Investigation of the Relationship Between Cortisol Hormone Response and Body Mass Index According to Bigorexia Levels in Sports Sciences Faculty Students

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Abstract

The aim of this study is to investigate the relationship between cortisol hormone response and body mass index (BMI) according to bigorexia levels in sports sciences faculty students. The study was conducted on 40 university students (20 female, 20 male) of different genders who study at the 3rd year Recreation Department of the Faculty of Sports Sciences at Bayburt University, do not have any health problems, and regularly engage in bodybuilding. Participants filled out the demographic data questionnaire and the Muscle Dysmorphic Disorder (Bigorexia) Inventory (MDDI) during a face-to-face interview. 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 $p<0.05$. The total average score obtained by the participants from the MDDI (Bigorexia scale) was found to be 37.550±6.61.There is a negative moderate relationship between bigorexia and weight (-.360*) and BMI (-.330*) among the continuous demographic variables of the participants, the bigorexia scale, its sub-dimensions and cortisol levels. It was determined that as the participants' weight and BMI measurements decreased, their scores from the bigorexia scale increased, and there was a very strong positive relationship (.908**) between the bigorexia scale score and cortisol. In addition, it was determined that the increase in salivary cortisol level due to the increase in the bigorexia scale score was statistically significant ($p<0.05$). Bigorexia nervosa is a serious health problem that is reported to be increasing in young people because it is associated with many psychological health problems such as eating disorders, anxiety, depression and social isolation. Considering the effect of bigorexia nervosa on health, it is thought that examining cortisol hormone levels will make a significant contribution and benefit in understanding the health problems associated with it and developing appropriate interventions.

Keywords: Bigorexia nervosa, Cortisol, Hormone, University Students

Introduction

Bigorexia nervosa, also known as muscle dysmorphia, is a subtype of body dysmorphic disorder, often accompanied by eating disorders, in which the individual describes his or her body as small, weak, and inadequate, even though his or her body structure is normal or even unusually large and muscular (Mosley, 2009; Vasiliu, 2023). In DSM-5, the term bigorexia is included in the scope of "body dysmorphic disorder" under the main title of "Obsessive-Compulsive and Related Disorders" (Krug et al., 2022). This situation points to the incompatibility between physical and mental health, which negatively affects the quality of life (Okur, 2024). Although the incidence of bigorexia is seen in men interested in muscle building, in recent years it has been reported that the media is a risk factor that can cause body image disorders for both genders. Bigorexic individuals can usually prefer more protein, less fat foods and use supplements (Mosley, 2009). They spend most of their time in exercise and sports centers. Bigorexic individuals may refuse treatment because they are hiding their devastating psychological and social problems. Although bigorexia is considered a subclass of body dysmorphic disorder, it is suggested that individuals with bigorexia symptoms should also be evaluated for eating disorders (Sabiston et al., 2019).

Bigorexic individuals may still see themselves as inadequate even if they have above-average muscle mass. However, in most cases, the person is either of normal weight or extremely large and muscular. Bigorexic individuals are perfectionists, individuals who compare themselves to extremely high standards, and have a tendency to constantly evaluate themselves critically (Azaiez et al., 2014). Although the incidence of bigorexia is seen in men interested in muscle building, in recent years it has been reported that the media is a risk factor that can cause body image disorders for both genders. Bigorexic individuals generally prefer more protein, less fat foods and may use supplements (Mosley, 2009). Appetite control is a

function of the hypothalamus in the brain. Signals released from the gut, pancreas and adipose tissue are transmitted to the hypothalamus. In the hypothalamus, the lateral hypothalamic area (LHA) acts as the hunger center, while the ventromedial hypothalamus (VHM) acts as the satiety center (Stanley et al., 2005).

Hormones are biomolecules that are secreted from glands and play a role in many physiological processes that affect organs (Bayraktar, 2020). Cortisol is a corticosteroid hormone that is synthesized in the zona fasciculus of the adrenal cortex and is associated with the body's response to stress. Known as the stress hormone, cortisol is regulated by the hypothalamus-pituitary-adrenal axis, Corticotropin-releasing hormone (CRH) and the pituitary hormone ACTH (Adrenocorticotropic Hormone). Cortisol also plays a role in many physiological processes, such as blood pressure, the immune system, anti-inflammatory effects, and protein, carbohydrate, and fat metabolism (Bayraktar, 2020). Cortisol level in saliva reflects free cortisol in the blood (Levine et al., 2007; Gatti et al., 2009; Kudielka et al., 2009; Kaushik et al., 2014; Orkun Erkılıç et al., 2024; Ozcan Böyük et al., 2024).

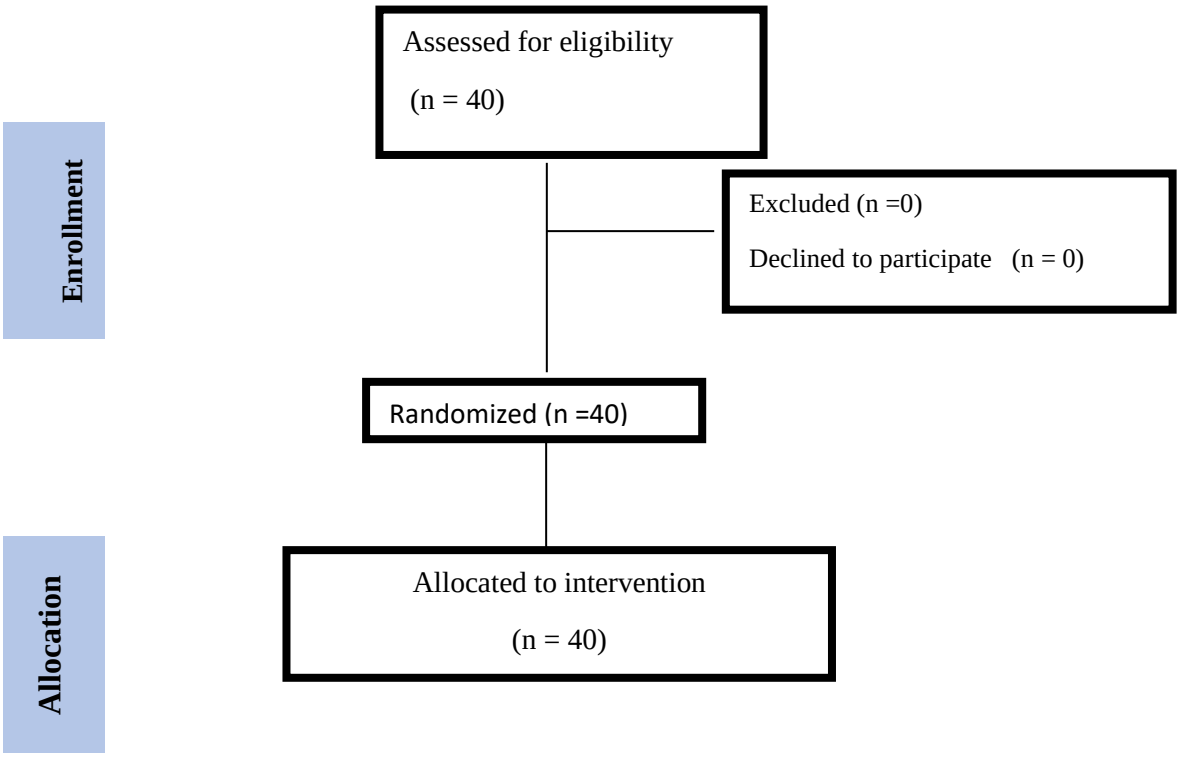
Body mass index (BMI) also known as height-weight index, is a measure of a person's weight according to their height, and is a value calculated by dividing the weight by the square of the height (kg/m^2). It is taken as an indicator of the amount of body fat and allows the determination of obesity. The body mass index, which is obtained by dividing the individual's body weight by the square of the height, is useful in determining whether the person is at a healthy weight (Garrow and Webster, 1985; Nutall, 2015;Okumuş and Çelikel Taşci, 2024). University students are reported to be at risk for body dysmorphic disorders such as bigorexia (Kaye, 2008;Lofrano-Prado et al., 2015; Cruz-Sáez et al., 2020). Although there is no research on the physiological role of cortisol hormones and changes in hormonal levels in bigorexic individuals, our current study is the first. In this context, it aims to investigate the relationship

between cortisol hormone response and BMI according to bigorexia levels in students of the Faculty of Sports Sciences.

Methods

Participants and Procedures

The universe of the study consisted of 40 university students of different genders (20 female, 20 male) who were studying in the 3rd year of the Recreation Department of the Faculty of Sport Sciences of Bayburt University, did not have any health problems and were regularly involved in bodybuilding (Figure 1). Ethics committee approval (2024/ Decision no: 100/10) 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.



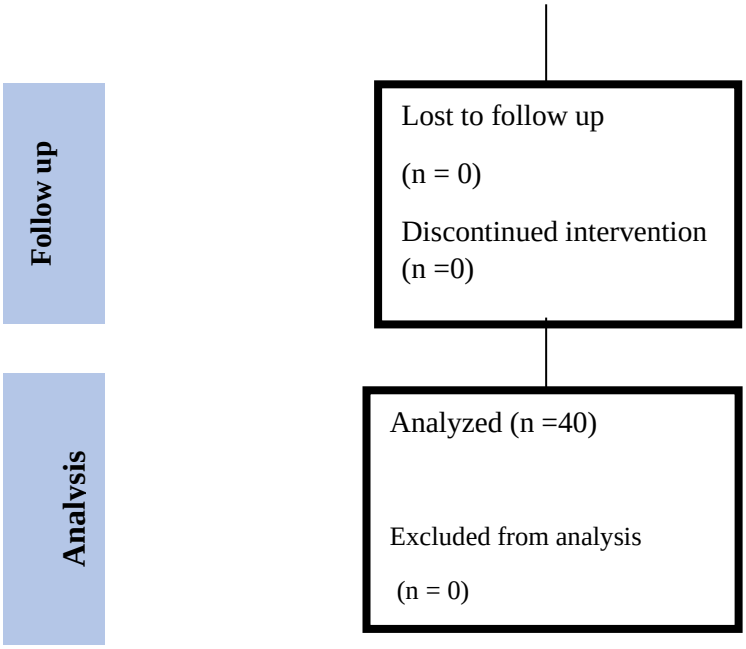


Figure 1. Study cohort flow chart.

The sample size of the study was calculated using the G*Power 3.1.9.7 analysis program; It was determined as 100 with 95% confidence interval, 5% margin of error, and 80% power. The data was collected face to face in an average of 15 minutes using a form containing general information and the MDDI scale for university students. In addition, saliva samples were collected from the individuals included in the study to determine cortisol hormone levels.

The collection of research data: The data were collected face-to-face with the Personal Information Form and MDDI (Bigorexia Scale) (Devrim, 2016) in university students (21 years) in an average of 15 minutes.

Collection of Saliva Samples: Saliva samples were collected from participants. Saliva samples were collected at a time period of 08:00-09:00 in the morning using the passive salivation method in Salivette tubes (Sarstedt, GERMANY) at a rate of 5 cc. After centrifuging at 2000 g for 20 minutes in a refrigerated centrifuge (NF 1200R, NUVE, Ankara, TÜRKİYE) in the laboratory, saliva samples were stored at -80°C until analyzes for cortisol hormone levels were

performed.

Measurement of salivary cortisol hormone levels: The study utilized the Human Cortisol ELISA Kit (BT LAB, Cat.No E 1 003Hu, China) to quantify the amounts of cortisol hormone in saliva samples. The ELISA kit was used to determine concentrations ranging from 31.25 to 2000 pg/mL. The intra-assay coefficients were 8.0% and the inter-assay coefficients were 10.0%. The protocol followed was as indicated in the manufacturer's catalog.

Statistical analysis: The data obtained through survey forms in the study were processed and analyzed by the researcher using the SPSS 26.0 package program. As a result of the analysis performed for the normality test of the data, the skewness and kurtosis (Skewness and Kurtosis) values of all scales and sub-dimensions were found to be between -2 and +2 and it was assumed that the normality assumption was accepted. In the analyses for the variables of gender and BMI status from the demographic questions, T-test, which is a parametric test for two-group comparisons, and ANOVA tests were applied for comparisons of more than two groups. In this context, independent sample T-Test was applied for the variables of gender and number of meals with two groups, and ANOVA analyses were applied for the BMI variable with more than two groups. The groups that caused the significant difference as a result of the comparison of more than two groups were determined with Tukey HSD, which is a Post-Hoc test. It was observed that the scales and sub-dimensions had a normal distribution and parametric tests were used in the analysis of the data. The KMO coefficient was found to be 0.667 and the Bartlet test result was found to be $p>0.00$. Cronbach Alpha analysis was performed to determine reliability values. Cronbach Alpha (α) value was determined as 0.857 (Gürbüz and Şahin, 2014:317). Pearson Correlation Analysis was applied to examine the relationships between the scale and its sub-dimensions used in the study and the cortisol measurements with age, height, weight and BMI. In all analyses, the significance (p) value was taken as 0.05. In the results of the

applied tests, when p<0.05, the difference was considered statistically significant, and when p>0.05, the differences were considered statistically insignificant.

Results

In Table 1, where the demographic data of the participants are examined, it is seen that there are 20 female (50.0%) and 20 male (50.0%) participants according to gender; 4 underweight (10%), 31 normal (77.5%), 4 overweight (10%), and 1 obese (2.5%) participants according to BMI groups.

Table 1: Demographic variables

Variable	Groups	f	%
Gender	Female	20	50,0
	Male	20	50,0
BMI Groups	Underweight	4	10,0
	Normal	31	77,5
	Owerweight	4	10,0
	Obese	1	2,5

	Min.	Max.	Mean	SD.
Age	21	21	21,00	,000
Height (cm)	154,00	188,00	168,90	7,207
Weight (kg)	45	90	62,20	9,993

It was determined that the average age of the participants was 21, their average height was 168.90±7.20 cm, and their average weight was 62.20±9.99 kg.

Table 2: Descriptive statistics of the MDDI (bigorexia scale) and its sub-dimensions

Scale	Min.	Max.	$\bar{X}$	ss	Skewness	Kurtosis	Cronbach Alfa

Bigorexia	24,00	52,00	37,55	6,618	,185	-,309	0,854
Functional disorder	7,00	16,00	11,450	2,330	,150	-,532	0,805
Working for volume	8,00	20,00	14,225	2,596	-,344	,395	0,813
Appearance intolerance	7,00	18,00	11,875	2,583	,258	-,133	0,821
Cortisol(ng/ml)	2,38	5,01	3,539	0,757	,180	-1,234	

Table 2 shows the mean, standard deviation, minimum-maximum and skewness-kurtosis values of salivary cortisol results for the bigorexia scale and its sub-dimensions used in the study. If the skewness and kurtosis values are between -2 and +2, the normality assumption is accepted. In this case, parametric tests will be used for the scale and its sub-dimensions where the normality assumption is provided, and non-parametric tests will be used for the scale and its sub-dimensions where the normality assumption is not provided. The total average score obtained by the participants from the bigorexia scale was found to be 37.550±6.61. When the sub-dimensions were examined, the highest scores were obtained from the work sub-dimension for volume, and the lowest scores were obtained from the functional disorder sub-dimension. According to the results of the normality analysis of the scale and its sub-dimensions, it is seen that normal distribution was provided. According to the results of the reliability analysis of the scale and its sub-dimensions; The overall internal consistency coefficient of the scale was calculated as 0.854, for functional impairment as 0.805, for volume work as 0.813, and for appearance intolerance as 0.21. The mean value of salivary cortisol level taken from the participants was found to be 3.539±0.75.

Table 3: Comparison of MDDI (bigorexia scale) and other measurement scores with gender

	Gender	**N**	$\bar{X}$	**sd**	**t**	**p**
Bigorexia	Female	20	3,285	,675	-2,227	,032*
	Male	20	3,793	,765		
Functional disorder	Female	20	10,750	1,712	-1,968	,056
	Male	20	12,150	2,680		
Working for volume	Female	20	13,550	2,114	-1,682	,101
	Male	20	14,900	2,900		

Appearance intolerance	Female	20	11,400	1,875	-1,168	,250
	Male	20	12,350	3,116		
Cortisol(ng/ml)	Female	20	3,285	,675	-2,227	,032*
	Male	20	3,793	,765		

According to the T-Tests examining the statistical differences in the participants' bigorexia scale and cortisol measurements according to gender groups; statistical significance was found in the general scores of the scale ($p<.05$). It was seen that the average score of the male participants from the scale was higher than the females. There was no difference according to gender in the functional disorder, working for volume and appearance intolerance sub-dimensions of the scale ($p>.05$). When the salivary cortisol levels were examined, a significant difference was found according to gender ($p<.05$). As in the general score of the bigorexia scale, the average salivary cortisol levels of the male participants were high.

Table 4: Comparison of MDDI (bigorexia scale) and other measurement scores with BMI groups (ANOVA)

	BMI	**N**	**x̄**	**sd**	**F**	**p**	**Post Hoc (Tukey)**
Bigorexia	Underweight	4	39,000	1,225	2,177	0,108	-
	Normal	31	38,450	6,796			
	Overweight	4	31,000	3,742			
	Obese	1	30,000	.			
Functional disorder	Underweight	4	11,750	2,061	1,713	0,182	-
	Normal	31	11,741	2,380			
	Overweight	4	9,750	0,957			
	Obese	1	8,000	.			
Working for volume	Underweight	4	14,500	1,732	2,321	0,092	-
	Normal	31	14,612	2,512			
	Overweight	4	12,000	2,708			
	Obese	1	10,000	.			
Appearance intolerance	Underweight	4	12,750	1,500	1,691	0,186	
	Normal	31	12,096	2,712			
	Overweight	4	9,250	0,500			
	Obese	1	12,000	.			
Cortisol(ng/ml)	Underweight	4	3,702	0,809	1,108	0,359	
	Normal	31	3,609	0,784			
	Overweight	4	2,937	0,134			

Obese	1	3,110	.	

* Post hoc tests cannot be performed because there are less than two values in at least one group.

According to one-way ANOVA analyses examining the statistical differences in the participants' bigorexia scale and cortisol measurements according to BMI groups, no significant difference was detected in the results of salivary cortisol, bigorexia scale and its sub-dimensions according to BMI groups (p>.05).

Table 5: Relationships between continuous demographic variables of the participants, MDDI (Bigorexia scale), its sub-dimensions and cortisol levels

		1	2	3	4	5	6	7	8	9
1.Age	r	a.								
2.Height (cm)	r	a.	1							
3.Weight (kg)	r	a.	,457**	1						
4.BMI	r	a.	-,012	,709**	1					
5.Bigorexia	r	a.	,218	-,360*	-,330*	1				
6. Functional disorder	r	a.	,279	-,265	-,297	,924**	1			
7. Working for volume	r	a.	,293	-,314*	-,330*	,871**	,758**	1		
8. Appearance intolerance	r	a.	,013	-,368*	-,247	,851**	,704**	,543**	1	
9. Cortisol(ng/ml)	r	a.	,377*	-,215	-,240	,908**	,860**	,804**	,741**	1

a. Cannot be calculated because all values are the same in at least one of the variables
** : Correlation is significant at the 1% level
** : Correlation is significant at the 5% level

According to the correlation analysis examining the relationships between the continuous demographic variables of the participants, the bigorexia scale, its sub-dimensions and cortisol levels; a negative moderate relationship was found between bigorexia and weight (-.360*) and BMI (-.330*). In other words, as the participants' weight and BMI measurements decrease, there will be an increase in the scores they receive from the bigorexia scale. When the relationship between bigorexia and cortisol is examined, it will be seen that there is a very strong positive

relationship (.908**). In other words, an increase in the bigorexia level will also cause an increase in cortisol levels. On the other hand, a moderate positive relationship (.377*) was found between cortisol and height, a very strong positive relationship (.860**) with the functional disorder sub-dimension, a very strong positive relationship (.804**) with the work sub-dimension for volume, and a strong positive relationship (.741**) with the appearance intolerance sub-dimension. A moderate negative relationship (-.368* / -.314*) was found between the study subscales of appearance intolerance and volume and weight, and a strong positive relationship (.709**) was found between BMI and weight.

Discussion

Bigorexia nervosa is a nosological disorder considered a subtype of feeding/eating disorder or body dysmorphic disorder, characterized by the desire of individuals to have less fat mass and the obsession with increasing muscle mass in this context (Vasiliu, 2023; Giordano et al.,2024). This study was conducted to investigate the relationship between salivary cortisol hormone response and body mass index according to bigorexia levels in sports science faculty students. In recent studies, it has been reported that with the increasing popularity of bodybuilding, young men are not satisfied with their appearance, their ideal body perception has changed and they find lean body mass more important (Mosley, 2009; Devrim *et al*. 2018; Duran *et al*. 2020). Body dysmorphic disorders are reported to be prevalent among male weightlifters (Sreshta et al., 2017) and male bodybuilders (Mitchell *et al*., 2017). According to the results of the research, the average score of male participants on the bigogrexia scale is higher than that of female participants. No difference was found between the genders in the functional disorder, volume work and appearance intolerance sub-dimensions of the scale ($p>.05$).According to the results of our current study, it was determined that the average score of male participants from the bigogrexia scale was higher than that of female participants ($p<0.05$). The results of our study

are consistent with the research results reported in the literature (Mosley, 2009; Swami *et al*., 2016; Swami *et al*., 2018; Mitchell *et al*., 2017; Devrim *et al*. 2018; Duran *et al*. 2020). We believe that the reason for this is that, as reported in many studies, men's body image concerns are more related to being muscular (McCabe *et al*., 2005; Swami *et al*., 2016; Swami *et al*., 2018).

Studies have shown that men feel more dissatisfied with their body appearance (Bucchianeri *et al*., 2014) and muscularity (Murray and Lewis, 2012) and are sensitive about having an idealized male body (Mulgrew and Cragg, 2017). Our current results differ from the literature (Murray and Lewis, 2012; Bucchianeri *et al*., 2014; Mulgrew and Cragg, 2017). We believe that this is due to the fact that the participants were university students and the sample size.

Cortisol is a corticosteroid hormone produced in the cortex of the adrenal gland and is associated with the body's response to stress (Jefferies, 1991).The idea that one does not have enough muscle mass or body size constantly occupies the individual's mind, leading to stress (Todd, 2024). In our current study, according to the correlation analysis examining the relationships between the continuous demographic variables of the participants, the bigorexia scale, its sub-dimensions and cortisol levels; a negative moderate relationship was found between bigorexia and weight (-.360*) and BMI (-.330*). As the participants' weight and BMI measurements decreased, their scores from the bigorexia scale increased, while a very strong positive relationship (.908**) was found between the bigorexia scale score and cortisol, and an increase in the salivary cortisol level was found with an increase in the bigorexia scale score ($p<0.05$). In our literature search, we did not find any research examining the relationship between the stress hormone cortisol hormone response and body mass index according to bigorexia levels in students of the faculty of sports sciences. The results of our study are the

first and, together with the limitation, they are consistent with the research results showing the distance between the bigorexia score and the stress level (Devrim and Bilgiç, 2018; Murray et al., 2022; Todd, 2024; Liman, 2020; Kaur et al., 2022).

Conclusion

In conclusion, this research has revealed the relationship between cortisol hormone levels and BMI according to bigorexia nervosa levels in sports science faculty students. It is thought that the information obtained will contribute and benefit to more effective strategies to protect the health of athletes and sports science students and to researchers and researches to be carried out in this field.

Declarations

Ethical considerations

The research was approved by the Bayburt University Research Ethics Committee (2024/ Decision no: 100/10). Before the data were collected by the researchers, participants were informed about the study in accordance with the Declaration of Helsinki and their written/verbal consent was obtained. All methods were conducted in accordance with relevant guidelines and regulations.

Authors' Contribution

T.O.E., B.B. and A.O.E designed the study. T.O.E and A.O.E collected data. T.O.E and B.B. analyzed the data. T.O.E and A.O.E prepared the draft plan. All authors contributed to writing the manuscript. All authors read and approved the final manuscript.

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Data Availability Statement

The corresponding author upon reasonable request will provide data supporting the findings of this study.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Azaiez, F., Alajjouri, M. H. I., Lahmar, S., & Chalghaf, N. (2014). Bigorexia, perfectionism and overtraining among Tunisian team sport players. *International Journal of Humanities and Social Science Invention*, *3*(6), 9-16.

Murray, S. B., Nagata, J. M., Griffiths, S., Calzo, J. P., Brown, T. A., Mitchison, D., ... & Mond, J. M. (2017). The enigma of male eating disorders: A critical review and synthesis. *Clinical psychology review*, *57*, 1-11.

Devrim, A., & Bilgiç, P. (2018). Bigoreksiya: Vücut Dismorfik Bozukluğu Mu, Yeme Bozukluğu Mu?. *Sağlık Bilimleri Dergisi*, *27*(1), 64-69.

Jefferies, W. M. (1991). Cortisol and immunity. *Medical hypotheses*, *34*(3), 198-208.

Todd, M. E. (2024). *The thinking body*. Rare Treasure Editions.

Bayraktar B. *Endocrine system* (*Endokrin sistem*). [In:] Taşkin E, Kocahan S, editors, *Physiology for Health Sciences* (*Sağlık bilimleri için fizyoloji*). Ankara: Akademisyen Kitabevi; 2020, 239–70.

Levine, A., Zagoory-Sharon, O., Feldman, R., Lewis, J. G., & Weller, A. (2007). Measuring cortisol in human psychobiological studies. Physiology & behavior, 90(1), 43-53.

Gatti, R., Antonelli, G., Prearo, M., Spinella, P., Cappellin, E., & Elio, F. (2009). Cortisol assays and diagnostic laboratory procedures in human biological fluids. Clinical biochemistry, 42(12), 1205-1217.

Kudielka, B. M., Hellhammer, D. H., & Wüst, S. (2009). Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. Psychoneuroendocrinology, 34(1), 2-18.

Kaushik, A., Vasudev, A., Arya, S. K., Pasha, S. K., & Bhansali, S. (2014). Recent advances in cortisol sensing technologies for point-of-care application. Biosensors and Bioelectronics, 53, 499-512.

Sabiston, C. M., Pila, E., Vani, M., & Thogersen-Ntoumani, C. (2019). Body image, physical activity, and sport: A scoping review. Psychology of Sport and Exercise, 42, 48–57. https://doi.org/https://doi.org/10.1016/j.psychsport.2018.12.010(open in a new window)

Swami, V., Barron, D., Lau, P. L. ve Jaafar, J. L. (2016). Psychometric properties of the Drive for Muscularity Scale in Malay men. Body Image, 17, 111–116.

Swami, V., Vintila, M., Tudorel, O., Goian, C. ve Barron, D. (2018). Factor structure and psychometric properties of a Romanian translation of the drive for Muscularity Scale (DMS) in university men. Body Image, 25, 48–55.

McCabe, M. P. ve Ricciardelli, L. A. (2005). A prospective study of pressures from parents, peers, and the media on extreme weight change behaviors among adolescent boys and girls. Behavior Research and Therapy, 43(5), 653–668. doi: 10.1016/j.brat.2004.05.004

Cabou, C., & Burcelin, R. (2011). GLP-1, the gut-brain, and brain-periphery axes. *The review of diabetic studies: RDS*, *8*(3), 418.

Murray, T., & Lewis, V. (2014). Gender-role conflict and men's body satisfaction: The moderating role of age. *Psychology of Men & Masculinity*, *15*(1), 40.

Mulgrew, K. E., & Cragg, D. N. (2017). Age differences in body image responses to idealized male figures in music television. *Journal of Health Psychology*, *22*(6), 811-822.

Bucchianeri, M. M., Serrano, J. L., Pastula, A., & Corning, A. F. (2014). Drive for muscularity is heightened in body-dissatisfied men who socially compare. *Eating disorders*, *22*(3), 221-232.

Cruz-Sáez, S., Pascual, A., Wlodarczyk, A., & Echeburúa, E. (2020). The effect of body dissatisfaction on disordered eating: The mediating role of self-esteem and negative affect in male and female adolescents. *Journal of health psychology*, *25*(8), 1098-1108.

Devrim, A., (2016) The validity and reliability study of the Muscle Dysmorphic Disorder Inventory and Bodybuilder Image Grid and the evaluation of their relations to eating attitude test, Hacettepe University, Graduate School of Health Sciences, Community Nutrition Programme, Master Thesis, Ankara.

Devrim, A., Bilgic, P., & Hongu, N. (2018). Is there any relationship between body image perception, eating disorders, and muscle dysmorphic disorders in male bodybuilders?. *American journal of men's health*, *12*(5), 1746-1758.

Duran, S., Çiçekoğlu, P., & Kaya, E. (2020). Relationship between orthorexia nervosa, muscle dysmorphic disorder (bigorexia), and self-confidence levels in male students. *Perspectives in psychiatric care*, *56*(4).

Orkun Erkılıç, T., Bayraktar, B., Erkılıç, A. O., & Özcan, G. B. (2024). Determination of Salivary Cortisol Levels and Nutrition, Smoking and Physical Activity Status of University Students during the Exam Period. *Mersin Üniversitesi Tıp Fakültesi Lokman Hekim Tıp Tarihi ve Folklorik Tıp Dergisi*, *14*(3), 594-604.

Garrow, J. S., & Webster, J. (1985). Quetelet's index (W/H2) as a measure of fatness. *International journal of obesity*, *9*(2), 147-153.

Giordano, F., Saladino, V., Cortis, C., Castellani, L., Verrastro, V., & Fusco, A. (2024). Bigorexia: Identification of Protective and Risk Psychological Factors in Young Adulthood. In *Book of Abstract 29th Annual Congress of the European College of Sport Science* (pp. 406-406). European College of Sport Science.

Kaye, W. (2008). Neurobiology of anorexia and bulimia nervosa. *Physiology & behavior*, *94*(1), 121-135.

Kirbas, Z. O., Bayraktar, B., & Odabasi Aktas, E. (2024). Investigation of the relationship of cardiac troponin I and cortisol hormone levels with some variables in children: Relational screening model. *Med Sci*, *13*, 310-4.

Krug, I., Fuller-Tyszkiewicz, M., Hughes, E. K., & Roncero, M. (2022). What Do We Know About Other Specified Feeding or Eating Disorders, Unspecified Feeding and Eating Disorder and the Other EXIAs (eg, Orthorexia, Bigorexia, Drunkorexia, Pregorexia etc.)?. *Frontiers in Psychology*, *13*, 953402.

Okur, S. (2024). Maneviyat ve Sağlık, Multidisipliner Yaklaşımla Bilimsel Çalışmalar, s: 43-62, İksad Yayınevi, Ankara.

Li E, Shan H, Chen L, Long A, Zhang Y, Liu Y, Jia L, Wei F, Han J, Li T, Liu X, Deng H, Wang Y. OLFR734 mediates glucose metabolism as a receptor of asprosin. Cell Metabolism. 2019;30:319-328.

Li, Y., Hansotia, T., Yusta, B., Ris, F., Halban, P. A., & Drucker, D. J. (2003). Glucagon-like peptide-1 receptor signaling modulates β cell apoptosis. *Journal of Biological Chemistry*, *278*(1), 471-478.

Lofrano-Prado, M. C., Prado, W. L., Barros, M. V. G., & de Souza, S. L. (2015). Eating disorders and body image dissatisfaction among college students. *ConScientiae Saúde*, *14*(3), 355-362.

Mitchell, L., Murray, S. B., Hoon, M., Hackett, D., Prvan, T., & O'Connor, H. (2017). Correlates of muscle dysmorphia symptomatology in natural bodybuilders: Distinguishing factors in the pursuit of hyper-muscularity. *Body image*, *22*, 1-5.

Mosley, P. E. (2009). Bigorexia: bodybuilding and muscle dysmorphia. *European Eating Disorders Review: The Professional Journal of the Eating Disorders Association*, *17*(3), 191-198.

Nuttall, F. Q. (2015). Body mass index: obesity, BMI, and health: a critical review. *Nutrition today*, *50*(3), 117-128.

Okumuş M., Çelikel Taşci S. (2024). Sporcu Beslenmesi Üzerine Bilgi Düzeyinin Araştırılması: Bayburt Üniversitesi Örneği. Sağlık ve Beslenme Üzerine Bilimsel Araştırmalar. s:277-316. İksad Yayınevi, Ankara.

Ozcan, G. B., Bozok, U. G., Battal, F., & Bayraktar, B. (2024). The impact of aromatherapy on glossophobia among medical students: A study on cortisol levels and stress reduction. *Medicine Science*, *13*(3).

Sreshta, N., Pope, G. H., Hudson, I., & Kanayama, G. (2017). Muscle dysmorphia. *Body dysmorphic disorder: Advances in research and clinical practice*, pp 81-107.

Stanley S, Wynne K, McGowan B, and Bloom S. Hormonal regulation of food intake. Physiol Rev. 2005; 85, 1131-1158.

Vasiliu, O. (2023). At the Crossroads between eating disorders and body dysmorphic disorders—the case of bigorexia nervosa. *Brain Sciences*, *13*(9), 1234.

Vasiliu, O. (2023). At the Crossroads between eating disorders and body dysmorphic disorders—the case of bigorexia nervosa. *Brain Sciences*, *13*(9), 1234.

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