Examination of Adipokine (Apelin, Leptin, Ghrelin) and Cortisol Hormone Response and Nutritional Status of University Students Studying in the Field of Health According to Their Orthorexia Nervosa Tendency

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Abstract:

Background: The aim of this study was to examine the adipokine (apelin, leptin, ghrelin) and cortisol hormone response and nutritional status of university students according to their tendency to orthorexia nervosa (ON) with anthropometric measurements.Methods: The study was conducted on a total of 100 university students of different genders (94 female, 26 male) aged 18-25, studying in the field of health sciences, without any health problems. Participants filled out the demographic data questionnaire and the ORTO-11 scale during a face-to-face interview. Apelin, leptin, ghrelin and cortisol hormone levels in the saliva samples taken from the students included in the study were examined by ELISA technique. Number, percentage, mean, chi-square, T Test, Pearson Correlation and ANOVA tests were used to evaluate the data. In all analyses, the significance value was taken as $p<0.05$. Results: The students' average orthorexia score was found to be 27.78±5.712. The frequency of consumption of other vegetables by students with high orthorexia scores differed compared to students prone to ON ($p<0.05$). Salivary apelin levels of students with high ON tendency were found to be lower, leptin levels were higher, and ghrelin levels were lower than students with normal tendency ($p<0.05$). Conclusions: In conclusion, examining the adipokine (apelin, leptin and ghrelin) and cortisol hormone response according to orthorexia nervosa tendencies reveals the psychological reflections of ON on physiological and feeding behaviors. Considering the impact of ON tendencies on students' health, it is thought that examining hormone profiles will make a significant contribution and benefit to understanding the health problems associated with orthorexia nervosa and developing appropriate interventions.

Keywords: Orthorexia nervosa; Apelin; Leptin; Ghrelin; Cortisol; Hormone; University Students

1. Introduction

Orthorexia nervosa (ON) is a personality and behavioral disorder that negatively affects daily life over time, along with an eating disorder that involves individuals' obsession with consuming excessively healthy and "right" foods (Bratman et al., 2007; Kalra et al., 2020; Gortat et al., 2021). ON, the state of obsession with healthy food is becoming increasingly pathological, leading to physically dangerous consequences that result in malnutrition, excessive weight loss, anemia, osteoporosis, neurological and cardiovascular problems, and death (Bratman et al., 2007). People with symptoms of ON eliminate products from their diet that contain preservatives, colorings, food flavors, pesticides, excess fat, sugar, salt, or genetically modified foods (Koven and Abry, 2015). Orthorexic people eat foods that make them feel healthy rather than the amount of food they consume and weight loss, meaning they are obsessed with the quality of food rather than quantity (Donini et al., 2004; Bellodi et al., 2001). Individuals with orthorexic behaviors are concerned about food preparation and cooking techniques, as well as the sterilization of tools and equipment used in food preparation. For this reason, they refuse to consume anything other than the foods they constantly consume and completely safe foods, and tend to consume only fruits and raw foods (Donini et al., 2004). ON individuals are seen in individuals who are concerned with the quality of food rather than the amount of eating, unlike individuals with anorexia and bulimia (Varga et al., 2014). There is no officially accepted official definition, no standard criteria for diagnosis. There is no officially accepted definition of ON and no standard criteria for its diagnosis (Dunn and Bratman,

2016). Changes experienced by an individual at some points in their life may cause deterioration in their general health status (Okur, 2024). Nutrition may also be affected by this situation.

This effect sometimes manifests itself as an eating disorder. One of these periods is when university students pass the university exam and leave the residential area they live in, and their university life, which includes an independent life, begins. In this case, they may become prone to gaining weight as a result of the stress they experience due to getting used to new processes, decrease in physical activity, and diet changes. Young adult university students may constantly resort to dieting due to low self-confidence, body dissatisfaction, excessive weight gain in university students, tendency to become obese, and social pressure (Celio et al., 2006; Liechty, 2013).

Nutrition is the process of taking in and using the nutrients necessary for living things to survive, grow and develop. Nutrition has a very important place at every stage from the birth of the baby to the geriatric period. The control of appetite and satiety, defined as the conscious desire for food, occurs through neuronal and hormonal signals. The neuronal regulation pathways of appetite include the arcuate nucleus (ARC), paraventricular nucleus (PVN), dorsomedial nucleus (DMH), lateral hypothalamic area/perifornical area (LHA/PFA) and ventromedical nucleus (VMH) regions of the brain (Stanley et al., 2005). Hormones, which are one of the other important factors, are important biomolecules that affect appetite and emotional state (Bayraktar, 2020).The hypothalamus is the area of the brain where hunger and satiety are managed by signals received by polypeptide hormones in peripheral organs. Signals released from Tue, pancreas and adipose tissue are transmitted to the hypothalamus. In the hypothalamus, the lateral hypothalamic area (LHA) acts as the hunger center and the ventromedial hypothalamus (VHM) acts as the satiety center. Energy intake is influenced by appetite-enhancing (oroxygenic) and appetite-reducing (anorexigenic) factors (Stanley et al., 2005). Hormones, one of the other important factors, are important biomolecules that affect appetite and emotional state (Bayraktar, 2020). Adipokines are secreted from adipose tissue, which is an important endocrine organ in the regulation of appetite and energy homeostasis. Adipokines, acting as hormones or paracrine factors, are involved in many physiological processes such as fat storage development, energy regulation, metabolism and eating behavior.Apelin is an adipokine secreted from adipose tissue that has an effect on appetite, energy balance and metabolism (Tatemoto et al., 1998). Apelin originates from a G-protein-bound, 77-amino acid preproapelin and has different forms such as apelin-10, apelin-11, apelin-12, apelin-13, apelin-15, apelin-17, apelin-19 and apelin-36. Apelin inhibits glucose-induced insulin secretion (Beltowski, 2006). Apelin is a hormone that plays a role in the regulator and control of emotional behavior (Kirbaş et al., 2024). Apelin regulates food intake through APJ receptor and corticotropin receptor activation in the brain (Lv et al., 2012). Apelin, which is associated with eating and mood disorders, plays a role in regulating behavior by increasing the level of apelin and its localization in the amygdala, hypothalamus, cerebroventricular system, dentate gyrus, which regulates behavioral response, especially in the limbic system (Bullich et al., 2022).

Leptin is an adipokine reported as a satiety hormone that has a role in controlling appetite and regulating eating behavior and energy balance. All receptor types of leptin are encoded by the Lepr gene, but they exist in 6 forms: OBRa, OBRb, OBRc, OBRd, OBRe and OBRf, depending on cytoplasmic domains of different lengths as a result of alternative mRNAs used in translation and proteolytic processes. The appetite-reducing effect of leptin occurs through the activation of its receptor in the mediobasal hypothalamus. The activated long form of the leptin receptor (OBRb) increases the level of α-melanocyte-regulating hormone (αMSH) by stimulating pro-opiomelanocortin (POMC) neurons. Increased α-melanocyte-regulating hormone (αMSH) level creates a strong anorexia (loss of appetite) signal and inhibits the release of orexigenic (appetite-increasing) neuropeptides released from there by suppressing neurons that secrete neuropeptide Y (NPY) and agouti-related neuropeptide (AgRP) (Cavaand Matarese, 2004;Bülbül et al., 2024).

Ghrelin is a hormone secreted from adipose tissue that is produced by ghrelinergic cells in the gastrointestinal tract and functions as a neuropeptide in the central nervous system (Inui et al., 2004). Ghrelin's stimulation of food intake due to hunger, that is, its appetite stimulating effect, occurs through the hypothalamic arcuate nucleus (ARC). Apart from this, peripherally synthesized ghrelin stimulates vagal afferent nerve endings, which causes the expression of Growth hormone secretagogue receptor (GHS-R) and stimulates the hypothalamus through the nucleus solitary, which has a vagal connection. Ghrelin is secreted in case of hunger, and its secretion level decreases when the stomach is stretched due to food intake (Tschop et al, 2001).

Stress causes biological and psychological changes that can change food preferences and consumption. Cortisol, also known as the stress hormone, can cause eating behavior in response to stress, and especially excessive consumption of comforting foods (Wolkowitz, 2001). Cortisol plays a role in appetite regulation and energy balance by increasing available energy through gluconeogenesis and lipolysis. Cortisol causes the development of obesity by increasing appetite and food intake by supporting fat accumulation, which causes a decrease in adipostatic signal and an increase

in orexogenic signal (Gaffey and Wirth, 2014). Cortisol level in saliva reflects free cortisol in the blood (Kaushik et al., 2014;Kirbaş et al., 2024; Orkun Erkılıç et al., 2024; Ozcan Böyük et al., 2024).

Orthorexia nervosa is a condition that can negatively impact a person's quality of life and functionality due to an excessive focus on healthy eating. Since the studies on ON are not yet sufficient, the etiology, epidemiology and treatment approaches of this disorder are not fully known. Research on ON to date has focused on the development of questionnaires with varying degrees of psychometric soundness. Apart from this, we focused on ON prevalence rates, evaluating risk factors, and comparing orthorexic eating behavior levels in different groups in the general population. Although the physiological roles of adipokines on appetite and food intake are known, Apelin is reported to be a biomarker of anorexia nervosa, a common metabo-psychiatric disease that is associated with the severity of mood and eating disorder psychopathology, with high relapse rates, comorbidity and mortality (Jowik et al., 2022). However, although no research has been found on the physiological role and change of hormonal levels of apelin, leptin, ghrelin and cortisol hormones in ON disease, our current study is the first. In this context, this study aims to examine the effect of adipokine (apelin, leptin, ghrelin) and cortisol hormone response and nutritional status with anthropometric measurements on the tendencies of orthorexia nervosa in university students.

2. Materials and Methods

2.1. Participants and Procedures

The data was collected face to face in an average of 15 minutes using a form containing general information and the ON scale for university students. In addition, saliva samples were collected from the individuals included in the study to determine apelin, leptin, ghrelin and cortisol hormone levels. For this purpose, it was conducted on a total of 100 university students between the ages of 18-25 studying at the faculty of health sciences at Bayburt University. Ethics committee approval (29.03.2023/ Decision no: 139/8) and institutional permission were obtained before the study. The participants were informed about the study in accordance with the Declaration of Helsinki and their consent was obtained for the Informed Consent Form. Volunteer participants were included in the study.

2.2. Data collection tool

The survey form was prepared for the individuals participating in the study to obtain demographic data such as gender, age, place of residence, cigarette consumption, number of people in the place of residence, and to determine their knowledge, attitudes and behaviors regarding nutrition, such as interest and education in nutrition issues and the number of meals consumed daily has been implemented. The Food Consumption Frequency form was used to determine the nutritional status of individuals. ORTO-11 scale was applied to determine individuals' obsession with healthy eating. The 10-question scale prepared by Bratman (1992) and was developed by Donini et al. (2004) and became ORTO-15. The Turkish validity and reliability of the scale was determined by Arusoğlu (2006) and Arusoğlu et al. (2008) and it was decided to use it as ORTO-11 in Turkish. The cut-off method was used to evaluate the ORTO-11 scale. The cut-off point of the study was determined as 24 points in the 25% slice, and 24 points and below were considered as orthorexic tendency. The questions in the survey form were asked to individuals through face-to-face interview technique.

2.3. Collection of Saliva Samples

Saliva samples were collected in the amount of 5 cc, using the passive drooling method in Salivette tubes (Sarstedt, GERMANY) between 08:00 and 09:00 in the morning. After being centrifuged at 1500 g for 15 minutes in a refrigerated centrifuge (NF 1200R, NÜVE, Ankara, TURKEY) in the laboratory, the saliva samples taken were stored at -20°C until analyzes were performed for apelin, leptin, ghrelin and cortisol hormone levels.

2.3. Measurement of Apelin, Leptin, Ghrelin and Cortisol Levels in Saliva

The commercial kits used in measurements are human-specific; Human Apelin ELISA Kit (BT LAB, Cat.NoE2014Hu, CHINA) for apelin level, Human Leptin ELISA kit (BT LAB, Cat.No E1560Hu, CHINA) for leptin level, Human Ghrelin for ghrelin level. ELISA kit (BT LAB, Cat.No E3091Hu, CHINA) was used. It was studied in accordance with the procedure specified in the manufacturer's catalog, using an intra-assay coefficient of 8.0% and an inter-assay coefficient of 10.0%. The results were evaluated by reading absorption values at 450nm in accordance with the procedure reported in the kit.

2.4. Statistical Analysis

In the study, the data obtained from the survey forms were processed and analyzed by the researcher in the SPSS 26.0 package program. As a result of the analysis conducted for the normality test of the data, the skewness and kurtosis (Skewness and Kurtosis) values of all scales and sub-dimensions were not found within the range of -2 and +2 and it

was assumed that the normality assumption was accepted. Among the demographic questions, gender, age, place of residence, cigarette consumption, number of people in the place of residence, interest in nutrition and education, number of meals consumed per day and body mass index were used in the analyses. Parametric tests were used for the comparison of two groups, T test for comparison of two groups and for comparison of more than two groups. ANOVA tests were applied. The groups that cause significant differences as a result of comparing more than two groups will be determined by Tukey HSD, one of the Post-Hoc tests. Cronbach Alpha analysis was performed for the reliability of the scales. Cronbach Alpha value is expected to be over 0.70 (Gürbüz and Şahin, 2014). Correlation analysis to examine the relationship between continuous demographic variables, ORTO-11 scores and four hormones; Chi-Square analyzes were applied to examine the relationships between food consumption frequency and ORTO-11 scores. The significance (p) value was taken as 0.05 in all analyses. In the results of the applied tests, when $p<0.05$, the difference v considered statistically significant, and when $p>0.05$, the differences were considered statistically insignificant.

3. Results

Information about students' demographic data such as gender, age, department, grade status, place of residence, number of people they live with, smoking status, whether they are interested in nutrition, status of receiving nutrition education, the source of nutrition education and number of meals consumed are given in Table 1.

Table 1. Demographic variables

Gender	n	%
Woman	75	75.0
Man	25	25.0
Total	100	100.0
Age	n	%
19 and younger	2	2.0
19-21	41	41.0
22-24	51	51.0
25 and older	6	6.0
Total	100	100.0
Department	n	%
Nutrition and dietetic	75	75.0
Other	25	25.0
Total	100	100.0
Grade	n	%
1st	7	7.0
2nd	17	17.0
3rd	62	62.0
4th	14	14.0
Total	100	100.0
Place where they live	n	%
Home	64	64.0
Dormitory	36	36.0
Total	716	100.0
Number of people living together	n	%
1-2	20	20.0
3-4	55	55.0
5 and more	25	25.0
Total	100	100.0

Cigarette consumption	n	%
Yes	25	25.0
No	75	75.0
Total	100	100.0
Interested in nutrition	n	%
Yes	90	90.0
No	10	10.0
Total	100	100.0
Education about nutrition	n	%
Yes	74	74.0
No	26	26.0
Total	100	100.0
Source of nutrition education	n	%
Dietitian	39	39.0
Doctor	7	7.0
Coach	4	4.0
Social Media	6	6.0
Other or neither	44	44.0
Total	100	100.0
Attention about foods	n	%
Yes	37	37.0
No	7	7.0
Sometimes	56	56.0
Total	100	100.0
Number of meals	n	%
1	2	2.0
2	43	43.0
3	45	45.0
4 and more	10	10.0
Total	100	100.0
Body Mass Index	n	%
Underweight	10	10.0
Normal	71	71.0
Overweight	16	16.0
Obese	2	2.0
Morbid Obese	1	1.0
Total	100	100.0
Income	n	%
0-2500 ₺	55	55.0
2501-5000 ₺	24	24.0
5001-7500 ₺	6	6.0
7501 ₺ and more	15	15.0
Total	100	100.0

₺: Turkish Lira

According to Table 1, where the demographic characteristics of the participants are examined; 75 of the participants are women (75%) and 25 are men (25.0%). There are 41 participants (41.0%) in the 19-21 age group and 51 participants (51.0%) in the 22-24 age group. There are 75 people (75.0%) studying in the department of nutrition and dietetics. There are 62 participants from 3rd grade students (62.0%) and 7 from 1st grade students (7.0%). There are 64 students living at home (64.0%) and 36 students living in dormitories (36.0%). There are 75 people (75.0%) who do not smoke. There are 20 people (20.0%) are living with 1-2 people in their place of residence, and 25 people (25.0%) are living with 5 or

more people in their place of residence. There are 90 people (90.0%) who are interested in nutrition issues and 74 people (74.0%) who have received education on nutrition. There are 39 people (39.0%) who received nutrition education from a dietician and 6 people (6.0%) who received it from social media. There are 37 people (37.0%) who stated that they pay attention to what they eat, and 7 people (7.0%) who do not. There are 43 people (43.0%) who eat 2 meals a day and 45 people (45.0%) eat 3 meals a day. According to their body mass index, there are 10 people (10.0%) who are underweight, 72 people (71.0%) are normal, and 1 person (1.0%) is morbidly obese. There are 55 people (55.0%) with a monthly income between 0-2500, and 15 people (15.0%) with a monthly income of 7501 and above.

Table 2. Descriptive statistics on research scales

	Min	Max	Mean	SD	Skewness	Kurtosis	Cronbach Alfa
ORTO-11	16	44	27.78	5.712	0.503	0.323	0.795
Apelin(ng/ml)	0.41	1.14	0.72	0.141	-0.542	0.339	
Leptin(ng/ml)	4.4	21.3	9.62	3.524	-0.192	1.132	
Ghrelin(ng/ml)	0.38	3.28	1.58	0.776	-0.512	-1.065	
Cortisol(ng/ml)	0.7	4.30	2.12	0.746	-0.717	0.348	

In Table 2, the mean, standard deviation, minimum-maximum and skewness-kurtosis values of the scales used in the research are given. The assumption of normality is accepted if the skewness and kurtosis values are between -2 and +2. In this case, parametric tests were used for the scales and sub-dimensions where the assumption of normality was met, and non-parametric tests were used for the scales and sub-dimensions where the assumption of normality was not met.

The total average score of the participants on the ORTO-11 scale was 27.78; The minimum score is 16 and the maximum score is 44. The assumption of normality (Skewness and Kurtosis) is accepted in the scale, and the Cronbach Alpha internal consistency coefficient of the scale calculated for the current research was found to be .795.

The average Leptin level of the participants was 9.62; average Ghrelin levels 1.58; average Cortisol levels are 2.12 and average Apelin levels are 0.72. The assumption of normality is accepted for all hormones.

1. Gender Comparisons

Table 3. Comparison of ORTO-11 scale and Leptin, Ghrelin, Cortisol and Apelin hormones by gender

	Gender	N	Mean	S	t	sd	p
ORTO-11	Woman	75	27.37	4.812	-1.413	98	0.161
	Man	25	29.08	6.350			
Apelin(ng/ml)	Woman	75	0.71	0.148	-0.520	99	0.604
	Man	25	0.73	0.121			
Leptin(ng/ml)	Woman	75	9.57	3.611	-0.218	99	0.828
	Man	25	9.75	3.314			
Ghrelin(ng/ml)	Woman	75	1.58	0.825	0.027	99	0.979
	Man	25	1.58	0.622			
Cortisol(ng/ml)	Woman	75	2.29	0.700	4.146	99	0.000
	Man	25	1.63	0.666			

According to the T-Test results, which examined the

scores of the participants from the ORTO-11 scale and the comparison of leptin, ghrelin cortisol and apelin levels by gender; There are statistically significant differences in the cortisol hormone ($p < .05$). Significant differences are due to the fact that the cortisol levels of women (Mean = 2.29) are higher than men (Mean = 1.63).

2. Age Group Comparisons

Table 4. ORTO-11 scale and comparison of Leptin, Ghrelin, Cortisol and Apelin hormones by age group

	Age	N	Mean	S	t	sd	p
ORTO-11	≥21	43	27.83	5.541	0.061	98	0.951
	22+	57	27.77	5.081			
Apelin(ng/ml)	≥21	43	0.68	0.135	-2.419	98	0.017
	22+	57	0.75	0.140			
Leptin(ng/ml)	≥21	43	9.57	3.424	-0.111	98	0.912
	22+	57	9.65	3.627			
Ghrelin(ng/ml)	≥21	43	1.59	0.745	0.069	98	0.945
	22+	57	1.58	0.806			
Cortisol(ng/ml)	≥21	43	2.14	0.764	0.230	98	0.819
	22+	57	2.11	0.739			

According to the results of the T-Test, which examined the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with age groups; There are statistically significant differences in the apelin hormone ($p < .05$). Significant differences are due to the fact that the apelin levels of participants in the 22 and over age group (Mean = 0.75) are higher than those in the 21 and under age group (Mean = 0.68).

3. **Place of Living Comparisons**

Table 5. Comparison of ORTO-11 scale and Leptin, Ghrelin, Cortisol and Apelin hormones with the place of participants' living

	Place	N	Mean	S	t	sd	p
ORTO-11	Home	64	27.71	4.999	-0.205	98	0.838
	Dormitory	36	27.94	5.756			
Apelin(ng/ml)	Home	64	0.74	0.132	1.927	98	0.057
	Dormitory	36	0.68	0.151			
Leptin(ng/ml)	Home	64	9.63	3.324	0.052	98	0.958
	Dormitory	36	9.59	3.903			
Ghrelin(ng/ml)	Home	64	1.66	0.737	1.315	98	0.192
	Dormitory	36	1.45	0.835			
Cortisol(ng/ml)	Home	64	2.16	0.766	0.708	98	0.481
	Dormitory	36	2.05	0.715			

According to the T-Test results, which examined the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with the place of residence; There are no statistically significant differences ($p > .05$).

4. **Comparisons of the Number of People in the Living Place**

Table 6. Comparison of ORTO-11 scale and Leptin, Ghrelin, Cortisol and Apelin hormones with the number of people living in the place (ANOVA)

	Number	N	Mean	SD	F	p	Post Hoc (Tukey)
ORTO-11	1-2	20	28.05	4.784	0.275	0.760	-
	3-4	55	28.01	5.576			
	5 and more	25	27.12	5.027			
Apelin(ng/ml)	1-2	20	0.70	0.114	0.126	0.882	
	3-4	55	0.72	0.155			
	5 and more	25	0.72	0.131			
Leptin(ng/ml)	1-2	20	10.54	4.301	0.896	0.412	-
	3-4	55	9.47	3.461			
	5 and more	25	9.20	2.948			
Ghrelin(ng/ml)	1-2	20	1.80	0.809	1.134	0.326	-
	3-4	55	1.50	0.767			
	5 and more	25	1.59	0.767			
Cortisol(ng/ml)	1-2	20	2.08	0.772	0.088	0.916	-
	3-4	55	2.15	0.745			
	5 and more	25	2.10	0.757			

	Cigarette	N	Mean	S	t	sd	p
ORTO-11	Yes	25	27.32	5.113	-0.525	98	0.601
	No	75	27.96	5.328			
Apelin(ng/ml)	Yes	25	0.75	0.120	1.226	98	0.223
	No	75	0.71	0.147			
Leptin(ng/ml)	Yes	25	9.92	3.585	0.499	98	0.619
	No	75	9.52	3.522			
Ghrelin(ng/ml)	Yes	25	1.56	0.838	-0.192	98	0.848
	No	75	1.59	0.760			
Cortisol(ng/ml)	Yes	25	2.08	0.772	-0.316	98	0.753
	No	75	2.14	0.742			

According to the results of ANOVA analysis, which examined the scores received by the participants from the ORTO-11 scale and the comparison of their leptin, ghrelin, cortisol and apelin levels with the number of people in the place of residence; There are no statistically significant differences (p>.05).

5. Cigarette Consumption Comparisons

Table 7. ORTO-11 and comparison of Leptin, Ghrelin, Cortisol and Apelin hormones with cigarette consumption

According to the T-Test results, which examined the scores of the participants from the ORTO-11 scale and the comparison of their leptin, ghrelin cortisol and apelin levels with cigarette consumption; There are no statistically significant differences (p>.05).

6. Comparisons of Eating Behaviors

Table 8. Comparison of ORTO-11 scale and Leptin, Ghrelin, Cortisol and Apelin hormones with individuals' interest in nutrition issues, their status of having received nutrition education and the number of meals per day

	Interest	**N**	**Mean**	**S**	**t**	**sd**	**p**
ORTO-11	Yes	90	27.61	5.081	-1.079	98	0.283
	No	10	29.5	6.721			
Apelin(ng/ml)	Yes	90	0.73	0.142	1.711	98	0.09
	No	10	0.65	0.117			
Leptin(ng/ml)	Yes	90	9.56	3.471	-0.526	98	0.6
	No	10	10.18	4.137			
Ghrelin(ng/ml)	Yes	90	1.5956	0.783	0.337	98	0.737
	No	10	1.5080	0.753			
Cortisol(ng/ml)	Yes	90	2.19	0.752	2.516	98	0.013
	No	10	1.58	0.416			
	Education	**N**	**Mean**	**S**	**t**	**sd**	**p**
ORTO-11	Yes	74	27.56	5.026	-0.744	98	0.459
	No	26	28.46	5.921			
Apelin(ng/ml)	Yes	74	0.73	0.146	1.001	98	0.319
	No	26	0.69	0.127			
Leptin(ng/ml)	Yes	74	9.95	3.633	1.609	98	0.111
	No	26	8.67	3.060			
Ghrelin(ng/ml)	Yes	74	1.67	0.795	2.102	98	0.041
	No	26	1.33	0.674			
Cortisol(ng/ml)	Yes	74	2.21	0.752	2.168	98	0.035
	No	26	1.87	0.680			
	Meal	**N**	**Mean**	**S**	**t**	**sd**	**p**
ORTO-11	1-2	45	28.04	4.809	0.419	98	0.676
	3-4+	55	27.6	5.632			
Apelin(ng/ml)	1-2	45	0.72	0.137	0.042	98	0.996
	3-4+	55	0.72	0.146			
Leptin(ng/ml)	1-2	45	10.02	3.812	1.033	98	0.304
	3-4+	55	9.29	3.268			
Ghrelin(ng/ml)	1-2	45	1.64	0.782	0.659	98	0.511
	3-4+	55	1.54	0.776			
Cortisol(ng/ml)	1-2	45	2.11	0.690	-0.162	98	0.872
	3-4+	55	2.14	0.795			

According to the T-Test results, which examined the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with interest in nutrition issues; There are statistically significant differences in cortisol hormone (p<.05). Significant differences are due to the fact that the cortisol levels of interested participants (Mean=2.19) were higher than those of uninterested participants (Mean=1.58).

According to the results of the T-Test, which examined the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with their education on nutrition; There are statistically significant differences in ghrelin and cortisol hormones (p <.05). Significant differences are due to the higher number of participants who were trained in both hormones (M = 1.67; 2.21) compared to those who were not interested (M = 1.33; 1.87).

According to the T-Test results, which examined the scores of the participants from the ORTO-11 scale and

the comparison of their leptin, ghrelin, cortisol and apelin levels with the number of daily meals; There are no statistically significant differences (p>.05).

7. Body Mass Index Comparison

Table 9. Comparison of ORTO-11 and the hormones Leptin, Ghrelin, Cortisol and Apelin with BMI (ANOVA)

	BMI	N	Mean	S	F	p	Post Hoc (Tukey)
ORTO-11	Underweight	10	28.8	4.732	0.218	0.805	-
	Normal	71	27.74	5.360			
	Obese	19	27.47	5.326			
Apelin(ng/ml)	Underweight	10	0.69	0.205	0.472	0.625	-
	Normal	71	0.71	0.135			
	Obese	19	0.74	0.129			
Leptin(ng/ml)	Underweight[a]	10	7.66	1.577	128.254	0.000	c>b>a
	Normal[b]	71	8.25	1.444			
	Obese[c]	19	15.77	3.064			
Ghrelin(ng/ml)	Underweight	10	1.36	0.76	1.856	0.162	-
	Normal	71	1.54	0.745			
	Obese	19	1.87	0.862			
Cortisol(ng/ml)	Underweight[a]	10	1.46	0.636	17.774	0.000	c>a>b
	Normal[b]	71	2.03	0.509			
	Obese[c]	19	2.84	1.016			

According to the results of ANOVA analysis, which examined the scores of the participants from the ORTO-11 scale and the comparison of leptin, ghrelin cortisol and apelin levels with BMI; There are statistically significant differences in leptin and cortisol hormones (p <.05). According to Tukey, from the Post-Hoc analyzes conducted to determine which options resulted from significant differences, all options are significant. In the comparison between significant options, the significant differences are due to the high leptin and cortisol levels of obese participants.

Table 10. The relationship between participants' demographic variables, ORTO-11 scores and leptin, ghrelin, cortisol and apelin levels

		1	2	3	4	5	6	7	8	9	10	11	12
1.Age (year)	r	1											
2.Height (cm)	r	-0.037	1										
3.Sleep duration	r	-0.084	-0.097	1									
4.Weight (kg)	r	0.004	.455**	-0.11	1								
5.Waist circumference (cm)	r	0.087	0.080	-.267**	0.138	1							
6.Hip circumference (cm)	r	0.181	0.056	-.221**	0.083	.824**	1						
7.BMI (kg/m²)	r	0.012	.205**	-0.093	.906**	0.155	0.109	1					
8.ORTO-11	r	-0.001	0.160	0.179	0.025	-0.126	-0.076	-0.059	1				
9.Apelin (ng/ml)	r	0.158	0.000	-0.124	0.081	.228*	0.182	0.070	-0.102	1			
10.Leptin (ng/ml)	r	-0.105	0.119	0.104	.593**	0.008	-0.015	.685**	.262**	0.005	1		
11.Ghrelin (ng/ml)	r	-0.031	0.119	0.129	0.085	-0.087	-0.054	0.089	.546**	.507**	-0.195	1	

12.Cortisol (ng/ml)	r	-0.053	-0.098	-0.075	.239*	.272**	.289**	.384**	-.325**	.350**	-0.015	0.182	1

*p<0.05 **p<0.01

According to the results of the correlation analysis, which examined the relationships between the demographic variables of the participants, ORTO-11 scores and leptin, ghrelin, cortisol and apelin levels; There are statistically significant (p<.05) and positive relationships (.685) between leptin and body mass indexes. As the leptin levels of the participants increase, their body mass index will also increase. There are statistically significant (p <.05) and positive relationships (.262) between leptin and ORTO-11 scores. As participants' leptin levels increase, their ORTO-11 scores will also increase.

There are statistically significant (p<.05) and positive relationships (.546) between ghrelin and ORTO-11 scores. As participants' ghrelin levels increase, their ORTO-11 scores will also increase. There are statistically significant (p <.05) and positive relationships (.507) between ghrelin and leptin scores. As the participants' ghrelin levels increase, their leptin levels will also increase.

There are statistically significant (p<.05) and positive relationships (.239) with cortisol and weight. As participants' cortisol levels increase, their weight will also increase. There are statistically significant (p<.05) and positive relationships (.272) between cortisol and waist circumference. As participants' cortisol levels increase, their waist circumference will also increase. There are statistically significant (p<.05) and positive relationships (.289) between cortisol and hip circumference. As participants' cortisol levels increase, their hip circumference will also increase. There are statistically significant (p<.05) and positive relationships (.384) between cortisol and body mass indices. As the cortisol levels of the participants increase, their body mass index will also increase. There are statistically significant (p<.05) and negative relationships (-.325) between cortisol and ORTO-11. As participants' cortisol levels increase, their ORTO11 scores will increase. There are statistically significant (p<.05) and positive relationships (.50) between cortisol and leptin. As the cortisol levels of the participants increase, their leptin levels will also increase.

Table 11. Relationships between participants' ORTO-11 scores and food frequencies

Milk-Yogurt	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	2	2	4			
5-6 times a week	4	12	16			
3-4 times a week	11	27	38	2.335	4	0.674
1-2 times a week	6	26	32			
Never	3	7	10			
Cheese	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	6	22	28			
5-6 times a week	4	15	19			
3-4 times a week	7	17	24	1.082	4	0.897
1-2 times a week	7	15	22			
Never	2	5	7			
Meat-Meat product	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	0	1	1			
5-6 times a week	2	7	9	0.703	4	0.951
3-4 times a week	9	23	32			
1-2 times a week	11	34	45			

Never	4	9	13			
Poultry	**Orthorexia Tendency**		**Total**	**X²**	**df**	p
	24-	**24+**				
Always	0	3	3			
5-6 times a week	5	8	13			
3-4 times a week	8	28	36	5.006	4	0.287
1-2 times a week	11	34	45			
Never	2	1	3			
Fish	**Orthorexia Tendency**		**Total**	**X²**	**df**	p
	24-	**24+**				
Always	0	0	0			
5-6 times a week	0	3	3			
3-4 times a week	2	3	5	3.673	4	0.299
1-2 times a week	14	28	42			
Never	10	40	50			
Egg	**Orthorexia Tendency**		**Total**	**X²**	**df**	**p**
	24-	**24+**				
Always	1	11	12			
5-6 times a week	2	18	20			
3-4 times a week	12	21	33	6.991	4	0.136
1-2 times a week	7	15	22			
Never	4	9	13			
Legumes	**Orthorexia Tendency**		**Total**	**X²**	**df**	**p**
	24-	**24+**				
Always	0	1	1			
5-6 times a week	5	9	14			
3-4 times a week	13	26	39	5.659	4	0.226
1-2 times a week	8	29	37			
Never	0	9	9			
Bread and Cereals	**Orthorexia Tendency**		**Total**	**X²**	**df**	p
	24-	**24+**				
Always	6	32	38			
5-6 times a week	7	7	14			
3-4 times a week	6	18	24	6.773	4	0.148
1-2 times a week	5	14	19			
Never	2	3	5			
Green Leafy Vegetables	**Orthorexia Tendency**		**Total**	**X²**	**df**	**p**
	24-	**24+**				
Always	2	4	2			
5-6 times a week	7	11	7			
3-4 times a week	8	24	8	2.955	4	0.565
1-2 times a week	8	27	8			
Never	1	8	1			

Other Vegetables	Orthorexia Tendency		Total	X^2	df	p
	24-	24+				
Always	4	4	8			
5-6 times a week	9	13	22			
3-4 times a week	9	25	34	9.55	4	0.049
1-2 times a week	4	26	30			
Never	0	6	6			
Potato	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	1	5	6			
5-6 times a week	8	13	21			
3-4 times a week	13	30	43	4.866	4	0.301
1-2 times a week	4	25	29			
Never	0	1	1			
Fruits	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	3	13	16			
5-6 times a week	10	16	26			
3-4 times a week	9	24	33	4.913	4	0.296
1-2 times a week	4	15	19			
Never	0	6	6			
Fats	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	4	8	12			
5-6 times a week	5	3	8			
3-4 times a week	6	18	24	7.255	4	0.123
1-2 times a week	7	32	39			
Never	4	13	17			
Oils	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	5	22	27			
5-6 times a week	8	8	16			
3-4 times a week	6	22	28	9.078	4	0.059
1-2 times a week	5	21	26			
Never	2	1	3			
Sugar and Candy	**Orthorexia Tendency**		**Total**	**X^2**	**df**	**p**
	24-	**24+**				
Always	3	17	20			
5-6 times a week	6	6	12			
3-4 times a week	9	13	22	9.202	4	0.056
1-2 times a week	6	27	33			
Never	2	11	13			

According to the results of Chi-Square analysis, which examined the relationships between participants' ORTO-11 scores and food consumption frequencies; There are statistically significant relationships between ORTO-11 scores and

other vegetable consumptions (p<.05; X2=9.550). Significant relationships result from participants with orthorexia scores of 24 and above consuming vegetables 1-2 times a week.

4. Discussion

Nutrition is the process of taking into the body and using the nutrients necessary for living things to survive, grow and develop. Nutrition has a very important place in every stage of life, from the intrauterine period to the geriatric period, for a healthy life. Nutritional habits may vary throughout individuals' lives due to many reasons such as environmental change, cultural and socio-economic factors. One of these periods is that they come to a different environment than the one they live in and experience economic, cultural, etc. It is the period of university student life where individuals' lifestyles may change for various reasons. ON is one of the eating disorders that is thought to negatively affect healthy lifestyle behaviors during this period. ON is a neglected eating disorder and its prevalence is increasing, but it is reported that students, especially those studying in the field of health, are at high risk. For this reason, examining and supporting the health behaviors of university students, especially students studying in health-related departments, is important for public health.

One of the socio-demographic variables is gender and it is a factor that should be taken into account in research (Oberle et al., 2017). When the orthorexic tendency is examined in terms of gender, it is reported that it is more common in women (Dunn et al., 2016; Arusoğlu, 2006; Şanlıer et al., 2016). Although our study, which examined the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin, cortisol and apelin levels by gender, is limited, the cortisol hormone level was significantly and higher in female participants (mean=2.29) than in male participants (mean=1.63). (p<0.05); no significant difference was detected between the average salivary apelin and ghrelin values and ORTO-11 score averages and gender (Table 3), (p>0.05). Our current study is compatible with studies that do not find the effect of an individual's gender on the ORTO-11 score (Baysal and Kızıltan, 2020) and differs from some research results (Oberle et al., 2017; Dell'Osso et al., 2016). We think that this is due to reasons such as the difference in study materials reported in the literature and the low number of male students studying at the faculty of health sciences, which constitute the sample group of our study.

Although age is one of the important risk factors for orthorexia nervosa, it is a parameter with different results in the literature. It is stated that it is more common in young adults than in older adults (Dell'Osso et al., 2016; McComb, 2019). In a study, it was reported that orthorexic education is common among university students, in terms of gender, in individuals aged 21 and under, the age group with a high level of education (Fidan et al., 2010). Although our study, in which the participants' scores from the ORTO-11 scale and the comparison of leptin, ghrelin cortisol and apelin levels were compared with age groups, is limited, there is a statistically significant difference (p <.05) in the average salivary apelin hormone; No significant difference was detected between the mean salivary ghrelin and cortisol values and the mean ORTO-11 scores and gender (Table 4), (p>0.05). Our current study is consistent with studies that found no effect of age on ORTO-11 score (Garipoğlu et al., 2019; Ormancı, 2022) and differs from some research results (Dell'Osso et al., 2016; McComb, 2019). For this reason, we believe that the apelin levels of participants in the 22 and older age group (mean=0.75) are higher than those of participants in the 21 and younger age group (mean=0.68), as well as the material difference of the studies reported in the literature, due to reasons related to physiological gender differences.

Nutritional habits and lifestyle affect the formation and metabolic processes of many diseases. The factors that create stress are classified into three groups: stress sources related to the individual himself, created by his environment and created by the environmental environment in which the individual lives (Güçlü, 2001). The place where the individual lives (house, dormitory, apartment, etc.), that is, the living spaces in which he maintains his daily life, is one of the important elements in which individuals acquire positive or negative eating habits in their lives, or in which eating disorders may develop. Individuals with Eating Disorders are reported to adopt an isolated lifestyle due to the fact that they show high levels of anxiety disorders (Toker and Hocaoğlu, 2009). Orthorexic individuals do not eat outside the home and their social relationships are reported to be impaired (Bratman, 2007; Kratina, 2006).

Bayar and Şahin (2024) reported that the mean scores of healthy orthorexia and orthorexia nervosa were higher in those living in student housing, those with high family income, and those who were on a diet. Although the studies examining the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with the place of residence are limited, there are no statistically significant differences (Table 5, 6), (p>.05). In our current study, the compatibility with the studies in which the place where an individual lives does not have an effect on the ORTHO-11 score [43] and shows differences with some research results (Bratman, 2007; Toker and Hocaoğlu, 2009; Kratina, 2006; Bayar and Şahin, 2024; Gezer and Kabaran, 2013; Oğur and aksoy, 2015).

Our current study is consistent with studies that found no effect of where an individual lives on the ORTO-11 score (Öcal et al., 2020) and also differs from some research results (Bratman, 2007; Kratina, 2006; Bayar and Şahin, 2024; Gezer

and Kabaran, 2013; Oğur and aksoy, 2015). We think that this is due to reasons such as the difference in study materials reported in the literature, the certain accommodation capacity of places such as state, private dormitories and apartments other than the house where students stay for economic reasons, and the difference in the scale used.

Smoking is known as a habit that harms health, and although there is no direct relationship between orthorexia and smoking, some individuals may choose to quit smoking while adopting healthy lifestyles. However, it is known that some people may view smoking as a "controlled" behavior amid their obsession with healthy eating. Although studies examining the comparison of participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with cigarette consumption are limited, it has been determined that there are no statistically significant differences ($p>.05$). Our current study is consistent with studies that found no effect of an individual's smoking on the ORTO-11 score (Bayar and Şahin, 2024) and differs from some research results (Öcal et al., 2020; Hyrnik et al., 2016; Strahler et al., 2018; Lloyd et al., 2023). The reason for this is that orthorexia is often associated with anxiety and obsessive-compulsive behaviors; For this reason, we think that this is due to reasons such as a smoker experiencing conflicting emotions in his search for a healthy life, that is, psychological differences that individuals may experience.

It is thought that being more educated and aware of healthy nutrition increases the risk of orthorexia nervosa. Medical doctors and medical students are in the risk group for orthorexia tendency (Depa et al., 2019; Berrada et al., 2018; Mete et al., 2019). Studies examining the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin cortisol and apelin levels with their nutritional education status show limitations, but there are statistically significant differences ($p <.05$) in the average salivary ghrelin and cortisol hormones, while there are statistically significant differences between the salivary cortisol levels and There is no difference (Table 8), ($p<0.05$). Our current study is consistent with studies that found no effect of an individual's educational status on the ORTO-11 score (Aksoydan and Camcı, 2009) and that it decreased (Korinth et al., 2010) and increased with educational status (Liechty and Lee, 2013; Arusoğlu et al., 2008) also differs from some research results.The reason for this is that education is an important actor that has the power to direct the individual to healthy and correct nutrition behavior. However, we think that it is due to material differences that are not addressed comprehensively in the studies.

Individuals with orthorexic tendencies are individuals who are sensitive about having regular meals, that is, not skipping meals (Koven and Abry, 2015). When the scores of the participants from the ORTO-11 scale and the comparison of their leptin, ghrelin cortisol and apelin levels with the number of meals per day are examined, there are no statistically significant differences (Table 8), ($p>0.05$). Our current study is consistent with studies (Baysal and Kızıltan, 2020; Yeşil et al., 2018; Eminsoy and Eminsoy, 2021; Ormancı, 2022), which found no effect of the number of meals on the ORTO-11 score.

BMI is one of the parameters that contributes to the evaluation and diagnosis of the individual's nutritional status and eating disorders, as well as evaluating the individual's body weight. It is reported that orthorexia scores are lower in individuals with low BMI (Bosi et al., 2007; Orkun Erkılıç et al., 2024; Okumus and Çelikel Taşci, 2024). In the study conducted by Fidan et al. (2010) using the ORTO-11 scale, they reported that orthorexia scores decreased as BMI increased, and the relationship between orthorexic tendency and BMI increases was statistically significant. On the other hand, Reynolds (2018) stated in his study on university students that there was no statistically significant difference between BMI and ORTO-15 score. Although the comparison of the participants' scores from the ORTO-11 scale and their leptin, ghrelin, cortisol and apelin levels with BMI is limited, there are statistically significant differences in the average salivary leptin and cortisol hormones ($p <.05$).Compatibility with the studies in which there is no effect of BMI use on ORTHO-11 score in our current study (Şanlıer et al., 2016; Garipoğlu et al., 2019; Reynolds, 2018; Cinosi et al., 2015; Plichta et al., 2019) and differences with some research results (Fidan et al., 2010; Yeşil et al., 2018; Bosi et al., 2007) shows. It is thought that it is normal that the relationships between BMI and ON give different results in the studies in the literature, since ON is a state of obsession with healthy eating, unlike the obsession with body image.

Apelin is considered an important modulator of lipid metabolism. Apelin plays a role in the regulation of cardiovascular and fluid homeostasis, food intake, cell proliferation and angiogenesis (Bayraktar et al., 2020a; Bayraktar et al., 2020b). In clinical and experimental studies, serum apelin levels increase in cases of obesity and insulin resistance (Soriguer et al., 2009; Demirpence et al., 2009). There are different literature results showing that plasma apelin concentrations increase (Castan-Laurell et al., 2011) or do not change (Can Fİgen, 2018) in obesity. On the other hand, due to obesity and BMI increase, satiety factor leptin and stress hormone levels increase (Hassink et al., 1996; Vicennati et al., 2009; Sáinz et al., 2014; Hewagalamulage, 2016).It is reported that as leptin levels increase, there is an increase in BMI level and a positive correlation between them. Our current results are consistent with literature results showing a positive relationship between leptin (Hassink et al., 1996; Sáinz et al., 2014) and cortisol level (Vicennati et al., 2009; Hewagalamulage, 2016) and BMI in obese individuals.

5. Conclusions

ON is a neglected eating disorder and its prevalence continues to increase, and especially healthcare professionals, athletes and individuals who attach great importance to healthy nutrition are at high risk for orthorexia nervosa, thus raising awareness and early diagnosis-treatment practices are critical. As a result, within the scope of the data obtained in our current study, it was determined that ghrelin levels were low and leptin and cortisol levels were high in individuals with high ON levels ($p<0.05$). We predict that leptin, ghrelin and cortisol hormone levels, which are the hormones underlying eating disorders, can be an early indicator in the evaluation and monitoring of ON tendency in university students and a biological marker in taking precautions for reported problems. However, it is thought that further studies may contribute to the elucidation of physiological mechanisms and the development of necessary strategies for ON disease.

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