Original article

Evaluation of Nutrient Intake in Bipolar Disorder I Patients According to Body Mass Index Level: A Pilot Study

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Summary. *Background*: Bipolar disorders (BD) are severe psychiatric disorders defined by variable mania or hypomania attacks, depression, or mixtures of manic and depressive features. Bipolar disorder I (BDI) is associated with obesity and nutrition. *Objectives*: To determine the nutritional status and evaluate the anthropometric measurements of BDI patients at Samsun Mental Health and Diseases Hospital. *Subjects and methods*: This case-controlled study was carried out among 50 BDI patients and 38 normal healthy volunteer individuals. Food frequency questionnaire was applied to the participants and anthropometric measurements were determined. Biochemical tests were retrospectively performed. *Results*: The mean energy, protein, and Omega 6 intake of the BDI group was significantly higher than the control group ($p < 0.05$). The mean waist circumference, waist/height ratio, and the frequency of obesity in the BDI group were statistically higher than the control group ($p < 0.05$). Hemoglobin, triglyceride, CRP, and T3 were significantly higher in the BDI group compared to the control group ($p < 0.05$). Protein, lipid, carbohydrate, and fiber intake of the individuals differed according to their health status ($p = 0.016$, $p < 0.001$, $p < 0.001$, $p = 0.007$, respectively). At the same time, the interaction between health status and BMI levels was also significant ($p = 0.019$). *Conclusions*: The data obtained may help assess the nutrition of BDI patients. Nutritional assessment should be a part of the plan of care in BDI patients.

Key words: Bipolar disorder, diet, obesity, body mass index, psychiatry

Introduction

Bipolar disorders (BD) are severe psychiatric disorders defined by variable mania or hypomania attacks, depression, or mixtures of manic and depressive features (1). Essential diagnostic features of bipolar disorder I (BDI) include having at least one lifetime manic episode and this manic episode not being due to medication, substances, or any medical illness (BDI) (2). BDI affects an individual's quality of life and functions due to its chronic and fluctuating nature. For this reason, the treatment of BDI should last throughout the course of life (3).

This disorder is seen in approximately 60 million people around the world and is a serious cause of disability and burden on the global scale (3, 4). According to a meta-analysis, the prevalence of BDI was 1.06% in the general population in China (5). The frequency of lifetime BDI in America is 1% (6, 7). In another meta-analysis, the prevalence of BDI in primary care was 1.9% (3). No significant differences were found in prevalence or incidence, depressive episodes, symptoms, and response to treatment in bipolar disorder between different sexes (8).

The etiology of BDI is not entirely clear. Genetic and environmental risk factors like medication expo-

sure, substance abuse, neuroendocrine and neurotransmitter dysfunctions, stressful life or lifestyle, metabolic syndrome, and binge-eating comorbidity play a role in the development of the disease (9, 10). Nutrition also has an effect on the maintenance of mental health and the prevention of mental diseases. When diet patterns of individuals with BD were examined, BD patients showed poorer eating habits and difficulty adopting healthy lifestyles (11). There may be complex mechanisms playing a role in nutrition, weight management, and relationship with mental health diseases (12). BDI is associated with obesity, overweight, and abdominal obesity (13). Additionally, the prevalence rates of obesity are higher in the bipolar disorder group than the general population and range from 20% to 49% (10, 14). In a study carried out on 9125 respondents, the lifetime diagnosis of BDI was significantly associated with obesity. This association was stronger for BDI that was present in the last 12 months (15). Similarly, in an analysis performed with 86,028 participants, the patients with BDI had significantly higher rates of obesity than those individuals without BDI (16).

BDI symptoms may also cause obesity. The mechanisms of this include biological, psychological, and sociodemographic factors. For instance, medications that lead to weight gain, depressive symptoms, or low levels of physical activity can act as risk factors for obesity in BDI patients (17). One of the hypotheses for the association between BDI and obesity shares similar characteristics like overeating, sleep disturbance, low physical activity, and a balance between energy intake and expenditure. The second hypothesis is that BDI and obesity have neurobiological abnormalities such as dysfunction in the hypothalamic-pituitary-adrenal axes and neurotransmitter systems. The last one is the association of weight gain with biological effects that improve mood (13). In other words, the relationship between nutrition and bipolar disorder (BD) is multidimensional and can be dealt with from different perspectives. This study was conducted to identify the nutritional status of BDI patients and to evaluate their anthropometric measurements at Samsun Mental Health and Diseases Hospital.

Subjects and Methods

This case-controlled study was carried out among 50 patients aged 18 years and over. The BDI participants were diagnosed by using the DSM-IV-TR diagnostic criteria and they underwent treatment with medication at Samsun Mental Health and Diseases Hospital between April 2017 and April 2018. The control group consisted of 38 healthy volunteer individuals without a diagnosis of mental disorders or a history of mental disorders in the family, and with age and gender characteristics similar to the patient group.

A questionnaire consisting of 3 parts (general and demographic characteristics, dietary habits, and anthropometric measurements) was applied to all the participants. The data were collected by using face-to-face interview method. The cases were at hospital for treatment. The control group consisted of individuals who visited the hospital. The targeted number of participants was reached according to the G-power analysis. The protocol for the study was approved by the Institutional Review Board and Ethics Committee of Acıbadem University (Project No: 2017-7/22) on April 20, 2017, confirming that it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh, 2000). Written informed consent was given to the volunteer participants. The exclusion criteria included bariatric surgery, diabetes, pregnancy, cancer history, and being aged below 18. Having a mental illness was also included in the exclusion criteria only for the control group.

Dietary intake assessment

The food frequency questionnaire consisting of 81 items was applied to the participants for dietary assessment. Food portions were determined using a picture booklet (18). The answers of the questionnaire were closed-ended, with one option selected. The frequencies of foods consumed in days, weeks, months, or years were determined as quantity. The intakes of energy and nutrients were calculated with a computerized food analysis program adapted to Turkey (BEBIS

7.2) (Nutrition Information System, Istanbul, Turkey) by dieticians who conducted the study.

Assessment of anthropometric measurements

Anthropometric measurements were determined according to the WHO criteria. Body weight, height, waist, and hip circumferences were measured and the BMI was calculated (BMI = body weight (kg)/height (m^2)). Waist-to-hip and waist-to-height ratios were also calculated. The waist circumference of the participants, the narrowest diameter between the arcus costarum and the processus spina iliaca anterior superior, was measured by the researcher with a tape measure held parallel to the ground at the navel. Body weight measurements of the participants were recorded with light clothes by Tanita Body Composition Analyzer UM-073. Height was measured in a standing position at Frankfort plane using a stadiometer (Seca 206).

Biochemical measurements

Routine biochemical profile was retrospectively evaluated through blood analysis for 3 months. Biochemical tests were performed for hemoglobin (Hg), total cholesterol, high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), triglyceride (TG), serum fasting plasma glucose, folic acid, vitamin B-12, triiodothyronine (T3), thyroxine (T4), thyrotrophin stimulating hormone (TSH), and c-reactive protein (CRP) at the laboratory of Samsun Mental Health and Diseases Hospital.

Statistical analysis

Descriptive statistics were used to determine the group included in the study. Since the number of observations per group was over 30, a two-independent samples t-test was used for group comparisons. Two-way ANOVA was used to evaluate the factors of health status and body mass index (BMI) and the interaction between them. The assessment of the dietary intakes of the participants according to health status and BMI was examined only for significant factors. In the bipolar patient group, multiple linear regression analysis was performed using the backward method for the BMI dependent variable. Data analysis was performed using the SPSS (The Statistical Package for Social Sciences) version 23.0 (IBM SPSS Statistics 23.0). Statistical significance was tested at the level of $\alpha=0.05$.

Results

In the bipolar group, 46% of the participants had primary school education and 78.9% of the control group were university graduates. Also, 89.5% of the control group and 32.0% of the bipolar group were married. The control group consisted of government officials; on the other hand, 46% of the bipolar group were unemployed (Table 1).

The median age of the diagnosis was 25.5 in males and 26.0 in females with BDI. In the BDI group, 35% of the males (n = 7) and 63% of the females (n = 17) had a history of bipolar disorder in the family (Figure 1). The mean age of the control group and the BDI group was 38.18 ± 8.09 and 39.34 ± 10.90, respectively (unshown data).

The mean energy intake of the BDI group was significantly higher than the control group (2073.40 kcal, 1584.61 kcal; $p < 0.05$). The protein intake of the BDI group compared to energy (17.52%) was significantly higher than the control group (19.55%). The fat intake was found to be similar for the BDI (30.70%) and control groups (29.34%).

Omega 6 intake was significantly higher in the BDI group than energy intake (5.17%) compared to the control group (3.92%) ($p < 0.05$). Carbohydrate intake was similar to energy intake for the BDI and control groups, 51.74% and 51.13%, respectively. Fiber consumption was 25.26 g and 21.5 g for the BDI and control groups. The intake of vitamin B-12, B-6, and folate was 5.64 μg and 4.72 μg, 1.61 mg and 1.36 mg, and 376.51 μg and 306.45 μg for the BDI and control groups, respectively (Table 2).

As shown in Table 3, the mean waist circumference (97.5 cm) and waist/height ratio (0.6) in the BDI group were statistically higher than the control group (85.0 cm and 0.5, respectively). In parallel with these

Table 1. Distribution of the sociodemographic characteristics of the participants

		BD I (n:50)		Control (n:38)	
Sociodemographic characteristics		**n**	**%**	**n**	**%**
Age	20-29	7	14.0	7	18.4
	30-39	22	44.0	13	34.2
	40-49	11	22.0	16	42.1
	50-59	8	16.0	2	5.3
	60-70	2	4.0	0	0
Education	Primary school	23	46.0	-	-
	Junior high school	9	18.0	-	-
	High school	9	18.0	6	15.8
	University	9	18.0	30	78.9
	Master degree	-	-	2	5.3
Marital status	Married	16	32.0	4	10.5
	Single	21	42.0	34	89.5
	Divorced	13	26.0	-	-
Occupation	Officer	9	18.0	38	100.0
	Housewife	23	46.0	-	-
	Insured employee	18	36.0	-	-

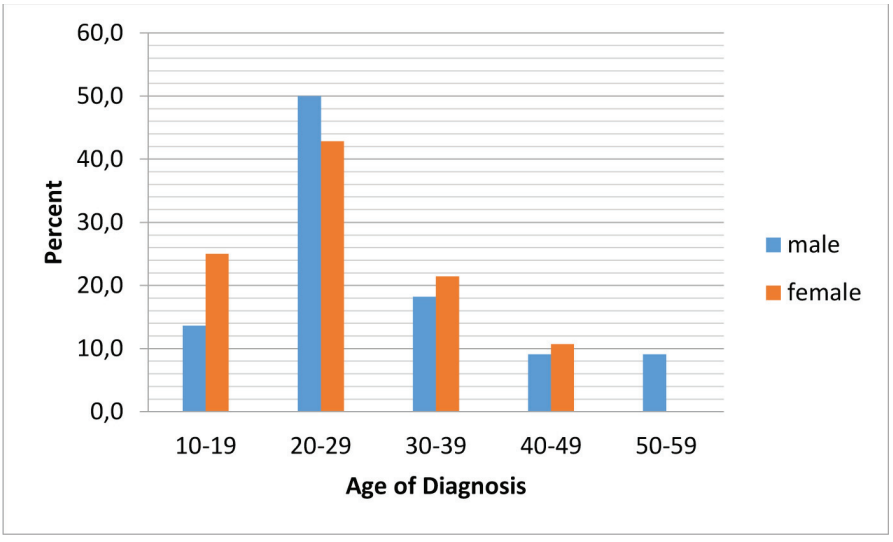

Figure 1. Age of Diagnosis

findings, the frequency of obesity in the BDI group was higher than the control group.

According to the blood analyses of the participants, hemoglobin, TG, CRP, and T3 were significantly higher in the BDI group compared to the control group ($p < 0.05$), whereas in the BDI group, HDL-C was significantly lower than the control group ($p < 0.05$) (Table 4).

The effect of health status on the participants' energy intake was statistically significant ($p < 0.001$). The bipolar group had a higher energy intake than the control group. Basal metabolic rate (BMR) also differed only from BMI. Group 3 differs from the other groups ($p < 0.001$). Protein, lipid, carbohydrate, and fiber intake of the individuals differed according to their health status ($p = 0.016$, $p < 0.001$, $p < 0.001$, $p = 0.007$, respectively). The bipolar group had a higher intake of protein, lipid, carbohydrate, and fiber. Also, folate and vitamin C intake showed a statistical significance according to the participants' health status ($p = 0.005$ and $p = 0.012$). Health status had a statistically significant effect on the vitamin B-6 intake of the participants ($p = 0.015$) and the BDI group had a higher intake of vitamin B-6. The interaction of health status and BMI was also statistically significant for vitamin

Table 2. Assesment of Participants Dietary intakes, Analysis of Covariance (ANCOVA)

	BDI (n=50)		**Control (n=38)**		
	Mean	**SD**	**Mean**	**SD**	**p**
BMH	1657.50	216.86	1497.68	257.16	**<0.05***
Energy (kcal)	2073.40	286.30	1584.61	270.90	**<0.05***
Protein (g)	89.05	22.09	75.13	20.69	**.003**
Protein (%)	17.52	2.94	19.55	3.61	**.003**
Lipid (g)	70.97	13.29	52.29	17.56	0.41
Lipid (%)	30.70	4.75	29.34	7.86	0.47
Carbohydrate(g)	260.71	46.30	195.70	48.04	0.48
Carbohydrate (%)	51.74	5.74	51.13	9.85	0.49
Fiber (g)	25.26	6.68	21.50	6.34	0.62
Vitamin B12 (µg)	5.64	2.09	4.72	2.26	0.9
Folate (µg)	376.51	135.89	306.45	139.51	0.54
Vitamin C (mg)	141.72	71.82	112.04	68.29	0.97
Vitamin B6 (mg)	1.61	0.60	1.36	0.45	0.23
Monounsaturated fatty acids (g)	23.44	4.92	18.70	9.26	0.62
Monounsaturated fatty acids (%)	10.21	1.75	10.51	4.80	0.60
Saturated fatty acids (g)	28.68	6.66	6.34	134.33	0.07
Saturated fatty acids (%)	12.49	2.49	35.57	73.62	0.08
Polyunsaturated fatty acids (g)	14.02	4.24	9.04	4.47	0.07
Polyunsaturated fatty acids (%)	6.10	1.80	5.12	2.39	0.07
Omega 3 (g)	1.78	1.40	1.61	1.58	0.83
Omega 3 (%)	0.77	0.61	0.94	0.96	0.89
Omega 6 (g)	11.89	3.34	6.98	3.46	**.009**
Omega 6 (%)	5.17	1.41	3.92	1.71	**.008**

*two independent sample t-test

Table 3. Anthropometric Measurements of Participants

	BDI (n=50)		Control (n=38)		
	Mean	**SD**	**Mean**	**SD**	**p**
Height (cm)	165.4	8.5	161.3	27.9	0.329
Weight (kg)	81.9	17.9	69.6	15.9	**0.001**
Waist circumference (cm)	97.5	19.7	85.0	13.1	**0.001**
Hip circumference (cm)	106.8	13.8	99.7	9.8	**0.009**
Waist/Height	0.6	0.1	0.5	0.1	**0.001**
Waist / Hip	0.91	0.1	0.85	0.1	**0.009**
BMI (kg/m²) *	n	%	n	%	
18.5-24.9	15.0	30.0	23.0	60.5	
25-29,9	12.0	24.0	9.0	23.7	**0.003**
>=30	23.0	46.0	6.0	15.8	

* chi-square

Table 4. Blood Parameters of Participants

	Mean	**SD**	**Mean**	**SD**	**p**
Hmg (g/dL)	13.6	2.0	12.8	1.3	**0.035**
Fasting glucose (mg/dL)	108.0	39.9	94.4	24.0	0.053
Total cholesterol (mg/dL)	185.0	60.5	197.8	40.7	0.350
HDL (mg/dL)	38.7	8.5	55.9	14.6	**<0.05**
LDL (mg/dL)	94.5	32.1	114.5	39.5	0.105
Triglyceride (mg/dL)	177.1	161.3	112.8	50.4	**0.032**
Folic acid (ng/mL)	7.5	3.2	11.5	9.3	0.196
B12 (pg/mL)	267.0	188.2	293.6	99.0	0.470
CRP (mg/dL)	5.6	6.4	1.3	1.5	**<0.05**
T3 (pmol/mL)	3.1	0.5	2.8	0.6	**0.006**
T4 (pmol/dL)	1.3	0.2	1.3	0.2	0.784
TSH (mU/L)	1.6	1.1	2.1	1.2	0.088

B-6 intake (p = 0,019). Vitamin B-6 intake varied for different BMI levels in the patient group.

The percentage of the intake of saturated fatty acids showed a statistically significant difference according to health status (p = 0.031), while the control group received more saturated fatty acids. The intake of polyunsaturated fatty acids was significantly higher in the bipolar group. The effect of health status on the intake of polyunsaturated fatty acids varied statistically according to the BMI levels of the individuals (p = 0.027). Omega 6 intake was statistically significantly higher in the bipolar group (p < 0.001) (Table 5).

When the model established in Table 6 is examined, it can be seen that only the age variable was found to be significant. An increase of 1 unit in the age variable causes an increase of 0.206 units in the BMI values of the BDI group.

Discussion

Sociodemographic characteristics of BDI patients can be different in all studies. The education level of the control group was higher than that of the BDI group. According to Arias et al., in patients with bipolar disorder, the education level of the majority of the participants was primary school, like the present

Table 5. Assesment of Participants' Dietary intakes according to Health Status and BMI

				95% Confidence Interval		
		Mean	**Std. Error**	**Lower Bound**	**Upper Bound**	**p**
Energy (kcal)	Control	1606.2	51.9	1503.0	1709.4	<0.001
	BD I	2063.1	40.7	1982.0	2144.1	
BMH	18,5-24,9 [1]	1478.0	35.2	1407.9	1548.1	<0.001 ([1-3, 2-3])
	25-29,9 [2]	1589.5	45.8	1498.3	1680.6	
	>=30 [3]	1779.8	47.6	1685.0	1874.6	
Protein (g)	Control	75.8	3.9	67.9	83.6	0.016
	BD I	88.2	3.1	82.0	94.3	
Protein (%)	Control	19.4	0.6	18.2	20.6	0.014
	BD I	17.5	0.5	16.5	18.4	
Lipid (g)	Control	54.3	2.9	48.6	60.1	<0.001
	BD I	71.2	2.3	66.7	75.7	
Carbohydrate (g)	Control	196.3	8.8	178.9	213.8	<0.001
	BD I	258.5	6.9	244.9	272.2	
Fiber (g)	Control	20.6	1.2	18.2	23.0	0.007
	BD I	24.9	0.9	23.0	26.8	
Folate (µg)	Control	285.3	25.7	234.3	336.4	0.005
	BD I	379.1	20.2	338.9	419.2	
Vitamin C (mg)	Control	97.4	13.3	71.0	123.8	0.012
	BD I	140.8	10.4	120.1	161.6	
Vitamin B6 (mg)	Control	1.3	0.1	1.1	1.5	0.015
	BD I	1.6	0.1	1.4	1.7	
	Control 18,5-24,9	1.4	0.1	1.2	1.7	0.019
	25-29,9	1.5	0.2	1.1	1.8	
	>=30	0.9	0.2	0.5	1.4	
	BD I 18,5-24,9	1.3	0.1	1.1	1.6	
	25-29,9	1.7	0.2	1.4	2.0	
	>=30	1.7	0.1	1.5	1.9	

(continued)

Table 5. (continued)

Monounsaturated fatty acids (g)	Control	19.7	1.3	17.0	22.4	0.026
	BD I	23.6	1.1	21.5	25.7	
Saturated fatty acids (%)	Control	37.7	9.0	19.7	55.6	0.031
	BD I	12.6	7.1	-1.5	26.7	
Polyunsaturated fatty acids (g)	Control	8.5	0.8	6.9	10.1	<0.001
	BD I	14.0	0.6	12.7	15.2	
	Control 18,5-24,9	9.9	0.9	8.2	11.7	0.027
	25-29,9	7.5	1.4	4.6	10.3	
	>=30	8.0	1.7	4.5	11.5	
	BD I 18,5-24,9	11.9	1.1	9.6	14.1	
	25-29,9	15.3	1.2	12.8	17.7	
	>=30	14.8	0.9	13.0	16.6	
Polyunsaturated fatty acids (%)	Control	4.7	0.4	4.0	5.5	0.007
	BD I	6.1	0.3	5.5	6.7	
	Control 18,5-24,9	5.7	0.4	4.9	6.6	0.048
	25-29,9	4.2	0.7	2.8	5.5	
	>=30	4.3	0.8	2.6	5.9	
	BD I 18,5-24,9	5.5	0.5	4.4	6.6	
	25-29,9	6.3	0.6	5.2	7.5	
	>=30	6.4	0.4	5.6	7.3	
Omega 6 (g)	Control	6.7	0.6	5.5	8.0	<0.001
	BD I	11.9	0.5	10.9	12.9	

Table 6. Multiple regression analysis results for BKI in BDI patients

	B	SE	Beta	p
Constant	17.920	4.372		0.000
Age	0.206	0.084	0.315	**0.018**
Gender (Female)	3.179	1.878	0.224	0.097
Family Story	3.554	1.858	0.252	0.062
TSH	-1.604	0.813	-0.256	0.055

r-sqr=0.289 adjusted r-sqr=0.226 SE of the estimate=6.267 (F=4.575;p=0.003)
independent variables: gender, age, family history, calcium, vitamin c, TSH, energy, fiber

study (19). Also, in the study of Sicras et al., the education level of the control group was higher than the bipolar patients (16). In our study, while the entire control group was employed, the majority of the BDI group was not working. The mean age of BDI diagnosis was 25.5 years in males and 26.0 years in females. The mean onset age of BD in another study was 25.0 (20). The onset of BDI can be seen in the 15–50 age range or at higher ages in some case studies in parallel with this study (20, 21). In this study, 35% of males (n = 7) and 63% of females (n = 17) had a family history of BDI. In the literature, Belmaker found 50% of patients with bipolar disorder could have a family history of BDI (22).

A higher energy consumption was found in patients with mental disorders than the control group according to Jacka et al. (23). In the study by Elmslie et al., bipolar patients consumed more total carbohydrates and their energy intake was higher in female patients than in reference subjects (24). The data obtained in the our study showed that energy and protein intake was significantly higher in the BDI group than the control group. While energy consumption increased, a significant increase was observed in protein compared to carbohydrates, which may be because the BDI group had a high socioeconomic status and easy access to protein sources. Moreover, the BDI group consumed 25.26 g of fiber, which is sufficient according to TUBER (25). The control group consumed less fiber than adequate intake recommendations (21.5 g). This may be due to the increased food intake while consuming more energy.

The omega-6 intake of the BDI group (5.17%) was significantly higher than the control group (3.92%). On the other hand, the omega-6 intake in the two groups was suitable for the dietary recommendations of Turkey. According to TUBER, for total fat intake, 5–10% of energy must be provided from omega-6 (LA: linoleic acid) and 0.6–1.2% from omega-3 (ALA: alpha linolenic acid) fatty acids (25). The omega-3 intake was 0.77% and 0.94% for the BDI and control groups, respectively.

One symptom of BDI is a change in appetite and weight, so the disorder may affect the choice of dietary patterns (26). The use of drugs for BDI may cause abnormal appetite and metabolism (27). Bipolar patients tend to have an unhealthier diet, and diet quality may play a role in bipolar disorder (28). In another study, BDI patients had difficulty in healthy eating ($p < 0.05$) than the control group (29). Furthermore, eating may improve the mood, and for this reason, BDI patients may have a high intake of energy. For example, the release of dopamine by eating may have certain antidepressant effects on BDI patients (13).

In this study, family history and gender were not significant in the regression model, but age was significant. However, all of these factors may affect BD in the literature and they are clinically important (8, 30). Our insignificant variables may be related to the sample size.

Similar to this study, waist circumference was significantly higher in the BDI group than the control group in the study of Sicras et al. (16). Chang et al. detected a large waist circumference in BDI patients (31). In another study, BMI was significantly different in BDI according to the NHANES data (32). Hunger can also be an important determinant of BMI. In a study, BDI patients had significantly higher fasting scores than the controls. The perception of hunger may be related to obesity in BDI (29). Also, BDI and obesity may have common characteristics, like overeating, decreased physical activity, sleep and impulse disorders, neurobiological abnormalities, and an unbalance between energy intake and expenditure. In addition, genetic and epigenetic factors may contribute to both obesity and BDI (13).

In our study, the levels of Hg, TG, CRP, T3, and HDL-C were significantly different between the two groups. Similarly, significant differences in HDL-C levels were found between the BDI and control groups in the literature (16). In the study of Chang et al., low HDL levels were detected in BDI patients (31). In Krishna et al., the BD group had significantly higher levels of T3 than the control group (33). Thyroid abnormalities can be seen in mood disorders (34). Moreover, the use of drugs for BDI or smoking may cause abnormalities in lipid metabolism (27).

There were some limitations in the current study. The first one is the sample size, which arises due to the limited number of BDI patients admitted to the hospital. The patient group was selected from only one city. While gender and family history were associated

with BP in the literature, it is another limitation that they were not statistically related in the regression model of this study because of the limited sample size.

Conclusion

BDI is a serious health problem that can cause life-threatening conditions. Recently, there has been an increasing interest in nutrition-related targets for the management of bipolar disorders. The data obtained in this study may help assess the nutrition of BDI patients. Considering the relationship between BMI and BDI, nutrition assessment should be a part of the plan of care in BDI patients. Anthropometric measurements and food frequency questionnaires can be useful for determining the general dietary habits of BDI patients. Further studies about BDI are necessary in order to understand which dietary habits may affect BDI pathophysiology, progression, and treatment. Nutritional recommendations for BD patients should be developed, and patients should be directed to dietitians and the necessary educations on nutrition should be completed. In conclusion, psychiatrists treating patients with BDI should be aware of nutritional problems in contact with the dietician.

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