obtain nutrients via the foods they eat, which is impacted by a range of demographic, cultural, and societal factors. Using patterns to describe food intake could be valuable in establishing educational programs. Instead of changing nutrient intakes, such programs could try to change the intake of easily recognized foods.[33] The patterns identified in this study differed from the results from other studies that were focused on general populations.[29‑35] Furthermore, patterns are evaluated based on their food items and corresponding loadings. It is not surprising that the results are not replicated across communities with varied eating habits because the food patterns are drawn based on data acquired among the observed population. This method requires the researchers to take decisions at several stages of the model, which may lead to skewed results in terms of the variables included in the study, the number of factors kept, and factor interpretation.[30,36] Based on prior studies utilizing comparable criteria, the variables in this investigation were categorized by likeness in terms of nutrients value.[30‑33] Moreover, the extracted three factors from the current study accounted for >70% of the total variances. Moreover, if the food patterns did not represent the maximum variance in overall food consumption, it is unlikely to explain their utility in nutritional epidemiology.[32] In addition, dietary pattern analysis is ineffective for examining the association between nutrients and diseases because it is not designed for this purpose. When the traditional technique that focuses on nutrients identifies only a few clear connections with diseases, pattern analysis may be informative.[31] Khat chewers care less about their health compared to non-chewers,[10] khat plants contain harmful substances,[12] and the present study found that chewers consumed high-carbohydrate foods. As a result, these factors will increase the risk of khat chewers’ health problems. Hence, this emphasizes the high need of health-care providers to get involved in such community.

Figure 3: Principal component analysis with derived factors
Limitations

Although the sample size was high, it was taken solely from the students. Hence, further research should consider the entire region of Jazan to generalize the outcomes. Recommendations suggest establishing the association between dietary patterns and nutrition-related diseases to provide a concrete nutrition intervention.

Conclusion

The current study explored the dietary patterns among khat-chewing students via factor analysis. It is important to identify the correlations between food patterns and the onset of diseases. Once these connections are established, dietary interventions can be developed.

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Ethical approval

This study was ethically approved by the Standing Committee for the Ethics of Scientific Research at Jazan University. All participants had the opportunity to consent and agree to participate in the study.

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Conflicts of interest

There are no conflicts of interest.

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