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Trabajo Original

Otros

Impact of a 6-week dietary and lifestyle modification intervention on food cravings and eating behaviors in women

Impacto de una intervención dietética y de modificación del estilo de vida de 6 semanas de duración sobre los antojos de alimentos y las conductas alimentarıas en mujeres

Pınar Hamurcu[1], Seminur Barlak[2]

[1]Department of Nutrition and Dietetic. Faculty of Health Sciences. Istanbul Okan University. Istanbul, Turkey. [2]FITSEM Nutrition and Diet Consultancy Office. Istambul, Turkey

Abstract

Introduction: the multifaceted nature of food craving mirrors the complexity underlying the development of eating disorders.

Objectives: the study aimed to investigate the impact of a 6-week dietary and lifestyle intervention on food cravings, eating behaviors, and changes in physical and biochemical measures among women.

Methods: this study constitutes a behavior modification investigation involving a cohort of 35 female participants who sought consultation at a private nutrition counseling facility. At first, anthropometric and biochemical data were recorded; Information Form, Food Craving Questionnaire-Trait Scale (FCQ-T), Three-Factor Eating Scale (TFEQ-R21) were applied and 3-Day Food Consumption Records were taken. After 6 weeks of dietitian follow-up, the data collection tools were repeated and the individuals were compared with the baseline.

Results: after 6-week follow-up, according to the examination of the food consumption records, differences in daily energy, fat, monounsaturated fatty acid, fibre, vitamin E, potassium, magnesium, iron intake levels were found significant ($p < 0.05$). Differences in body weight, body mass index (BMI), waist/height ratio, fat mass, fat ratio and fasting glucose, HbA1c, total cholesterol, triglyceride, LDL, AST, TSH, free T3, free T4 levels were found significant ($p < 0.05$). According to the FCQ-T evaluation; differences in total and nine sub-dimension scores of the scale were found significant ($p < 0.001$). According to the TFEQ-R21 evaluation; differences in cognitive restraint, emotional eating and uncontrolled eating scores were found significant ($p < 0.05$).

Conclusions: a successful 6-week dietary and lifestyle intervention with improvement in anthropometric measurements and biochemical parameters is effective in reducing food cravings and regulating eating behaviours.

Keywords:

Feeding behavior. Feeding and eating disorders. Dietary management. Follow-up studies.

Authors´ contributions: PH was responsible for all stages of the article; writing process designing the review protocol and screening potentially eligible studies. She contributed to writing the report, interpreting results and creating ´Summary of findings´ tables, extracting and analysing data and interpreting results and provided feedback on the report. SB was responsible for writing the protocol and report, conducting the search, screening potentially eligible studies, extracting data, updating reference lists.

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Data availability: the datasets generated during the current study are available from the corresponding author on reasonable request.

Ethics approval: numbered 61351342/2022-54 and dated 26.04.2022 was obtained from Uskudar University Non-Interventional Research Ethics Committee.

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Correspondence:

Pınar Hamurcu. Department of Nutrition and Dietetic. Faculty of Health Sciences. Istanbul Okan University. Tuzla Campus. Tepeören, 34959, Istanbul, Türkiye
e-mail: pinarham@gmail.com

Resumen

Introducción: la compleja relación entre el deseo de alimentos y los trastornos alimentarios es el foco de este estudio.

Objetivos: ınvestigamos el efecto de una intervención de 6 semanas en la dieta y el estilo de vida sobre los antojos, los comportamientos alimentarios y las mediciones físicas y bioquímicas en mujeres.

Métodos: este estudio involucró a 35 mujeres que buscaban asesoramiento nutricional privado. Inicialmente, se recopilaron datos antropométricos y bioquímicos, se aplicó el Formulario de Información, el Cuestionario de Ansia Alimentaria-Escala de Rasgos (FCQ-T), la Escala de Tres Factores Alimentarios (TFEQ-R21) y se registró la ingesta de alimentos durante 3 días. Tras 6 semanas de seguimiento por un dietista, se repitieron las evaluaciones y se compararon con los datos iniciales.

Resultados: tras 6 semanas se observaron diferencias significativas ($p < 0.05$) en la ingesta diaria de energía, grasas, ácidos grasos monoinsaturados, fibra, vitamina E, potasio, magnesio y hierro. También se encontraron diferencias significativas en el peso corporal, el índice de masa corporal (IMC), la relación cintura/altura, la masa grasa, la proporción de grasa y los niveles de glucosa en ayunas, HbA1c, colesterol total, triglicéridos, LDL, AST, TSH, T3 libre y T4 libre ($p < 0,05$). En cuanto al FCQ-T, las puntuaciones totales y de las nueve subdimensiones mostraron diferencias significativas ($p < 0,001$). Además, según el TFEQ-R21, las puntuaciones de restricción cognitiva, alimentación emocional y alimentación incontrolada fueron significativamente diferentes ($p < 0,05$).

Conclusiones: una intervención dietética y de estilo de vida de 6 semanas, que mejora las medidas antropométricas y los parámetros bioquímicos, resulta eficaz en la reducción del deseo por la comida y la regulación de los comportamientos alimentarios en mujeres.

Palabras clave: Conducta alimentaria. Trastornos de la alimentación y la ingestión. Manejo dietético. Estudios de seguimiento.

INTRODUCTION

Obesity is a multifactorial and intricate medical condition characterized by excessive adiposity, and it is strongly associated with an elevated risk of numerous non-communicable diseases. The report from the World Health Organization (WHO) in May 2022 revealed that the prevalence of overweight and obesity has reached epidemic proportions in the European Region, impacting almost three out of every five adults and one out of every three children —a staggering 138 % increase over the past half-century. Notably, Turkey stands out as the nation with the highest prevalence of overweight individuals, with 66.8 % of its adult population being overweight and 32.1 % falling into the obese category. This weight-related condition stands as a primary contributor to mortality due to afflictions such as thirteen distinct forms of cancer, cardiovascular disorders, and type 2 diabetes *mellitus*. Significantly, the sobering reality is that none of the 53 countries composing the European region are currently on course to achieve their 2025 objectives aimed at curbing the escalating obesity rates. The report contends that the underlying causes of obesity exhibit a complexity that surpasses the mere amalgamation of an unhealthy diet and physical inactivity (1). This intricate situation is exacerbated by the widespread availability of food products, which consequently fosters a propensity for unrestrained food consumption and the consequent development of numerous maladies associated with eating disorders. While the perpetuation of distorted cognitions about food undeniably contributes to the surge in food intake, the formulation of strategies to mitigate these cognitions unveils a fundamental aspect –namely, the desire to consume food (2).

Food craving constitutes a concept characterized by the compelling urge to indulge in delectable foods, even in the absence of physiological hunger (3). The desire to eat encompasses a remarkably comprehensive spectrum of dimensions (4). This entails cognitive facets, including contemplations of eating; emotional dimensions, manifesting as food cravings or fluctuations in mood (5); physiological elements, exemplified by heightened salivation; behavioral components, evident through the pursuit and consumption of food (6); and pleasurable aspects, involving the activation of the body´s reward center (7). The intricate multidimensional structure characterizing the food craving parallels the intricate origin of eating disorders. The development of these disorders, influenced by biological, psychological, and social factors (8), underscores the criticality of delving into the biopsychosocial underpinnings, including the exploration of precarious eating behaviors (9).

Van Strien, Frijters, Bergers, and Defares (1986) delineate three distinct categories of eating behaviors: *external eating,* rooted in the externality theory, denotes an escalation in food consumption prompted by external food cues, rather than by internal sensations of hunger or satiety; *restrained eating,* aligned with the cognitive restraint theory, encompasses a deliberate endeavor to attain or sustain a desired weight through reduced caloric intake; and *emotional eating,* drawing from the psychosomatic theory, is characterized by heightened food intake as a reaction to internal emotional states, such as anger, fear, sadness, or happiness (10). The interplay of food intake and subsequent craving manifests with emotional ambivalence, particularly evident among individuals meeting the criteria for food addiction. In these cases, there exists a duality of "wanting" and "liking" food, despite the acknowledgment that its consumption won´t yield emotional improvement and will instead lead to negative emotions and feelings of guilt (11).

The extensive examination of attitudes within the field of psychology underscores the predictive relationship between attitudes and behaviors, while emphasizing the need to assess attitudes and behaviors as distinct entities (12). In this context, an individual´s sentiments, cognitions, and actions concerning eating collectively shape their eating attitude (13). Simultaneously, an individual forges an emotional eating attitude amid negative emotion, while also holding the expectation that weight loss can be achieved through conscious reduction of food intake in the cognitive realm (14). Underpinning this anticipation, the individual, rather than gravitating towards foods aligned with physiological requirements, adopts

a behavior that diminishes the allure of desired foods (15). For those who find themselves unable to counteract the restrictive messages originating within their psyche regarding eating, the eventual outcome of this process is an escalated desire to eat coupled with an inability to regulate their restrictive disposition, ultimately leading to overconsumption. In this context, the theory of restraint, as formulated by Lowe and Butryn posits that the excessive desire for overeating may stem from the cognitive restraints instituted in response to this very desire (16). Within the relevant body of literature, an exploration reveals studies suggesting that restrictive eating attitudes can indeed bolster the desire for food consumption (17,18).

Taking all these factors into consideration, the objective of this study was to investigate the impacts of 6-week interventions involving dietary and lifestyle modifications on various aspects including anthropometric measurements, body composition, biochemical parameters, levels of cravings, and eating behaviors among women.

MATERIALS AND METHODS

PARTICIPANTS

This study was conducted as a behavior modification study with the objective of investigating the effects of a 6-week medical nutrition therapy (MNT) and intensive lifestyle modification interventions (ILMIs) –dietary and lifestyle intervention– on anthropometric measurements, biochemical parameters, food craving levels, and eating behaviors among women who were suffering from overweight or obesity. The study´s population consisted of 50 women who sought assistance at a private nutrition counseling office during the period of April to June 2022. The sample size determination involved using the random sampling method with a 90 % confidence interval and ± 10 % margin of error. A sample size of 35 was achieved, exceeding the initially calculated minimum of 33, based on a population of 50, using the formula:

$$n = \frac{(N \times t^2 \times p \times q)}{(d^2 \times (N-1)) + (t^2 \times p \times q)}$$

The "Ethics Committee Approval" bearing the reference number 61351342/2022-54 and dated 26.04.2022 was obtained from Uskudar University´s Non-Interventional Research Ethics Committee for the purpose of this research. The participants were provided with a comprehensive explanation of the study´s objectives and scope, and their participation was contingent upon providing informed and voluntary consent. This research was conducted in strict adherence to the principles outlined in the "Helsinki Declaration" and guidelines for "Research and Publication Ethics".

STUDY DESIGN

At the commencement of the study, participants were provided with the Information Form, the Food Cravings Questionnaire-Trait (FCQ-T), and the Three-Factor Eating Questionnaire-R21 (TFEQ-R21). Furthermore, the women underwent assessments for anthropometric measurements and body composition, with recorded within the last 3 months biochemical parameters and the acquisition of 3-Day Food Consumption Records.

Utilizing this information, MNT plans was individually prescribed based on patients´ specific characteristics, encompassing food preferences, dietary habits, physical activity levels, working conditions, sociocultural contexts, and lifestyles. The dietary plans were crafted to ensure that 45-65 % of daily energy derived from carbohydrates, emphasizing complex carbohydrates with low- and medium-grade glycemic index and glycemic load values to meet daily fiber needs. Protein intake was set at 15-20 %, with half sourced from high-value animal products, and fats were targeted at 25-35 %, aligning with the directives of TÜBER (Dietary Guidelines for Turkey) (19) and the principles of the Mediterranean diet (20). These tailored plans took into consideration the distinctive characteristics of each woman. Subsequently, the participants underwent a 6-week monitoring phase led by a dietitian, which encompassed nutritional education and guidance for cultivating a health-conscious lifestyle. This intervention was classified as ILMIs. During weekly consultations with the dietitian, comprehensive analyses were conducted on the 3-Day Food Consumption Records, while the ILMIs recommendations were integrated to ensure the continuity of the training and the seamless integration of MNT into participants´ lifestyles.

Upon the culmination of the 6-week period of dietary and lifestyle intervention, the FCQ-T and TFEQ-R21 assessments were re-administered. Furthermore, anthropometric measurements, body composition evaluations, and biochemical parameter recordings were conducted anew on the female participants.

The study´s inclusion criteria encompassed women aged 18 years or older who were classified as overweight or obese (with a BMI > 25 kg/m²). These individuals were required to be free from health conditions that could hinder their ability to comprehend written material. Conversely, individuals failing to meet the predefined inclusion criteria, along with those under specific circumstances such as pregnancy or lactation, were deemed to meet the exclusion criteria.

DATA COLLECTION

Information form comprises a set of 12 questions designed to gather insights into the general characteristics of the women participating in the study. These questions encompass details such as age, educational background, current employ-

ment status, smoking and alcohol consumption habits, as well as eating patterns.

Food Craving Questionnaire-Trait (FCQ-T), developed by Cepeda-Benito et al. in 2000, serves as an assessment tool aimed at gauging individuals´ inclinations toward eating in relation to various timeframes and situations. Comprising 39 items, the FCQ-T employs a 6-point scale for scoring (ranging from 1: never to 6: always). This questionnaire encompasses nine distinct subscales that gauge different aspects of food cravings, including intentions to consume food, anticipation of positive reinforcement, relief from negative emotional states, perceived lack of control over eating, preoccupation with food, hunger, emotional triggers, cues prompting cravings, and feelings of guilt. Higher scores attained from both the overall scale and its individual sub-dimensions indicate a heightened propensity for desiring food consumption. The FCQ-T underwent a validation and reliability study specific to the Turkish context in 2019, carried out by Akkurt et al. (21).

Three-Factor Eating Questionnaire-R21 (TFEQ-R21), devised by Cappelleri et al. in 2009, serves as a tool for exploring individuals´ eating behaviors. This questionnaire comprises 21 items that are distributed across three distinct sub-dimensions: uncontrolled eating, cognitive restraint, and emotional eating. Participants provide responses to these items using a four-point Likert-type scale (ranging from 1: definitely false to 4: definitely true). Elevated scores in any of the TFEQ-R21´s sub-dimensions indicate a heightened propensity for exhibiting eating behaviors related to that particular factor. The TFEQ-R21´s Turkish validity and reliability evaluation was conducted by Karakuş et al. in 2016 (22).

Anthropometric measurements and body composition, evaluations were conducted following specific protocols. The height of the participants was determined using the Mesilife Portable Height Gauge, following the guidelines of the frankfort horizontal plane. To assess body composition, the bioelectrical impedance analysis method was employed, facilitated by the Tanita MC-780 MA model.

To ensure accuracy and consistency, several precautions were taken during the measurements. Participants were required to have fasted for a minimum of 4 hours, abstained from consuming caffeinated beverages for at least 4 hours prior, refrained from intensive exercise for 12 hours before the measurements, and avoided using diuretics for at least the last 6 hours. Measurements were performed at room temperature and the subjects were asked to remove metal jewellery (23).

Biochemical parameters, were assessed through a comprehensive array of analyses, providing insights into various aspects of participants´ health. The following parameters were examined: fasting blood glucose, HOMA-IR, HbA1c, total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, ALT, AST, TSH, free T3, free T4, and ferritin levels.

Distinct timeframes were established to categorize these analyses. Parameters evaluated within the 3 months prior to the study were designated as pre-study biochemical parameters. Conversely, analyses conducted subsequent to within 5 days after termination of the 6-week period of dietary and lifestyle intervention were classified as post-study biochemical parameters. This approach facilitated a comparative understanding of participants´ biochemical profiles before and after the intervention.

Three-Day Food Consumption Record played a crucial role in the study´s dietary assessment. The "3-Day Food Consumption Records" recorded over two weekdays and one weekend day, were explained in detail to the participants by the dietitian (SB) before the study commenced. Both before the study commenced and throughout the 6-week intervention period, these records were meticulously evaluated in face-to-face interviews between the participants and the dietitian. To ensure the accuracy of the records, resources including the "Food and Food Photo Catalogue: Measurements and Quantities", "Food Atlas" and replicas were employed. These tools aided in verifying the precision of the recorded dietary information (24). The dietary energy and nutrient intake on a daily basis were subjected to thorough analysis. This analysis was conducted using the "Computer Assisted Nutrition Programme, Nutrition Information System - BeBIS 7.2," a specialized software developed for Turkey (25).

STATISTICAL ANALYSIS

Descriptive statistics were employed to provide a clear overview of the demographic characteristics. The frequency and percentage distributions were utilized for this purpose. For assessing the normal distribution of numerical variables, the Shapiro-Wilk test was executed. In instances where data exhibited normal distribution, the results were summarized using mean ($\bar{x}$) and standard deviation (SD) values. Conversely, non-normally distributed data were presented with median values along with their corresponding range (min-max). To analyze paired data with normal distribution, the Dependent Sample T Test was applied. For paired data that did not conform to normal distribution, the Wilcoxon Signed Rank Test was employed. These tests enabled the comparison of two dependent groups under different conditions. Statistical analysis was conducted utilizing the SPSS v26 software (IBM Inc., Chicago, IL, USA), a renowned statistical package program. This software facilitated the robust examination of the collected data, yielding valuable insights for the study´s analysis.

RESULTS

A total of 35 female participants, with a mean age of 36.49 ± 11.90 years and 40 % had been diagnosed with various medical conditions by a physician. The most prevalent conditions were thyroid diseases, accounting for 14.3 %, followed by hypertension at 11.4 %, followed by gynecological diseases and menstrual irregularitiesat 8.6 % and followed by cardiovascular diseases at 5.7 %. When participants were

requested to assess their appetite on a scale ranging from 1 to 10, the obtained mean score was 5.37 ± 1.24 (Table I).

The estimates of energy, macro, and micronutrient intake, based on the three-day food consumption records collected both baseline and after the 6-week dietary and lifestyle intervention are presented in table II. The variations in participants´ daily intake levels of energy ($p = 0.042$), fat (g) ($p = 0.045$), monounsaturated fatty acid (g) ($p = 0.012$), dietary fiber (g) ($p = 0.001$), water-soluble fiber (g) ($p < 0.001$), water-insoluble fiber (g) ($p = 0.008$), vitamin E ($p = 0.016$), potassium ($p = 0.031$), magnesium ($p = 0.006$), and iron ($p = 0.001$) were found to be statistically significant.

Table III provides the anthropometric measurements, body composition, and biochemical parameters of the female participants both before and after the 6-week dietary and lifestyle intervention. Statistically significant differences were observed in the following parameters: body weight ($p < 0.001$), BMI ($p < 0.001$), waist/height ratio ($p < 0.001$), fat mass (g) ($p < 0.001$), and fat percentage (%) ($p < 0.001$). Moreover, the analysis revealed statistically significant differences in fasting glucose ($p < 0.001$), HbA1c ($p = 0.001$), total cholesterol ($p < 0.001$), triglycerides ($p = 0.001$), LDL ($p = 0.001$), AST ($p = 0.045$), TSH ($p < 0.001$), free T3 ($p = 0.013$), and free T4 ($p < 0.001$) levels between the pre-intervention and post-intervention periods.

The baseline and post-6-week dietary and lifestyle intervention FCQ-T and TFEQ-R21 scores for the female participants were detailed in table IV. Notably, there were notable reductions observed in the FCQ-T´s total score and all its sub-dimension scores among the women, and these reductions were statistically significant ($p < 0.001$). Upon analyzing the eating behaviors of the women, notable differences emerged in the levels of cognitive restraint ($p = 0.016$), emotional eating ($p < 0.001$), and uncontrolled eating ($p < 0.001$), all of which were determined to be statistically significant.

Table I. Baseline characteristics of study participants

	n	%
Age (mean ± SD)	36.49 ± 11.90	
Marital status		
Married	25	71,4
Single	10	28,6
Educational background		
High School and below	12	34,3
University and above	23	65,7
Employment status		
Not working	14	40,0
Working	21	60,0
Diagnosis of chronic disease		
Yes	14	40,0
No	21	60,0
*> 150 min/week physical activity status**		
Yes	8	22,9
No	15	42,9
Sometimes	12	34,3
Smoking status		
Smoker	5	14,3
Non-smoker	30	85,7
Alcohol consumption status		
Yes	4	11,4
No	31	88,6
Average daily sleep duration (mean ± SD)	7.20 ± 1.55	
Appetite assessment level (mean ± SD)	5.37 ± 1.24	

**WHO suggestion.*

Table II. Effect of 6-week dietary and lifestyle intervention on intake of energy, macro and micronutrients

	Baseline	**After**		
	Mean ± SD / Median (min-max)	**Mean ± SD / Median (min-max)**	**t / W**	***p***
Energy and macronutrients				
Energy (kcal)	810.31 ± 183.45	895.62 ± 150.97	*-2.111*	*0.042*
Protein (%)	21.91 ± 2.68	21.34 ± 4.19	0.651	0.519
Protein (g)	42.86 ± 10.79	46.38 ± 11.30	-1.353	0.185
CHO (%)	34.09 ± 7.11	32.43 ± 6.69	0.985	0.332
CHO (g)	65.62 ± 15.98	69.77 ± 15.05	-1.146	0.260
Fat (%)	44.09 ± 6.85	46.26 ± 5.72	-1.146	0.166

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Table II (cont.). Effect of 6-week dietary and lifestyle intervention on intake of energy, macro and micro nutrients

	Baseline	After		
	Mean ± SD / Median (min-max)	**Mean ± SD / Median (min-max)**	**t / W**	***p***
Fat (g)	40.64 ± 12.90	46.76 ± 11.40	*-2.078*	*0.045*
Saturated fat (g)	11.91 ± 4.20	12.19 ± 3.02	-0.335	0.740
Monounsaturated fat (g)	15.37 ± 5.77	19.09 ± 6.06	*-2.659*	*0.012*
Polyunsaturated fat (g)	10.43 ± 4.87	12.10 ± 4.75	-1.503	0.142
Cholesterol (mg)	198.13 ± 86.96	235.40 ± 98.31	-1.934	0.061
Fiber (g)	12.74 ± 2.74	15.28 ± 3.27	*-3.563*	*0.001*
Water soluble fiber (g)	3.93 ± 0.94	5.10 ± 1.50	*-4.027*	*< 0.001*
Water ınsoluble fiber (g)	*8.3 (4.6-11.4)*	*9.41 (6.4-13.2)*	*-2.653*	*0.008*
Vitamins				
Vitamin A (µg)	*632.34 (225.27-1852.11)*	*854.5 (368.63-2984.16)*	-1.769	0.077
Vitamin E (mg)	*10.85 (3.09-26.67)*	*13.04 (5.1-24.32)*	*-2.408*	*0.016*
Vitamin B1 (mg)	*0.57 (0.28-0.68)*	*0.55 (0.39-0.81)*	-1.738	0.082
Vitamin B2 (mg)	1.01 ± 0.27	1.04 ± 0.16	-0.547	0.588
Vitamin B6 (mg)	0.86 ± 0.21	0.93 ± 0.18	-1.579	0.124
Folate (µg)	*183.93 (85.26-285.98)*	*206.58 (136.79-347.27)*	-1.425	0.154
Vitamin C (mg)	*93.56 (22.84-160.74)*	*87.13 (29.48-176.51)*	-0.655	0.512
Minerals				
Sodium (mg)	1817.16 ± 550.74	2007.32 ± 571.99	-1.436	0.160
Potassium (mg)	1664.31 ± 323.95	1840.73 ± 293.76	*-2.252*	*0.031*
Calcium (mg)	580.28 ± 169.90	597.10 ± 111.7	-0.491	0.627
Magnesium (mg)	188.70 ± 44.91	217.16 ± 37.01	*-2.940*	*0.006*
Phosphorus (mg)	793.59 ± 197.73	846.091 ± 31.92	-1.298	0.203
Iron (mg)	7.07 ± 1.38	8.29 ± 1.55	*-3.594*	*0.001*
Zinc (mg)	5.77 ± 1.46	6.00 ± 1.11	-0.701	0.488

t: dependent sample t test; W: Wilcoxon Signed Rank Test.

Table III. Effect of 6-week dietary and lifestyle intervention on anthropometry, body composition and biochemical profiles

	Before	After		
	Mean ± SD / Median (min-max)	**Mean ± SD / Median (min-max)**	**t / W**	***p***
Anthropometric measurements				
Body weight (kg)	73.38 ± 14.09	69.91 ± 13.40	*11.888*	*< 0.001*
BMI (kg/m^2)	26.99 ± 4.34	25.67 ± 4.11	*11.428*	*< 0.001*
Waist circumference (cm)	83.37 ± 17.68	82.37 ± 12.59	0.345	0.732
Waist/height ratio	0.52 ± 0.07	0.50 ± 0.07	*12.423*	*< 0.001*
Fat (kg)	22.96 ± 8.25	20.21 ± 7.54	*9.424*	*< 0.001*
Fat (%)	30.28 ± 6.13	27.93 ± 6.33	*7.637*	*< 0.001*
Muscle (kg)	47.53 ± 7.14	47.70 ± 7.26	-0.353	0.726

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Table III (cont.). Effect of 6-week dietary and lifestyle intervention on anthropometry, body composition and biochemical profiles

	Before	After		
	Mean ± SD / Median (min-max)	**Mean ± SD / Median (min-max)**	**t / W**	***p***
Biochemical parameters				
Glucose	88.00 ± 12.95	82.86 ± 8.70	*3.877*	*< 0.001*
HbA1c	*5.5 (2.4-8.4)*	*5.4 (4.5-6.2)*	*-3.348*	*0.001*
Total cholesterol	*196 (126-355)*	*170 (120-362)*	*-4.917*	*< 0.001*
Triglyceride	120.97 ± 60.79	102.69 ± 45.92	*3.589*	*0.001*
LDL	118.53 ± 40.88	107.54 ± 40.84	*3.619*	*0.001*
HDL	58.32 ± 15.06	62.31 ± 21.36	-1.492	0.145
ALT	21.16 ± 17.93	16.96 ± 7.99	1.642	0.110
AST	18.25 ± 8.14	15.80 ± 4.75	*2.081*	*0.045*
TSH	*1.8 (0.7-5.5)*	*1.5 (0.6-5)*	*-4.281*	< 0.001
FT3	2.82 ± 0.77	2.58 ± 0.75	*2.703*	0.013
FT4	0.99 ± 0.17	0.90 ± 0.18	*4.797*	*< 0.001*
Ferittin	*20.3 (3-95.5)*	*22 (5-98)*	-1.669	0.095

BMI: body mass index; t: dependent sample t test; W: Wilcoxon Signed Rank Test.

Table IV. Effect of 6-week dietary and lifestyle intervention on FCQ-T and TFEQ-R21 levels

	Baseline	After		
	Mean ± SD / Median (min-max)	**Mean ± SD / Median (min-max)**	**t / W**	***p***
FCQ-T total	3.24 ± 1.16	2.49 ± 0.89	*7.015*	*< 0.001*
Intentions to consume food	*3.33 (1-5.67)*	*2.67 (1-4.33)*	*-4.214*	*< 0.001*
Anticipation of positive reinforcement	*3.4 (1-6)*	*2.4 (1-4.8)*	*-4.571*	*< 0.001*
Relief from negative states	*3.33 (1-5.67)*	*2 (1-5.67)*	*-4.014*	*< 0.001*
Perceived lack of control over eating	*3 (1-6)*	*2 (1-4.5)*	*-3.985*	*< 0.001*
Preoccupation with food	*2.43 (1-5.57)*	*1.86 (1-4.14)*	*-3.717*	*< 0.001*
Hunger	3.68 ± 1.35	2.75 ± 0.98	*5.954*	*< 0.001*
Emotional triggers	*2.75 (1-6)*	*2 (1-5.75)*	*-4.128*	*< 0.001*
Cues prompting cravings	*3 (1-6)*	*2.25 (1-4.75)*	*-3.787*	*< 0.001*
Feelings of guilt	3.56 ± 1.54	2.93 ± 1.21	*4.331*	*< 0.001*
TFEQ-R21				
Cognitive restraint	15.83 ± 3.98	17.31 ± 3.98	*-2.535*	*0.016*
Emotional eating	*12 (6-24)*	*10 (6-24)*	*-4.035*	*< 0.001*
Uncontrolled eating	*20 (9-36)*	*17 (9-33)*	*-3.989*	*< 0.001*

TFEQ-R21: Three-Factor Eating Questionnaire-R21; FCQ-T: Food Craving Questionnaire-Trait; t: dependent sample t test; W: Wilcoxon Signed Rank Test.

DISCUSSION

In this investigation, a comprehensive assessment of participants´ nutritional status following the 6-week dietary and lifestyle intervention unveiled noteworthy outcomes. A substantial rise in daily energy intake was observed, along with a notable increase in total fat attributed to heightened consumption of monounsaturated fats. Furthermore, a marked augmentation in total fiber intake, contributed by amplified consumption of both water-soluble and water-insoluble fibers, was evident. This dietary modulation correspondingly led to statistically significant elevations in the intake of key micronutrients, namely vitamin E, potassium, magnesium, and iron. Scrutinizing the anthropometric measurements and body composition of the female participants yielded compelling results. A significant reduction was observed across body weight, fat mass, fat ratio, BMI, and waist/height ratio, col-

lectively underscoring the effectiveness of the intervention on shaping these parameters. The intricate interplay between diet and physiological profiles was further substantiated through the analysis of biochemical parameters. The intervention prompted noteworthy declines in fasting blood glucose, HbA1c, total cholesterol, LDL cholesterol, triglyceride levels, as well as AST, TSH, free T3, and free T4 levels. These findings collectively underscore the success of the 6-week medical nutrition therapy (MNT) and ıntensive lifestyle modification interventions (ILMIs) –dietary and lifestyle intervention– in generating functional and constructive outcomes across anthropometric, compositional, and biochemical profiles, thus highlighting its potential for positive transformation within this cohort.

Through the 6-week dietary and lifestyle intervention undertaken in this study, notable transformations were observed in participants´ food cravings and eating behaviors. A compelling reduction was identified in the participants´ inclinations across all sub-dimensions of food cravings, underpinning the efficacy of the intervention. In a parallel manner, a notable elevation in cognitive restraint tendencies, coupled with marked decreases in the tendencies for uncontrolled eating and emotional eating, both integral sub-dimensions of eating behavior, were noted and established as statistically significant outcomes of the intervention. These findings resonate with Meule´s (2020) proposition that food deprivation can contribute to the fading of conditioned food craving responses (26). Additionally, they align with Rogers and Smit´s (2000) (27) assertion that ambivalence towards specific foods, such as chocolate, may prompt deliberate attempts to restrict, evade, or eliminate consumption of these foods. This alignment is particularly evident given a study´s outcome indicating that individuals predisposed to food overconsumption tend to exhibit lower executive control and reduced motor inhibition of food cravings compared to those who practice eating restraint (28). However, the current study´s findings diverge from Hill´s (2007) proposition that heightened avoidance, driven by physiological or cognitive mechanisms, may amplify the desire for certain foods (29). Affirming this notion, it´s noteworthy that an individual´s craving for food can persist even in scenarios where the food is merely imagined (30) or when they are subjected to deprivation, as in the case of restricted intake (31). These findings underscore the intricate interplay of both physical and psychological deprivation as pivotal factors influencing food craving dynamics (18).

In the broader literature, a spectrum of insights and perspectives emerges on the intricate relationship between cognitive restraint, dietary interventions, and food craving. While some studies resonate with the findings of this study, suggesting that interventions can indeed lead to decreased food cravings, others present contrasting viewpoints. A study involving the assessment of 7-day food diaries among 129 female dieters and non-dieters unveiled that dieters manifested heightened cravings for foods they intentionally restricted, compared to non-dieters (32). Likewise, another study highlighted that individuals instructed to abstain from consuming a favored food for a span of 5 days exhibited an increase in preoccupation with the restricted food and a concurrent escalation in food cravings (29). Similarly, akin to the complex dynamics in cognitive restraint, the literature presents a lack of consensus concerning the correlation between calorie restriction and food cravings. There are studies in the literature showing that 12 weeks of low-calorie dietary intervention decreases food craving (33) and 16 weeks of low-calorie dietary intervention may increases food cravings, possibly due to alterations in appetite-regulating hormones (34). Furthermore, it´s noteworthy that emotional and psychological factors can play a significant role in shaping cravings. For instance, a study by Van Strien et al. (2013) highlighted that certain personality traits, such as external eating and emotional eating, could mediate the relationship between dietary restraint and food cravings (35). These divergent findings underscore the intricate and multifaceted nature of the relationship between dietary interventions and the complex phenomenon of food cravings. The interplay of physiological, psychological, and contextual factors within these interventions necessitates a holistic approach for a comprehensive understanding of the underlying dynamics.

The intricate interplay between food restriction, encompassing cognitive restraint and calorie restriction, and the phenomenon of cravings introduces a realm of complexity and ambiguity. A comprehensive view emerges when considering findings from a 2017 systematic review and meta-analysis, which revealed that extended energy-restricted diets exhibited the capacity to diminish both overall food cravings and desires for high-energy-dense foods (36). The triggers behind diet-induced cravings can be rooted in either physiological factors, such as an insufficiency of food or nutrients, or psychological factors, which can manifest as the ironic consequence of attempting to suppress the innate desire to consume. Supporting this intricate relationship, research conducted by Boswell and Kober (2016) demonstrated that food craving could elucidate up to 11 % of the variance in both eating behavior and weight gain (37). Intriguingly, certain studies delve into the correlation between lack of control over eating and the subsequent surge in the urge to consume (food craving), highlighting a linkage with heightened levels of anxiety and a negative mood (38,39). This heightened sensitivity may be underpinned by the challenge of inhibiting intrusive thoughts related to food —a hallmark characteristic of food craving (40). The intricate dynamics encompassing food restriction, cravings, psychological factors, and mood underscore the need for a holistic perspective in interpreting the interrelationships at play.

In the context of the current study, the inclusion of lifestyle change education alongside a prescribed calorie-restricted dietary intervention yielded a reduction in food cravings. This reduction corresponded with an increase in cognitive restraint —a tendency to regulate food intake to maintain body weight and shape. Additionally, there was a decrease in uncontrolled eating —a tendency characterized by a loss of control over food in response to hunger or external stimuli. Moreover, a decrease in emotional eating —a tendency to overconsume in the presence of negative emotions like loneliness, anxiety, or demoralization— was observed. These changes in eating behaviors are pivotal, as they contribute to the amelioration of eating disorders, obesity, and obesity-related disorders. By fostering cognitive restraint,

curbing uncontrolled eating, and mitigating emotional eating tendencies, the intervention equips individuals with valuable tools to counteract the emergence of these complex issues.

In essence, the study´s findings contribute to the evolving discourse surrounding effective strategies to promote healthier eating behaviors and mitigate the adverse consequences of obesity-related disorders. The integration of dietary modifications with comprehensive lifestyle education emerges as a potent approach to not only curb food cravings but also foster sustainable habits that promote overall well-being.

CONCLUSION

In summation, the findings of this study substantiate the profound impact that a well-structured nutrition plan, coupled with comprehensive nutrition education, can exert on a multitude of health dimensions. Beyond its discernible effects on anthropometric measurements, body composition, and biochemical parameters, such interventions demonstrate a remarkable potential to mitigate the emergence of obesity-related ailments in the future. By fostering favorable shifts in food selectivity within eating behaviors and attitudes, these interventions serve as a preventative measure against potential health complications associated with obesity.

Building upon this framework, the significance of addressing food cravings and cultivating healthful eating behaviors is evident. To this end, the establishment of structured training programs and counseling services, guided by a collaborative approach involving dietitians and psychologists, emerges as an imperative. This multidisciplinary perspective underscores the need to approach food cravings and eating behaviors holistically, recognizing the intricate interplay of psychological, emotional, and physiological factors.

In light of the study´s outcomes, it becomes evident that fostering a synergistic partnership between dietary interventions, nutrition education, and psychological support holds the key to promoting resilient eating habits and preventing the onset of obesity-related diseases.

STRENGTHS AND LIMITATIONS OF THE STUDY

This study is very important as it is the first behaviour modification study in Turkey to evaluate the effects of dietary and lifestyle intervention on both food cravings and eating behaviour. Despite our meticulous approach, it is important to acknowledge the limitations inherent in this study. Primarily, the sample size, could be expanded to encompass a more diverse demographic, thereby bolstering the generalizability of the conclusions drawn. Secondarily, it´s crucial to note that the study exclusively focused on female participants. Inclusive research that incorporates male participants and encompasses a wider spectrum of individuals would undoubtedly enrich the comprehensiveness of future studies. Furthermore, our evaluation was conducted within a relatively concise timeframe of 6 weeks. To more comprehensively discern the lasting implications of lifestyle changes, an extended follow-up period could prove invaluable. The pursuit of prolonged investigations is warranted to ascertain the enduring sustainability of the observed effects.

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