



The effects of the relationship between psychological status and nutritional status on success in adolescent students with canonical correlation analysis

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Abstract

The primary aim of this study is to determine statistically significant relationship between nutrition and psychological status in adolescent students with the help of canonical correlation analysis, and then to reveal whether nutritional and psychological status of adolescents with gender has an effect on their educational success by using logistic regression analysis. Nutritional status and psychological status variable sets were created by using the Demographic Information Form, Beck Depression Inventory, Beck Anxiety Inventory, Conners-Wells Adolescent Self-Report Scale and Food Frequency Questionnaire (FFQ), and antropometric measurements. These assessments were applied face-to-face to the students with their consent and the scales were filled in by themselves. In the canonical correlation analysis, the variable set for Nutritional Status (U), were represented with body mass index (BMI) and also energy, iron, folic acid and calcium that were obtained by entering the FFQ into the Nutrition Information Systems (BeBiS Program). On the other hand the Psychological Status (V) variable set consisted of Beck depression scale, Beck anxiety scale and Conners-Wells scale scores. Finally, students' success levels were determined by taking their grade point averages over the e-school system of the Ministry of National Education for educational success. According to the canonical correlation analysis; the variable that contributed the most to the Nutritional Status (U) variable set was Body Mass Index while the variable that contributed the most to the V variable set was the Beck Depression Scale Score. The canonical correlation coefficient between the U and V variable sets was 22.4% and it was found statistically significant ($p < 0.05$). In the logistic regression analysis, the dependent variable was educational success, which was categorized the grade point average as successful or unsuccessful with cut-off points 60, then gender, U and V were taken as the independent variables. The result of the logistic regression analysis was determined as that gender and V had significant effects on the educational success in adolescents ($p < 0.05$).

Keywords: adolescent, nutritional status, psychological status, canonical correlation analysis, educational success

1. Introduction

Adolescence is defined as the age range of 10-19 by the World Health Organization (WHO). It is a special period that covers the transition from childhood to adolescence and in terms of biological change and development, it has significant potential (1). Current epidemiological findings predict that one in five children is expected to develop some type of mental health problem when they reach adulthood, and that 50% of all adult mental health problems occur during adolescence (2). In this period, adolescents continue to develop not only in physically, but also cognitively and psychosocially (3).

Adolescence generally begins at the age of 12-13 in girls and 14-15 in boys (4). Since girls enter the adolescence period on average 2 years before than boys and complete the adolescence period 2 years earlier than boys on average,

therefore physical and mental changes in this period also differ according to gender (5). In this period, it is known that the nutritional status of adolescents changes according to their psychological status, or similarly, their nutritional status affects their psychological status (6).

The main statistical analyzes used in our study are canonical correlation analysis and logistic regression analysis. Canonical correlation analysis is one of the multivariate statistical methods that aims to maximize the relationship between variable sets, each of which has more than one variable (7). Logistic regression analysis is used modelling discrete and continuous independent variables when the dependent variable is categorical (8).

In this context, the aim of our study is to determine statistically significant relationship of the nutritional status

and the psychological status variables of adolescent students by using canonical correlation analysis and to reveal whether nutritional and psychological status with gender have an effect on their educational success.

2. Materials and Methods

This study, is a cross-sectional study, which was conducted in the 2018-2019 academic year. It was carried out in 4 randomly selected state high schools in Istanbul, two of them were on the European side and the others were on the Anatolian side. 451 adolescent students participated to this study, the students filled the Demographic Information Form, Beck Depression Scale, Beck Anxiety Scale, Conners-Wells Adolescent Self-Report Scale and FFQ by themselves in the hours recommended by the school administration. This study is approved by local ethical committee with the approval number 09.2019.938.

The variables as energy, iron, folic acid and calcium obtained from the entry of the FFQ into Nutrition Information Systems (the BeBiS program). This nutrient which was considered deficient and necessary in the nutrition status of adolescents in the Turkey Dietary Guidelines 2016 (9) and National Turkey Nutrition and Health Survey (TNHS) 2010 reports (9) with BMI, were selected for the Nutritional Status (X) variable set. Daily energy recommendation is an average of 2500 calories for adolescent girls and 3000 calories for adolescent boys. Daily recommendation is 330 mg for folic acid and 1150 mg for calcium. Daily iron recommendation is an average of 11 mg for girls and 13 mg for boys (10).

Beck depression scores, Beck anxiety scores, and Conners-Wells scores were considered as the variables, which expressed the Psychological Status (Y) variable set.

The success of the students was determined by taking their grade point averages over the e-school system of the Ministry of National Education and the grade was categorized as successful or unsuccessful with cut-off points 60. Adolescent students with a score of 60 and above were considered successful and those with less than 60 points as unsuccessful.

2.1. Scales Used in the Study

Food Frequency Questionnaire: It is a questionnaire used to categorize certain foods consumed and the frequency of consumption of these foods such as fruit, vegetables, milk and dairy products, etc. Food consumption frequency questionnaire contains also questions about portion size and cooking methods (11).

Nutrition Information System (BeBiS Program): It is a program where all foods consumed including beverages were entered according the consumption amount and frequency, then daily energy, macro and micro nutrient etc. amounts can be determined (12). In our study, the foods that adolescent students reported in the FFQ questionnaire what they consume according to the meal information with their consumption frequency and amount were entered into the

BeBiS (v8.2) software, then daily energy, water, carbohydrate, protein, fat, etc. quantities have been obtained.

Beck Depression Scale: This scale is developed by Beck et al. in 1961 and used to measure the emotional, somatic, cognitive and motivational symptoms of depression. It is a scale that shows the level or severity of depression by choosing the sentences that best express oneself in the last week, including the day of the application. A high score indicates the severity of depression. Turkish validity and reliability studies of the scale were performed by Hisli et al. in 1988 (13).

Beck Anxiety Inventory: This scale is developed by Beck et al. in 1988 and used to measure the frequency of anxiety symptoms. It is a self-assessment scale within the last week, including the day of application. A high score on the scale indicates the level of anxiety experienced by the person. The validity and reliability studies of the Turkish version of the scale were performed by Ulusoy et al. in 1993 (13).

Conners-Wells Adolescent Self-Report Scale: This scale was developed by Conners et al. in 1997. It consists of Conduct Disorder, Cognitive Problems and Hyperactivity subscales which aims to evaluate behavioral disorders, attention deficit and hyperactivity problems in adolescents. It is based on the self-evaluation of individuals aged 12-17 according to the last month. A high score from the Conners-Wells Adolescent Self-Report Scale indicates that the adolescent has the same level of problems as described in this scale. The validity and reliability studies of the Turkish version of the scale were performed by Kaner et al. in 2012 (14).

2.2. Canonical Correlation Analysis

Canonical correlation analysis is a reducing dimension method. It is a method based on the aim of maximizing the correlation between canonical variable pairs (U, V) formed by linear combinations of variable sets with more than one variable, in other words, examining the relationship between two variable sets consisting of more than one variable (15). Some assumptions are needed to be provided for the implementation of this analysis (16). These assumptions have to be multivariate normal distribution of the data, minimum error in terms of the relevant variables, no multicollinearity between the variables, and a fairly large sample size (20 times the number of variables) for reliability of the analysis results.

The mathematical representation of canonical correlation analysis can be expressed as follows:

Let there be two sets of independent variables X with p observations and Y with q observations,

$$X = X_1 + X_2 + \dots + X_p,$$

$$Y = Y_1 + Y_2 + \dots + Y_q$$

$$a_{i1}.X_{i1} + a_{i2}.X_{i2} + \dots + a_{ip}.X_{ip} = U_i \rightarrow \rho_i \leftarrow V_i = b_{i1}.Y_{i1} + b_{i2}.Y_{i2} + \dots + b_{iq}.Y_{iq}$$

The equation giving the correlation between the U and V canonical variables can be expressed as follows;

$$\rho_{u,v} = \frac{Kov(U,V)}{\sqrt{Var(U)Var(V)}}$$

2.3. Logistic regression analysis

Logistic regression analysis is an analysis based on the logarithm of probability, odds and odds ratio where the independent variables are continuous or discrete when the dependent variable is a categorical variable (17).

The logistic regression model can be written as follows for p independent variables (18).

$$L = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1.X_1 + \dots + \beta_p.X_p$$

In logistic regression analysis, the significance of the model is tested with the Omnibus chi-square test and the model is expected to be statistically significant (p<0.05). Nagelkerke R² is expressed as the percentage of independent variables explaining the dependent variable, and if it is close to 1, it means that the model is well determined (18). The efficiency of the best model created to explain the dependent variable gives the goodness of fit (19). In other words, it is the harmony between the observed value and the expected value in the dependent variable, and the Hosmer-Lemeshow statistics are used for this purpose (20). The fact that the result of this test was not found to be statistically significant (p>0.05) indicating that the model and data fit well (17). The percentage of correct classification shows how accurately the model classifies the dependent variable.

3. Results

451 adolescent students between the ages of 16-20 participated in the study. The descriptive characteristics of these students, defined as the “adolescent period”, are given in Table 1.

It was determined that 53.2% (n=240) of the 451 adolescents participating in the study were girls. There was a significant difference between boys and girls for the average height and body weight, respectively (p<0.0001, p< 0.0001). In nutritional status variables; there was no significant difference between boys and girls for BMI and for the percentage amount of energy and iron that meet the known requirement (p>0.05), on the other hand; significant differences were observed between boys and girls for the percentage of meeting daily folic acid and calcium recommendations (p<0.0001) (Table 1).

In the psychological state variables; while there were statistically significant differences between boys and girls for Beck depression and Beck anxiety (p<0.0001), but there was no significant difference between boys and girls for Conners-Wells (p>0.05).

Table 1. Descriptive statistics

	Total (n=451)	Girls (n=240)	Boys (n=211)	
Variables	Mean ± SD	Mean ± SD	Mean ± SD	p*
Characteristic Features				
Height (cm)	166.5 ± 8.6	160.8 ± 5.9	173.0 ± 6.3	
Body weight (kg)	62.5 ± 13.2	57.8 ± 11.0	67.8 ± 13.5	
Age (year)	16.8 ± 0.7	16.7 ± 0.6	16.9 ± 0.8	
Nutritional Status Variables (X₁)				
BMI (kg/m ²)	22.5 ± 4.1	22.4 ± 4.1	22.6 ± 4.1	0.586
Energy (kcal)	2998.0 ± 917.8	2760.4 ± 913.0 (110.4%)**	3268.3 ± 847.5 (108.9%)**	0.630
Folic acid (g)	379.3 ± 140.9	337.6 ± 124.0 (102.3%)**	426.7 ± 144.2 (129.3%)**	<0.0001
Calcium (g)	1152.8 ± 426.2	1061.7 ± 426.4 (92.3%)**	1256.3 ± 402.6 (109.2%)**	<0.0001
Iron (g)	15.3 ± 5.8	13.6 ± 5.4 (124.1%)**	17.1 ± 5.8 (131.9%)**	0.080
Psychological Status Variables (X₂)				
Beck Depression	13.6 ± 9.8	15.6 ± 10.2	11.2 ± 8.7	<0.0001
Beck Anxiety	14.3 ± 10.7	17.0 ± 11.0	11.2 ± 9.5	<0.0001
Conners-Wells	12.1 ± 6.0	12.1 ± 5.4	12.1 ± 6.6	0.990

*p values express the statistical significance of the difference between the means according to the characteristics of interest among the gender.

**Values shown in parentheses are the percentage of adolescents' meeting recommendation.

According to the results of canonical correlation analysis, the 1st canonical correlation coefficient was found as 0.224 and statistically significant with p=0.022. This means that there was a 22.4% relationship between nutritional status canonical variable set (U) and psychological status canonical variable set (V).

The linear canonical variable sets of nutritional status and psychological status were as follows.

The equation of the first canonical variable of the Nutritional Status variable set;

$$U = (-0.124)*BMI + (-0.001)*Energy + (0.011)*Folic Acid + (0.001)*Calcium + (-0.075)*Iron.$$

The variable that contributes the most to the canonical variable of nutritional status was body mass index and contributes approximately 12%. This negative contribution indicates that the nutritional status of adolescents with an increased body mass index was adversely affected.

The equation of the first canonical variable of the Psychological Status variable set;

$$V = (-0.095) * \text{Beck Depression Scale} + (0.009) * \text{Beck Anxiety Scale} + (-0.036) * \text{Conners-Wells Scale}.$$

The variable that contributes the most to the canonical variable of psychological status is the Beck depression score with a 10% contribution.

In the logistic regression analysis, the effects of nutritional

Table 2. Logistic regression analysis output

	β Coefficient	Standard Error	Wald Statistics	p value	Odds Ratio	%95 C.I. Exp(B)	
						Lower	Upper
Gender	1.197	0.246	23.683	0.0001	3.309	2.044	5.358
Psychological Status (V)	0.328	0.102	10.372	0.001	1.389	1.137	1.696
Constant	1.081	0.228	58.069	0.0001	2.948		

According to the omnibus test result, this regression model was found to be statistically significant ($p < 0.001$). The Nagelkerke R^2 value, which is expressed as the percentage of independent variables explaining the dependent variable, was found to be approximately 10% (0.103). Hosmer-Lemeshow test, which expresses the goodness of fit of the model, was $p = 0.704$ then it can be said that the model-data fit at a sufficient level. Finally, the percentage of correct classification was found to be 74.5%.

4. Discussion

The significant relationship between nutritional status canonical and psychological status canonical variables of adolescents was found as 22.4% where the 1st canonical correlation coefficient was taken into account, according to the result of the canonical correlation analysis.

When it was taken into account of the nutritional problems and nutritional needs of adolescents; the variables as folic acid, calcium and iron which were taken for nutritional status canonical variable (U), were not found deficient in our study sample, contrary in TBSA 2010-2019 report. Besides, in all scales, the psychological status of adolescent students was not at alert level, generally. In a study, the adolescence period has positive effects on the mental health of boys, while depression and anxiety disorders are higher in girls (21). At the same time, in another study when the psychological status of adolescents compared between gender, it was observed that the mean score of psychological symptoms was higher in girls than in boys (22). In our study, the fact that adolescent girls were more depressive and anxious compared to boys, therefore it was consistent with the results of the studies mentioned.

The strenght of this study was to use logistic regression analysis, combining with the canonical correlation analysis. Once the significant relationship between nutritional status canonical variable (U), psychological status canonical variable (V) was determined, then to perform logistic regression these canonical variables were used with gender on

status canonical variable (U) and psychological status canonical variable (V) with gender were examined on educational success of the adolescents. While the nutritional status canonical variable (U) was not statistically significant on the educational success of adolescents ($p > 0.05$), but gender (OR= 3,309; %95 C.I.: 2,044 – 5,358) and psychological status canonical variable (OR= 1,389; %95 C.I.: 1,137 – 1,696) were found as significant variables respectively ($p < 0.0001$, $p < 0.0001$) Table 2.

educational success. If educational success were analyzed separately for individual nutrition and psychological variables; some variables might have been found statistically insignificant in univariate analyzes and thus these insignificant variables can not take place in multiple logistic regression analysis. However, the canonical correlation analysis creates the canonical variables, by using every variable in nutrition and psychological variable set even they have small contribution by assigning with a certain weight. In other words, by this way, all variables considered were included in the logistic regression analysis with some weight (23).

Although Nagelkerke R^2 value, which is the percentage value of gender and psychological status canonical variable (V) explaining the educational success of adolescents, was low - about 10%- but it could be cited as the weaknesses of this study. One reason might be that this study was a screening study and the other reason might be that the adolescent students have been filled all the forms and scales based on their own declaration. It can be said that gender is more effective on educational success than psychological status canonical variable and girls were 3,309 times more successful than boys. In addition, there is a statistically significant difference in terms of gender for Beck depression and Beck anxiety levels. Valid and reliable enough sample size is one of the assumptions of the canonical correlation analysis, 451 adolescents participated in this study that the results of the study findings could be considered reliable and valid. By this way the condition, that the sample size should be at least 20 times of the variable number, was satisfied (24).

Although canonical correlation analysis was used rarely in health sciences but it is also happened across in some studies. Erkorkmaz et al. (2013) titled "Examination of the Relationship Between Children's Eating Behaviors and Parents' Nutrition Styles Using Canonical Correlation Analysis", were used canonical correlation analysis in their article. In another study, Çetin et al. (2015), titled "The Role of Five Factor Personality Traits in Explaining Psychological

Resilience: A Canonical Relationship Analysis” reported that the use of multivariate statistical methods, such as canonical correlation analysis which explains the relationship patterns of the variables in the selected variable sets, is highly considerable method in health sciences.

As a result, instead of comparing educational success status with the variables in the nutritional status and psychological status variable sets separately, it would be better to use canonical correlation analysis, which is the main analysis of our study. Because it is not correct to have an idea about the nutritional status of an adolescent by looking at only for a significant variable such as calcium or iron etc. Likewise, the same for the psychological status; if the Beck depression scale was not found statistically significant between successful and unsuccessful adolescent students but the two other scores as Beck Anxiety Scale and Conners-Wells Scale were found significant. Thus, it will not be easy to deduce a definite idea about psychological status.

For this reason, instead of comparing the variables in the sets of nutrition and psychological status with educational success one by one, it will be more reliable and valid to compare the new canonical variables obtained by the canonical correlation analysis with educational success. These new canonical variables are a linear combination of variables nutritional status and psychological status variable sets and the canonical variables are linearly formed with the contribution of each variable in the variable set. This analysis also increases the importance of the estimation results obtained by logistic regression analysis.

Conflict of interest

None to declare.

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None to declare.

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