**Original Article** 

# The Effect of 16 : 8 Intermittent Fasting Diet on Cognitive Eating Behavior in Individuals with Metabolic Syndrome

Yasemin Kunduracı<sup>1</sup>, Hanefi Özbek<sup>2</sup>

**CLINICAL SCIENCE OF** 

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<sup>1</sup>Department of Nutrition and Dietetics, Bandırma Onyedi Eylül University, Faculty of Health Sciences, Balıkesir, Turkey <sup>2</sup>Department of Medical Pharmacology, İzmir Bakırçay University, Faculty of Medicine, Izmir, Turkey

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#### ABSTRACT

**Objective:** The aim of this study is to determine the effect of intermittent fasting diet on cognitive eating behavior in individuals with metabolic syndrome.

**Methods:** This intervention-type study was conducted on 70 individuals with metabolic syndrome between the ages of 18 and 65 who were directed by a physician to an obesity counseling center. In the study, energy-restricted diets were planned similarly for all participants. Participants were randomly divided into 2 groups according to age and gender. The control group was followed up for 12 weeks with the frequent intermittent diet plan and the intervention group with the 16 : 8 model intermittent fasting diet plan. The general demographic characteristics of the participants were defined before the research. Three-factor Nutrition Questionnaire was applied before and after the study in order to define the cognitive eating behavior level.

**Results:** The majority of the participants are in the 54-65 age group. The research group is married (94%), has primary-secondary (52.3%) level of education, whose income is at or above the minimum wage (95.4%), is a housewife (43.1%), retired (24%)), and consists of individuals who are public employees (12.3%). There was no significant difference between the groups in the total score of the 3-Factor Nutrition Questionnaire before the intervention. In terms of the sub-components of the 3-Factor Nutrition Questionnaire, statistically significant differences were found in both groups during the diet in uncontrolled eating, conscious restriction, and emotional eating scores (P < .05).

**Conclusions:** As a result, it has been determined that the application of energy-restricted diet as frequent or 16 : 8 model intermittent fasting diet does not have any superiority over the components of cognitive eating behavior, uncontrolled eating, conscious restraint, and emotional eating. Both energy-restricted diet plans have similarly positive effects on cognitive eating behavior.

Keywords: Eating behavior, fasting, metabolic syndrome, diet

## INTRODUCTION

Metabolic syndrome (MetS) has been defined as a series of metabolic dysfunctions that increase the risk of developing diabetes and cardiovascular disease.<sup>1</sup> Although various criteria are used in the definition of MetS, its basis is obesity, hyperglycemia, hypertension, hyperlipidemia, and dyslipidemia components characterized by low highdensity cholesterol.<sup>2</sup> Along with the increase in obesity and comorbid diseases in the world, the increase in MetS reaches threatening dimensions in terms of public health<sup>3</sup>. In studies conducted between various countries and groups, the frequency of MetS has been reported to be between 28% and 50% in adults.<sup>4-6</sup> According to the data of the Turkey Metabolic Syndrome Research conducted on the frequency of MetS in our country, 1 out of every 3 adults suffers from MetS.<sup>7</sup> The most basic point in the physiopathology of MetS is insulin resistance and obesity.<sup>8</sup> On the other hand, the sedentary life brought by modern life increases the complications of the disease.<sup>9</sup>

Lifestyle change is the basis of MetS treatment.<sup>10</sup> It is also possible to use pharmacological agents and receive support from surgical treatments for the regulation of insulin resistance, hyperlipidemia, and hypertension.<sup>11,12</sup> The effect of diet therapy in MetS is of major clinical importance. It is known that losing 5%-10% of weight in cases within a 6-month period is very effective in regulating hyperglycemia, hyperlipidemia, and hypertension.<sup>11</sup>



Energy restriction is the most effective method for weight loss in MetS cases. If a difference is created between the energy spent and the energy taken, it is inevitable that the amount of body fat will decrease.<sup>13</sup> Intermittent fasting diets are also types of diets that allow energy restriction. When examined in terms of terminology, "intermittent fasting" is defined as fasting in a certain period and feeding in a certain period.<sup>14,15</sup> It has been argued that this form of nutrition, which has a very old history, has a healing feature of hunger.<sup>16</sup> As a religious practice, it has been practiced in different forms by many communities for centuries.<sup>17,18</sup>

In vivo and in vitro experiments on the use of intermittent fasting have increased in recent years, with the identification of the molecular mechanisms of long-term fasting.<sup>19</sup> In animal experiments, positive effects have been reported that suppress inflammation, alleviate insulin resistance, and regulate blood pressure.<sup>20</sup> The most common types of intermittent fasting diets are religious fasting such as Ramadan fasting, 5 days of feeding known as the 5 : 2 model, 2 days of fasting or very low-energy nutrition, and 16-hour fasting combined with 8-hour feeding period in a day known as the 16 : 8 model.<sup>21,22</sup> In 16 : 8 model fasting diets, which are also defined as time-limited nutrition, water, unsweetened-cream-free tea and coffee may be consumed during the 8-hour fasting period.<sup>23</sup> In a study examining the effect of dietary intervention on cognitive eating behavior using the 3-Factor Nutrition Questionnaire, cognitive eating behavior scores were compared after 6 and 18 months of standard dietary interventions, and no statistically significant difference was found.<sup>24</sup> There is no study in the literature on the effect of intermittent fasting diet intervention on cognitive eating behavior. This study aimed to investigate the effect of applying an energyrestricted diet and an intermittent fasting diet for 12 weeks on cognitive eating behavior in individuals with MetS.

## METHODS

This non-interventional study, which included only dietary intervention, was conducted on patients followed in an

#### **Main Points**

- Metabolic Syndrome (MetS) threatens public health in terms of obesity, diabetes, and cardiovascular diseases.
- Energy restriction is the most effective method for weight loss in MetS cases.
- Application of energy-restricted diet in the form of frequent intermittent or 16 : 8 model intermittent fasting nutrition plan has similar positive effects on cognitive nutrition behavior, uncontrolled eating, conscious restriction, and emotional eating components, and it was determined that there was no superiority over each other in this study.

obesity counseling center between June 2019 and March 2020. Reference studies were taken into account in the selection of the sample. Based on the assumption that there will be a 5% weight loss during the research, it was assumed that 30 participants in the control and intervention groups would complete the research with the G-power analysis performed with 80% power and  $\alpha = 0.05$ margin of error. It was aimed to reach 70 participants, with the assumption that they could discontinue the diet intervention or leave the study for any reason. Participants consist of individuals between the ages of 18 and 65, diagnosed with MetS by a physician and referred to a dietitian, and having a body mass index of 27 kg/m<sup>2</sup> and above. Participants with conditions such as pregnancy, lactation, menopause, type 1 diabetes, the presence of a disease requiring a special diet such as celiac, the use of special nutritional support, heavy physical activity, the presence of problems in liver-kidney functions or immunodeficiency, and the use of insulin or sulfonamide-derived diabetic drugs were excluded. A total of 19 patients were screened in the study, and 128 patients were eliminated due to exclusion criteria. Participants who met the research inclusion criteria were randomized into control and intervention groups according to age and gender. At the end of the study, 33 participants (15 male, 18 female) in the intervention group and 32 participants in the control group (16 male, 16 female) completed the research.

The necessary permissions for the research were obtained. The Data Collection Form prepared by the researcher was used as a data collection tool in the research. The form was filled out by the researcher using face-to-face interview technique. The 3-Factor Nutrition Questionnaire, which is used to determine the level of cognitive eating behavior, was used in the form that included sociodemographic characteristics. The questionnaire was developed by Stunkard and Messick and later revised by the Swedish Obesity Study Group.<sup>25,26</sup> Turkish validity and reliability of the questionnaire were made by Kıraç et al .<sup>27</sup> Necessary permissions for the use of the scale were obtained via e-mail. The 3-Factor Nutrition Questionnaire is a Likerttype scale and measures cognitive eating behavior in the subcomponents of conscious eating, uncontrolled eating, and emotional eating.

Statistical Package for the Social Sciences 20.0 package program was used for statistical analysis. Mean, standard deviation, minimum-maximum, number, and percentage were used to define the variables. Shapiro–Wilk test was used to determine normality. Independent samples *t*-test was used in the analysis of normally distributed data, and Mann–Whitney *U* test was used in the analysis of nonnormally distributed data. Chi-square test was used for categorical data. P < .05 was accepted as statistical significance level.

Age, gender, body weight, and physical activity levels of the participants were taken into account in the planning of the diets. The Turkish Dietary Guidelines were used to calculate the daily energy expenditure of the participants, and the physical activity factor was added to the basal metabolic rates determined according to age and gender. In the study, 75% of the calculated energy requirement was planned as diet in order to ensure weight loss in all participants. The diets are completely planned according to individual characteristics and macro-micro nutrient needs are taken into consideration. A menu consisting of 5-6 meals was planned at 3-3.5 hour intervals for the participants in the control group and 2 main meals, and 2 snacks between 10:00 and 18:00 or 11:00 and 19:00 in the intervention group. Example menus are shown in Figure 1.

### RESULTS

This study was conducted with subjects aged between 18 and 65 years who were referred to an obesity counseling center with the diagnosis of MetS. The male-to-female ratio of the research group is almost equal. There was no significant difference in age distribution between the control and intervention groups. Most of the male participants are retired, and most of the females are housewives. The education level of the participants is generally at the level of primary-secondary education (Table 1). The majority of the group (94%) has a monthly income of minimum wage and above. 83% of the participants use regular medication with the recommendation of a physician. 70% of the participants use antihypertensive, 46% antidiabetic, and 26% hyperlipidemia drugs. It was determined that 86% of the participants had first-degree chronic disease and 69% had second-third-degree chronic disease. There was no statistically significant difference between the groups in terms of income status and presence of disease.

In terms of nutrition and physical activity habits, half of the participants reported that they consumed 2 main meals a day before the study. One out of every 3 participants declared that they do not eat snacks. Most of the participants skipped meals frequently and the most frequently skipped meal was reported as lunch. The main reasons

One-day sample menu of research groups				
Control Group Sample Menu	Response Group Sample Menu			
Morning (07:30)	Morning (10:30)			
Light tea (unsweetened)	Light tea (unsweetened)			
1 boiled egg	1 boiled egg			
2 walnut kernels	2 walnut kernels			
1 slice of semi-skimmed cheese (30 g)	1 slice of semi-skimmed cheese (30g)			
2 slices of whole grain bread (25g)	2 slices of whole grain bread (25g)			
Tomato/cucumber cold cuts	Tomato/cucumber cold cuts			
i nedrun sized peach	1 medium sized peach			
Noon (12:30)				
1 bowl of lentil soup (200 ml)	Snack (13:30)			
4 tablespoons of vegetable food	1 glass of kefir (150 ml)			
1 slice of whole grain bread	4 apricots			
Snack (15:30)	Snack (15:30)			
2 wholemeal breadcrumbs (20 g)	1 bowl of lentil soup (200 ml)			
1 bowl of yogurt (150 ml)	2 wholemeal breadcrumbs (20 g)			
	1 bowl of yogurt (150 ml)			
Evening (18:30)	Evening (18:30)			
2 grilled meatballs (60 grams cooked)	2 grilled meatballs (60 grams cooked)			
3 tablespoons of bulgur pilaf	3 tablespoons of bulgur pilaf			
Mixed Season Salad (without oil)	4 tablespoons of vegetable food			
1 glass of buttermilk (200 ml)	1 slice of whole grain bread (25g)			
	Mixed Season Salad (without oil)			
Snack (21:30)	1 glass of buttermilk (200 ml)			
1 glass of kefir (150 ml)				
4 apricots				
Water/unsweetened tea/unsweetened black	coffee/mineral water free every hour			
Rest	(23:00)			

Figure 1. One-day sample menu of research groups.

Table 1. General Characteristics of the Research Group					
	Control Group	Intervention Group	Total		
	(n = 33)	(n = 32)	(n=65)		
Characteristics	n (%)	n (%)	n (%)	Р	
Age					
18-29	4(1.1)	3(9.4)	7(10.8	.668	
30-41	5(15.2)	9(28.1)	14(21.5)		
42-53	9(27.3)	7(21.9)	16(24.6)		
54-65	15(45.5)	13(40.6)	28(43.1)		
Gender	1				
Male	15(45.5)	16(50.0)	31(48)	.714	
Female	18(54.5)	16(50.0)	34(52)		
Marital status	I				
Married	30(90.9)	31(96.9)	61(94)	.613	
Single	3(9.1)	1(3.1)	4(6)		
Educational statu	s				
Literate	0(0)	5(15.6)	5(7.7)	.116	
Primary education	16(48.5)	12(37.5)	28(43.1)		
Secondary education	2(6.1)	4(12.5)	6(9.2)		
High school and equivalent	11(33.3)	4(12.5)	15(23.1)		
University	4(12,1)	7(21.9)	11(16.9)		
Job		I			
Housewife	13(39.4)	15(46.9)	28(43.1)	.808	
Self-employment	4 (12.1)	1(3.1)	5(7.7)		
Officer	4(12.1)	4(12.5)	8(12.3)		
Paid employee	1 (3.0)	5(15.6)	6(9.2)		
Employee	2 (6.1)	0(0)	2(3.1)		
Retired	9(27.3)	7(21.9)	16(24.6)		

for skipping meals are loss of appetite and lack of time. When classified in terms of physical activity level, it was concluded that 3 out of every 4 people were sedentary (Table 2).

The results of the food consumption record obtained during the research are summarized in Table 3. There was no statistically significant difference between the control and intervention groups. As both groups were given similar

Table 2. Nutrition and Physical Activity Habits of theResearch Group						
	Control Intervention Group Group		Total			
	(n = 33)	(n = 33) (n = 32) (n =		)		
Features	n (%)	n (%)	n (%)	Р		
Number of main	meals p	er day				
2	13(39.4)	19(59.4)	32(49.2)	.107		
3	17(51.5)	13(40.6)	30(46.2)			
4	3(9.1)	0(0)	3(4.6)			
Number of snacks	per day					
none	9(27.3)	16(50)	25(38.5)	.028		
1	9(27.3)	11(34.4)	20(30.8)			
2	13(39.4)	3(9.4)	16(24.6)			
3	1(3.0)	2(6.2)	3(4.6)			
4	1(3.0)	0(0)	1(1.5)			
Meal skipping stat	tus					
Yes	26(78.8)	25(78.1)	51(78.5)	.948		
No	7(21.2)	7(21.9)	14(21.5)			
Skipped meal						
Morning	8(30,8)	9(36.0)	17(33.3)	.768		
Noon	16(61,5)	14(56.0)	30(58.8)			
evening	2(7.7)	2(8)	4(7.8)			
Skipping frequence	:y					
Always	3(11,5)	8(32)	11(21.6)	.206		
Often	15(57.7)	11(44)	26(51.0)			
Rarely	8(30,8)	6(24.0)	14(27.5)			
Reason for skippir	ng					
Lack of time	6(23.1)	6(24)	12(23.5)	.105		
Does not want it-without appetite	12(46,2)	4(16.0)	16(31.4)			
To lose weight	4(15,4)	7(28.0)	11(21.6)			
Non habit	4(15,4)	8(32.0)	12(23.5)			
Physical activity le	vel					
Physically inactive	27(81.8)	23(71.9)	50(76.9)	.381		
Low level of physical activity	4(12,1)	6(18.8)	10(15.4)			
Adequate physical activity level	2(6.1)	3(9.4)	5(7.7)			

Table 3. Ene	rgy, Macro, and	d Micronutrient	Intakes of the R	esearch Group								
		Col	ntrol Group (n =33)				Interve (r	ntion Group n =32)			Tota (n=6	_ (2
Food items	Beginning Mean ± SD	4th week Mean ± SD	8th week Mean ± SD	12th week Mean ± SD	٩	Beginning Mean ± SD	4th week Mean ± SD	8th week Mean ± SD	12th week	٩	Doeginning	Oweek 12
Energy (kcal )	$2043.50 \pm 355.16$	$1556.82 \pm 322.61$	1578.71 ± 306.83	$1519.52 \pm 295.71$	<.001	2066.14 ± 402.59	$1535.88 \pm 288.34$	$1518.4 \pm 358.33$	$1496.54 \pm 341.95$	<.001	.811	.773
Carbs (g)	$216.10 \pm 62.57$	$161.54 \pm 46.81$	163.47 ± 42.16	158.46 ± 29.28	<.001	201.99 ± 48.42	155.03 ± 44.22	153.6 ± 46.98	$151.58 \pm 43.39$	<.001	.314	.458
Carbs (%)	$42.1 \pm 8.49$	41.68 ± 10.09	41.47 ± 7.3	42.32 ± 6.5	.963	39.23 ± 7.01	$40.19 \pm 8.58$	40.31 ± 7.57	40.66 ± 8.56	.882	.144	.380
Oil amount (g)	$92.71 \pm 24.72$	68.26 ± 23.02	$69.44 \pm 18.87$	63.26 ± 21	<.001	98.89 ± 29.91	66.37 ± 16.25	$65.08 \pm 18.46$	66.16 ± 23.82	<.001	.367	.603
Fat percentage (%)	41.11 ± 9.06	$39.4 \pm 10.05$	39.62 ± 8.77	$36.8 \pm 8.53$	.146	42.82 ± 8.42	39.41 ± 8.8	38.57 ± 6.34	39.43 ± 8.63	.487	.431	.221
Protein amount (g)	$80.54 \pm 22.08$	67.41 ± 22.61	68.73 ± 22.53	72.62 ± 22.62	.001	85.63 ± 22.32	74.27 ± 30.96	73.07 ± 22.53	67.66 ± 19.75	.003	.359	.351
Protein (%)	$15.69 \pm 3.02$	$17.19 \pm 4.02$	$17.3 \pm 3.84$	19.13 ± 4.6	.001	16.66 ± 3.23	19.02 ± 6.13	19.41 ± 4.6	$18.25 \pm 4.16$	960.	.217	.423
Fiber amount (g)	22.77 ± 5.64	28.21 ± 7.74	27.88 ± 8.49	27.92 ± 7.03	<.001	22.68 ± 7.49	25.51 ± 8.16	25.43 ± 9.35	24.86 ± 8.47	.265	.960	.118
Vitamin A (µg)	1714.25 ± 657.02	$2615.83 \pm 1590.97$	2297.01 ± 1340.93	$2486.61 \pm 1599.57$	.005 ¥	2830.12 ± 4899.56	$2154.04 \pm 1156.48$	1746.76 ± 902.71	$1985.91 \pm 1289.1$	.473	.199	.198
Vitamin B9 (µg)	$311.22 \pm 89.34$	380.88 ± 132.25	385 ± 134.77	372.67 ± 127.09	¥ 200.	381.4 ± 186.69	370.67 ± 140.77	358.47 ± 122.37	351.45 ± 110.95	.693	.057	.319
Vitamin B12(µg)	$5.49 \pm 8.41$	4.26 ± 2.98	<b>4.18</b> ± <b>1.88</b>	$3.58 \pm 1.51$	.324 *	8.7 ± 17.67	$3.93 \pm 2.42$	$4.65 \pm 1.93$	<b>4.73</b> ± <b>1.95</b>	.177	.352	.010
Vitamin C (mg)	$109.2 \pm 68.47$	133.5 ± 69.41	138.59 ± 67.14	125.74 ± 64.39	.051 <sup>€</sup>	$80.04 \pm 40.3$	$108.85 \pm 60.83$	99.31 ± 49.21	$110.54 \pm 56.5$	.037	.083	.316
Sodium (mg)	$3740.57 \pm 1308.27$	2866.54 ± 1224.49	3046.12 ± 1165.18	2702.52 ± 973.81	<.001	3325.97 ± 855.33	2703.07 ± 894.21	2571.16 ± 703.56	2805.94 ± 784.5	<.001	.135	.640
Calcium (mg)	$901.83 \pm 312.75$	840.02 ± 230.24	879.76 ± 287.58	792.66 ± 294.52	.126	921.65 ± 314.05	871.49 ± 298.29	856.19 ± 287.63	852.9 ± 288.52	.514	.800	.408
Phosphorus (mg)	1290.41 ± 286.58	1228.14 ± 319.4	1215.16 ± 324.68	1213.71 ± 292.73	.314	1320.31 ± 287.61	1220.58 ± 365.25	1263.74 ± 354.47	$1191.76 \pm 320.94$	.141	.676	.774
Iron (mg)	10.72 ± 2.82	$10.84 \pm 3.35$	$11.64 \pm 3.54$	11.77 ± 3.03	.272	11.67 ± 3.79	$10.75 \pm 4.93$	11.18 ± 4.02	$10.35 \pm 3.16$	.394	.257	690.
Zinc (mg)	10.21 ± 2.89	9.87 ± 4.86	$10.4 \pm 3.59$	$9.93 \pm 2.53$	.877	11.27 ± 2.95	9.69 ± 3.49	10.76 ± 3.13	9.53 ± 3.26	.020	.150	.583
SD, standard dev	viation.											

Table 4. Mean, s	standard deviation, and reliability coefficients of the Th	ree Factor Nu	utrition Ques	tionnaire Scoi	es
Subscores	Three-Factor Nutrition Questionnaire Items (Items in the Scale Are Shown with Numbers)	Pre-test Mean ± SD	Post-test Mean <u>+</u> SD	Pre-test Confidence Coefficients	Post-test Confidence Coefficients
Uncontrolled Eating Score	<ol> <li>Even if I have just eaten food, when I smell a nice meat being cooked, I can hardly stop myself from eating it.</li> </ol>	3.05 ± 0.84	2.71 ± 1.00	0.867	0.820
	<b>4)</b> Sometimes when I start eating, it feels like I can't stop.	3.02 ± 0.84	2.23 ± 0.77		
	<b>5)</b> Being with someone who is eating often makes me feel hungry enough to eat.	2.83 ± 0.78	2.08 ± 0.83		
	7) When I see a delicious food, I get so hungry that I have to eat it right away.	2.95 ± 0.80	2.28 ± 0.78		
	8) I'm so hungry that I can't get enough.	2.88 ± 0.80	2.03 ± 0.68		
	<b>9)</b> I am always so hungry that it is very difficult for me to stop eating before I finish the food on my plate.	2.72 ± 0.80	1.92 ± 0.74	-	
	<b>13)</b> I'm always hungry enough to eat.	2.54 ± 0.81	1.85 ± 0.75		
	14) How often do you feel hungry?	2.95 <u>+</u> 0.86	1.98 ± 0.82		
	<b>17)</b> Do you continue to overeat even though you are not hungry?	2.86 ± 0.77	2 ± 0.77		
Emotional	3) When I am restless or anxious, I find myself eating.	2.65 ± 0.76	2.18 ± 0.68	0.828	0.669
Eating Score	6) When I am sad, I often eat too much.	2.52 ± 0.89	1.97 ± 0.71		
	10) When I feel lonely, I find myself eating.	2.54 ± 0.85	1.97 ± 0.81		
Conscious restraint	<b>2)</b> I try to eat small portions to keep my weight under control.	2.14 ± 0.85	3.06 ± 0.66	0.821	0.796
	<b>11)</b> I consciously stop myself from gaining weight during meals.	2.06 ± 0.73	3.18 ± 0.68		
	<b>12)</b> I do not eat certain foods because they cause me to gain weight.	2.23 ± 0.77	3.26 ± 0.67		
	<b>15)</b> How often can you stop yourself from buying the foods you love to eat?	2.14 ± 0.7	3.05 ± 0.65		
	<b>16)</b> To what extent do you manage to eat less than you would like?	1.95 ± 0.72	3.37 ± 0.8		
	<b>18)</b> When a 1 to 8 rating is made, a 1 indicates no restriction on your eating (eat what you want when you want), and 8 totally restricts eating (strictly limiting your amount of food and not eating again after your portion is gone), giving yourself Indicate which number you will give by ticking the box below which is closest to you.	1.86 ± 0.68	3.25 ± 0.69		

diets as planned, it is expected that macro and micronutrient intakes would be similar.

The mean, standard deviation, and reliability coefficients of the 3-Factor Nutrition Questionnaire scores are given in Table 4. Participants' uncontrolled eating scores were found to be in the range of 0.9-0.8 in the pre-test and post-test, while the reliability coefficients of emotional eating and conscious restraint were found to be between 0.9 and 0.8 in the pre-test and 0.7 and 0.6 in the post-test. Considering the sub-components of the uncontrolled eating score, the highest score of the participants in both the

Table 5. Three Factor Nutrition Questionnaire scores of the research groups								
	Control Group (n=33) Intervention Group (n=32)		Total (n	=65)				
Variables	Baseline (Mean ± SD) (Min-Max )	12th week (Mean ± SD ) (Min-Max )	Р	Baseline (Mean ± SD) (Min-Max )	12th week (Mean $\pm$ SD) (Min-Max )	Р	<b>P</b> beginning	P <sup>12th</sup> week
Uncontrolled eating score	24.48 ± 4.14 (17-33)	19 ± 4.65 (12-29)	<0.001	27.16 ± 5.64 (16-36)	19.16 ± 4.61 (10-29)	<.001 °	.033	.892
Emotional eating score	7.73 ± 2.11 (3-12)	6.18 ± 1.74 (3-10)	<0.001	7.69 ± 2.24 (4-12)	6.06 ± 1.7 (3-11)	<.001 °	.941	.781
Conscious restraint	12.97 ± 2.57 (7-17)	19.06 ± 2.54 (13-24)	<0.001	11.78 ± 3.75 (6-19)	19.28 ± 3.31 (12-24)	<.001 °	.143	.764
Three-Factor Nutrition Questionnaire Total Score	45.18 ± 3.9 (36-56)	44.24 ± 4.83 (36-57)	0.152	46.63 ± 5.22 (39-57)	44.5 ± 4.75 (37-56)	.006	.213	.829
Three-Factor Nutrition Questionnaire scores of male participants	Control G	iroup (n = 15 Male)		Intervention Group (n = 16 Male)			Total (n	=31)
Uncontrolled eating score	25.93 ± 4.20 (20-33)	21.07 ± 4.11 (17-29)	<0.001	28.88 ± 5.44 (19-36)	20.31 ± 3.94 (14-28)	<.001	.104	.606
Emotional eating score	7.93 ± 1.91 (4-10)	6.27 ± 1.75 (3-10)	0.001	7.56 ± 2.61 (4-12)	5.75 ± 1.48 (4-9)	.001	.656	.382
Conscious restraint	11.93 ± 2.96 (7-17)	19.13 ± 1.73 (16-23)	<0.001	10.44 ± 4.00 (6-18)	17.81 ± 3.51 (12-24)	<.001	.249	.193
Three-Factor Nutrition Questionnaire Total Score of Male Participants	45.80 ± 3.80 (41-56)	46.47 ± 5.10 (40-57)	0.457	46.88 ± 4.80 (39-55)	43.88 ± 4.75 (38-56)	.001	.497	.153
Three-Factor Nutrition Questionnaire scores of female participants	Control Group (n = 18 Female)		Intervention Group (n = 16 Female)			Total (n = 34)		
Uncontrolled eating score	23.28 ± 3.79 (17-31)	17.28 ± 4.46 (12-28)	<0.001	25.44 ± 5.46 (16-34)	18 ± 5.06 (10-29)	<.001	.186	.661
Emotional eating score	7.56 ± 2.31 (3-12)	6.11 ± 1.78 (3-9)	<0.001	7.81 ± 1.87 (6-11)	6.38 ± 1.89 (3-11)	.001	.726	.678
Conscious restraint	13.83 ± 1.86 (9-16)	19.00 ± 3.11 (13-24)	<0.001	13.13 ± 3.03 (9-19)	20.75 ± 2.41 (16-24)	<.001	.426	.078
Three-Factor Nutrition Questionnaire Total Score of Female Participants	44.67 ± 4.01 (36-52)	42.39 ± 3.82 (36-48)	0.012	46.38 ± 5.76 (39-57)	45.13 ± 4.83 (37-56)	.327	.330	.075

pre-test and the post-test was determined "Even if I have just eaten, when I smell a nice cooking meat, I find it hard not to eat it." item, "I'm always hungry enough to eat." substances was detected.

In the sub-components of the emotional eating scores of the participants, the highest score in both the pretest and the posttest was "When I am restless and anxious, I find myself eating." and the lowest score was "When I am sad, I often eat too much." received from the items. Conscious restraint subcomponent also had the highest score in both the pretest and posttest, "Some foods I do not eat because they cause me to gain weight." item, the degree of conscious restraint measured in the last question in the pretest, and "How often can you stop yourself from buying the foods you love to eat" in the posttest? received from the research.

The data of the 3-Factor Nutrition Questionnaire scores and its sub-components are presented in Table 5. In terms of total and sub-scores, it was determined that there was no statistically significant difference in the mean scores of both groups at the end of the diet intervention. In terms of sub-scores, there was no difference between the groups according to gender, while a decrease was observed in the intervention group in males and in the control group in females in terms of total scores, and these decreases were found to be statistically different (Table 5).

## DISCUSSION

As far as is known, this study, in which the effect of applying an energy-restricted diet and an intermittent fasting diet for 12 weeks on cognitive eating behavior in individuals with MetS was investigated, is the first study in the literature. During intermittent fasting diets, only energy intake is limited. Although the results regarding its use in healthy volunteers and individuals without comorbidities are promising, there is still no consensus regarding its long-term use.<sup>28</sup> According to the Australian Dietetic Association and the British Dietetic Association, it has been reported that it is used as an alternative method for its safety, but attention should be paid to the macro and micronutrient requirements of the patients.<sup>29,30</sup>

Macro and micronutrient needs should not be ignored in diets planned for MetS patients, and very low-energy diets should be avoided. In order to ensure the sustainability of diet therapy and to meet individual needs, it is important to provide 45%-55% of the energy from complex carbohydrates, 25%-35% from healthy fats, and meet the protein requirement not exceeding 15%. Highfiber foods; whole grains, legumes, fresh vegetables, and fruits help provide a feeling of fullness.<sup>31</sup> Epidemiological studies have shown that the Mediterranean diet is also suitable for MetS patients due to its cardiovascular effects.<sup>32</sup>

It is known that chronic diseases such as obesity and diabetes have a genetic background.<sup>33</sup> In this study, it was determined that almost all of the participants had chronic diseases such as first- and second-degree diabetes, hypertension, and coronary artery disease, and it is known that it contains findings supporting that chronic diseases may have a familial background. It is known that initiating both a pharmacological and dietary intervention at the same time to understand the effectiveness of the diet may be a confounding factor for research.<sup>34,35</sup>

Based on the hypothesis that an energy-restricted but planned diet with frequent meal intervals will reduce total insulin secretion in individuals and thus keep blood glucose levels under control, it is claimed that it will facilitate the adaptation of individuals to the diet and contribute to the digestion of food and energy expenditure. Although health professionals have different opinions about increasing the number of meals, diets planned with frequent meals by dividing the energy to be taken into parts are widely used.<sup>36</sup> While some epidemiological studies have shown an inverse relationship between increased eating frequency and body mass index, some studies have suggested that there is no such relationship between eating frequency and weight loss and body mass index and that energy intake increases with increasing frequency of eating.  $^{\scriptscriptstyle 37,38}$ 

In this study, when the results obtained from the patients' food consumption were compared with the reference values of the Turkish Nutrition Guide (TUBER), it was observed that the daily energy intake was within the expected range.<sup>31</sup> In both groups, it was observed that the ratio of energy from carbohydrates in the diet was above 40%, and it was close to the 45%-60% carbohydrate energy ratio given as a reference. Implementation of diets planned with a carbohydrate intake of 50-130 q, under the control of a dietitian, by the British Dietetic Association, where daily carbohydrate intake above 130 g is safer in type 2 diabetes or individuals with cardiovascular risk, lower intakes are considered risky in terms of ketosis and cardiac and it has been reported that returning to safe carbohydrate intake levels in the remission period after a 5% weight loss may be more effective.<sup>39</sup> In this study, it was determined that the daily carbohydrate intake amount was approximately 155 g/day in both groups during the diet.

In terms of protein intake, reference intake values for males and females for TUBER were reported as 63.1 g/ day and 55.2 g/day, respectively. In this study, it was observed that the protein intake of the participants varied between 64 and 75 g/day. Although it is thought that the daily protein intake is somewhat high, considering that this study was conducted among individuals with a body mass index of 27 kg/m<sup>2</sup> and above, it is interpreted that the amount of protein per body weight is consistent with the reference value. According to TUBER, it has been reported that the ratio of daily energy from fat should be between 20% and 35%. In this study, it was determined that the rate of energy from fat of the participants in both groups was between 34% and 40%. This range is considerably higher than the range specified by TUBER as a reference. Although the patients were informed about dietary fat patterns and unsaturated fats were given priority in the menus during diet planning, it is obvious that in practice, individuals eat a little more fat-rich food than expected. In terms of fiber intake, the intake increased during the diet in both study groups and the daily intake amounts were approximately between 23 and 28 g/day, which is consistent with the reference value of 25 g/day reported in TUBER.<sup>31</sup>

The 3-Factor Nutrition Questionnaire, which was developed to measure cognitive eating behavior, allows to measure adults' conscious or uncontrolled eating levels and emotional eating levels. In recent years, intermittent fasting diets, which are based on restriction at certain hours as well as classical energy-restricted eating models, have become popular. In this study, the 3-Factor Nutrition Questionnaire was applied before and after the study in order to evaluate the effects of classical energyrestricted diet and intermittent fasting diet applied for 12 weeks on cognitive eating behaviors. It is concluded that doing an intermittent fasting diet does not have a statistically significant effect on the eating behaviors of individuals when compared to only an energy-restricted diet. In terms of sub-scores, there was no difference between the groups according to gender, while a decrease was observed in the intervention group in males and in the control group in females in terms of total scores, and these decreases were found to be statistically different. We think that this is due to the difference in the uncontrolled eating score between the groups at the beginning. There was no significant difference between total scores at baseline in both the control and intervention groups. At the end of the study, statistically significant differences were observed in the scores of conscious eating, uncontrolled eating, and emotional eating in both the classical energy-restricted group and the intermittent fasting group in females. No significant difference was observed between the groups in terms of cognitive eating behaviors.

In the literature, no research has been found that examines the effect of the 16 : 8 model fasting diet on nutritional behaviors using the 3-Factor Nutrition Questionnaire. The findings obtained from this study are a pilot for future studies on this subject. As a result, although intermittent fasting diet is more interesting for individuals, it has similar effects on cognitive eating behavior as classical energyrestricted diets. However, alternatively, intermittent fasting diets are to be compared in different groups in terms of modulating cognitive eating behavior. This study has some limitations, such as the fact that it was conducted in a single obesity counseling center and that psychiatric diseases and conditions that may affect cognitive eating behavior were not taken into account. In order to reach a conclusion at the level of evidence about whether the nutritional behaviors measured by the 3-Factor Nutrition Questionnaire are affected by the intermittent fasting diet, multicenter studies with larger sample size and representativeness are needed.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of the Non-Interventional Ethics Committee of Istanbul Medipol University (Date: June 21, 2019, No: 10840098-604.01.01-E.1866).

**Informed Consent:** Verbal informed consent was obtained from all patients who participated in this study.

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