Erzincan Üniversitesi
Fen Bilimleri Enstitüsü Dergisi
2024, ÖZEL SAYI, 82-98
ISSN: 1307-9085, e-ISSN: 2149-4584
Araştırma Makalesi

Erzincan University
Journal of Science and Technology
2024, SPECIAL ISSUE, 82-98
DOI: 10.18185/erzifbed.1521455
Research Article

Evaluation of Nutritional Status in Adult Women Diagnosed with Insulin Resistance

Nur Nagehan KAR[1]*, Aylin SEYLAM KÜŞÜMLER[2]*

[1] Kar Klinik, Bayır neighbourhood, Sümer street number:35/A Karabük, Turkey, [2] Nutrition and Dietetics Department, Faculty of Health Sciences, Istanbul Okan University, Tuzla, Istanbul, Turkey

Received: 24/07/2024, **Revised:**11/12/2004, **Accepted:** 29/12/2024, **Published:** 31/12/2024

Abstract

Objective: Obesity, which prepares the ground for various chronic metabolic diseases, is known as a risk factor for insulin resistance, and its prevalence is increasing in our country and the world. This study aimed to evaluate the nutritional status of 71 obese women with insulin resistance before and after medical nutrition therapy. The participants were between the ages of 18-65 and were diagnosed with obesity and insulin resistance by a physician at least six months ago.

Materials and Methods: In the study, sociodemographic information, health and nutritional data, anthropometric measurements, food consumption frequencies, Attitude Scale for Healthy Nutrition, and Three-Factor Eating Questionnaire were used. The biochemical findings obtained from patient files and three-day food consumption records before medical nutrition therapy were examined.

Results: The mean body mass index of the participants was calculated as 35.23±4.2 kg/m^2 ($p<0.05$). The significant improvement in the Attitude Scale for Healthy Nutrition scores following medical nutrition therapy showed that the participants gained more information about healthy eating. In the Three-Factor Eating Questionnaire, participants had high scores in terms of uncontrolled eating, emotional eating, and sensitivity to hunger before therapy ($p<0.05$).

Conclusion: In general, this study reveals the contribution of medical nutrition therapy to treatment with diet-related lifestyle changes in improving the nutritional status of obese individuals with insulin resistance.

Keywords: Obesity, insulin resistance, medical nutrition treatment.

İnsülin Direnci Tanısı Almış Yetişkin Kadınlarda Beslenme Durumunun Değerlendirilmesi

Özet

Amaç: Çeşitli kronik metabolik hastalıklara zemin hazırlayan obezite, insülin direnci için bir risk faktörü olarak bilinmekte hem dünyada hem de ülkemizde prevalansının arttığı görülmektedir. Bu çalışmada, insülin direnci olan 71 obez kadın bireyin tıbbi beslenme tedavisi öncesi ve sonrası beslenme durumlarının değerlendirilmesi amaçlanmıştır. Katılımcılar 18-65 yaş aralığında olup, en az altı ay önce bir hekim tarafından obezite ve insülin direnci tanısı almıştır.

Gereç ve Yöntemler: Çalışmada sosyodemografik bilgiler, sağlık ve beslenme verileri, antropometrik ölçümler, besin tüketim sıklıkları, Sağlıklı Beslenmeye İlişkin Tutum Ölçeği ile Üç Faktörlü Beslenme Anketi uygulanmıştır. Hasta dosyalarından elde edilen biyokimyasal bulgular ve tıbbi beslenme tedavisi öncesi üç günlük besin tüketim kayıtları incelenmiştir.

Bulgular: Katılımcıların ortalama beden kütle indeksi 35,23±4,2 kg/m^2'dir ($p<0,05$). Sağlıklı Beslenmeye İlişkin Tutum Ölçeği puanlarının tıbbi beslenme tedavisinden sonra önemli ölçüde iyileşmesi katılımcıların sağlıklı beslenme hakkında daha fazla bilgi edindiğini göstermiştir. Üç Faktörlü Beslenme Anketi'ne göre, katılımcılar tedavi öncesinde kontrolsüz yeme, duygusal yeme ve açlığa karşı duyarlılık açısından yüksek puanlara sahiptir ($p<0,05$).

Sonuç: Genel olarak bu çalışma, insülin direnci olan obez bireylerin beslenme durumlarının iyileştirilmesinde tıbbi beslenme tedavisinin beslenmeye bağlı yaşam tarzı değişikliği ile tedaviye sağladığı katkıyı göstermektedir.

Anahtar Kelimeler: Obezite, insülin direnci, tıbbi beslenme tedavisi.

*Corresponding Author: dyt.nuna@gmail.com
Nur Nagehan KAR, https://orcid.org/0009-0006-1154-5470
Aylin SEYLAM KÜŞÜMLER, https://orcid.org/0000-0003-4705-8042

1. Introduction

The World Health Organization (WHO] defines obesity as "abnormal food intake". It is predicted that 51% of the global population will be obese by 2030 [1]. In Turkiye, the prevalence of obesity is estimated to be 20% according to the 2019 data from the Turkish Statistical Institute (TURKSTAT) [2].

Obesity due to long-term malnutrition is generally known to cause the development of insulin resistance (IR). IR can develop due to many factors such as a sedentary lifestyle, unhealthy eating habits, especially abdominal obesity, certain hereditary diseases, and certain drug treatments [3].

Since the discovery of insulin in 1921, numerous research studies on insulin resistance have been conducted [4]. Insulin is a peptide hormone secreted by β cells in the islets of Langerhans of the pancreas in response to fluctuations in glucose and fatty acid levels [5]. Prevalence of IR is reported to be 15.5-49.5% worldwide [6]. Glucose intolerance, which is the first symptom of IR, is expected to reach 587 million by 2045 [7].

The etiology of IR is not fully understood; however, it can be divided into three main categories: acquired, genetic, and hereditary factors [8]. The development of IR is accepted to be associated with behavioral patterns such as pharmacological interventions such as the use of steroids, dietary habits, and sedentary lifestyle, and numerous factors including pregnancy, hepatitis C prevalence, polycystic ovary syndrome (PCOS), aging process, and presence of hyperglycemia [9, 10]. Studies report that as the amount of fat in the body increases, the risk of metabolic syndrome and IR also increases [11]. The National Institute of Diabetes and Digestive and Kidney Diseases states that central obesity is among the main causes of IR [12].

IR can be defined as the inability to show its biological effect in the presence of insulin in circulation as well as the impairment of the biological response to endogenous and exogenous insulin levels in the body [13].

In the measurement of IR, the gold standard is the hyperinsulinemic-euglycemic glucose clamp technique [14]. However, Homeostasis Model Assessment-Insulin Resistance (HOMA-IR), which is more practical in the clinic, is used due to the difficulty of applying this technique [15]. A HOMA level above 2.5 μU/mL in the clinic indicates the presence of IR [16].

While IR is considered to be an important factor contributing to the development of type 2 diabetes, hypertension, dyslipidemia, polycystic ovary syndrome, non-alcoholic fatty liver disease, metabolic syndrome, and atherosclerotic vascular disease, it is also seen as a risk factor for coronary heart disease and stroke [17].

IR can be treated by losing weight and increasing physical activity, and drug treatment can be applied when necessary [10].Studies have reported that physical activity contributes to increased energy expenditure and skeletal muscle insulin sensitivity [15, 18, 19, 20].

No diet alone has been proven to be effective on IR [10]. However, losing 5-7% of body weight is recommended for obese individuals diagnosed with IR [21]. Options such as Atkins and Protein Diet in the treatment of obesity-related IR are created by increasing the intake of high-quality protein provided that carbohydrate intake is less than 50 g [22]. Since high-carbohydrate diets increase postprandial peaks of insulin and glucose, the Mediterranean diet and DASH diet are recommended in IR. In addition, it is suggested to increase the intake of foods rich in fiber and low in glycemic index and to consume whole-grain foods, legumes, vegetables, and fruits [23]. It has been reported that intermittent fasting (IF), which is also recommended in the treatment of IR, minimizes glycogen storage by supporting lipid-induced gluconeogenesis in the liver and skeletal muscle, while a ketogenic diet greatly improves glycemic control but may cause problems in lipid metabolism and the liver [24]. In recent guidelines, in order to provide glycemic control in individuals with IR, it is recommended to consume 2-3 main meals and 2-3 snacks, and 40-65% of daily energy requirement (DRE] should be carbohydrate (min 130 g], 14/1000 kcal (25-35 g/day], DRE <30% fat, DRE <7% saturated fat, 12-15% monounsaturated fat, cholesterol <300 mg/day, DRE <1% trans fat, 0.8-1 g/kg, protein (15-20%], sodium <2300 mg/day (5 g salt] [25].

In this study, it was aimed to evaluate the nutritional status of female individuals between the ages of 18-60 who were diagnosed with insulin resistance and admitted to a special nutrition clinic.

2. Material and Methods

2.1. Type, Place, Time, and Sample Selection

This study is an intervention study and the sample of the study consists of adult women aged 18-65 years with a diagnosis of insulin resistance who applied to the Kar Nutrition and Diet Clinic and voluntarily agreed to participate in the study. Individuals with any chronic disease other than insulin resistance, individuals over the age of 65, and individuals under the age of 18 were excluded from the study. Participants received medical nutrition therapy containing 1200-1800 kcal/day by their anthropometric measurements and IR diagnosis, taking into account the recommendations. In addition, information about nutrients was provided during the diet process and a diet suitable for the diagnosis of IR was established.

Before starting the study, an application was made to the Istanbul Okan University Non-Interventional Clinical Research Ethics Committee, and ethics committee approval numbered 133/9 and dated 18/10/2023 was obtained. When it was known that the population size was 87 (the number of clients who applied to the clinic in a 6-month period) and the number of clients diagnosed with insulin resistance was 50, the incidence rate of the person profile of interest in the population was calculated as 50/87=0.57. When the significance level is taken as α=0.05,

the z-test statistic value is 1.96, and the minimum sample size obtained as a result of the calculation made with these parameters was calculated as 71.

2.2. Collection and Evaluation of Data

A questionnaire was applied to the participants by face-to-face interview. Within the questionnaire: general sociodemographic information (marital status, age, employment status, education level, smoking and alcohol use), health information (family and individual disease status, drug use), eating habits, anthropometric measurements (height, body weight, body mass index (BMI), waist circumference), biochemical data (fasting blood glucose, fasting insulin, HOMA-IR, HDL and LDL cholesterol, total cholesterol), Attitudes Towards Healthy Eating Scale (AHS), and Three-Factor Nutrition Questionnaire (TFEQ-18) were repeated at 1-month intervals before and after medical nutrition therapy (MNT) and reported for comparison. Since it has been reported in the literature that a one-month period is effective in determining the change in dietary habits of individuals diagnosed with IR, the study was completed in a one-month period. The differences in the scale information of the participants before and after MNT were compared.

2.3. Attitude Scale for Healthy Eating (SBITO)

The validity and reliability of SBITO were evaluated by Tekkurşun Demir and Cicioğlu (2019). The participants were invited to appraise their attitudes towards healthy nutrition across five categories [26]. The rating of the positive items on the scale is as follows: 'Strongly Disagree', 'Disagree', 'Undecided', 'Agree', and 'Strongly Agree'. The positive attitude items were assigned a value of 1, 2, 3, 4, and 5, while the negative attitude items were assigned a value of 5, 4, 3, 2, and 1. Based on the content of the items collected within the factors and the theoretical structure, the first factor was designated as Knowledge about Nutrition (KN), the second factor was designated as Emotion Towards Nutrition (EBN), the third factor was designated as Positive Nutrition (PN), and the fourth factor was designated as Poor Nutrition (PN). The participants exhibited a markedly low attitude towards healthy nutrition, with a mean score of 21. This was followed by a low attitude, with a mean score of 23-42, a moderate attitude, with a mean score of 43-63, a high attitude, with a mean score of 64-84, and finally, an ideal attitude, with a mean score of 85-110 [27].

2.4. Three-Factor Nutrition Questionnaire (TFEQ-18)

The Three-Factor Eating Questionnaire (TFEQ), initially developed by Stunkard and Messic in 1985, is a psychometric instrument designed to assess three distinct dimensions of eating behavior: cognitive restriction, uncontrolled eating, and emotional eating [28, 29]. The revised version of the TFEQ-R18 comprises 18 questions. It was established that questions 1, 7, 13, 14, and 17 were indicative of uncontrolled eating; questions 3, 6, and 10 were indicative of emotional eating; questions 2, 11, 12, 15, 16, and 18 were indicative of conscious restriction of eating; and questions 4, 5, 8 and 9 were indicative of hunger sensitivity. The questionnaire was translated into Turkish as the "Three-Factor Nutrition Questionnaire" by Kıraç et al. in 2015

and validity and reliability analyses were performed. This questionnaire also measures the hunger sensitivity level of individuals apart from the three factors mentioned [30]. The factors of the scale and the ranking of the lowest and highest scores that can be obtained are as follows: uncontrolled eating (UE) 5-20, cognitive restriction (CR) 6-24, emotional eating (EE) 3-12, and sensitivity to hunger (FS) 4-16 [31].

2.5. Anthropometric Measurements

Body weight (kg), height (cm), and waist circumference (cm) of 71 individuals with BMI above 30 kg/m^2 were measured and recorded by the researcher. Body weight was measured using a Tanita Perfecto brand device without shoes and wearing the lightest clothing possible. BMI value was calculated by dividing the square of height (m^2) by body weight (kg). Obesity in adults (over 18 years of age) is defined as having a BMI≥30 kg/m^2. Waist circumference was measured with a tape measure from the midpoint of the lateral iliac processes and the lowest rib while standing [32]. Height was measured with an infantometer. All parameters were analyzed based on the WHO classification criteria [33].

2.6. Biochemical Measurements

Individuals diagnosed with insulin resistance by a physician within the previous six months were referred to a dietitian for medical nutrition therapy. Biochemical parameter values were obtained from the data in the patient file. Fasting insulin, fasting blood glucose, total cholesterol, HOMA-IR, triglycerides, LDL, and HDL cholesterol were the parameters used in the study. Individuals with HOMA values greater than 2.5 μU/ml were included in the study, with a diagnosis of insulin resistance [34].

2.7 Statistical Evaluation

The analyses were conducted using the IBM SPSS Statistics 25 software. The data were subjected to descriptive statistical analysis, which entailed the determination of the number, percentage, mean, standard deviation, minimum, and maximum values. The normality assumption of the data was verified through the utilization of the Shapiro-Wilk test, while the homogeneity of variance was evaluated through the application of the Levene test. In cases where the normality assumption was met, the Independent Sample t-test was employed to examine the difference between the averages of two independent groups. Conversely, in cases where the assumption was not met, the Mann-Whitney U test was applied. In testing the relationship between categorical variables, the Pearson Chi-Square test was used when the sample size assumption was met, and the Fisher's Exact test was applied when the sample size assumption was not met.

3. Results and Disscussion

Seventy-one women diagnosed with insulin resistance with a BMI over 30 kg/m^2 participated in the study. The demographic characteristics of the participants and their distribution according to health information are shown in Table 1.

Table 1: Distribution of participants according to demographic characteristics and health information

Demographic features		**n**	**%**
Marital status	Single	16	22.50
	Married	55	77.50
Educational background	Primary education	16	22.50
	Secondary education	23	32.40
	University and above	32	45.07
Working status	Working	26	36.60
	Not working	41	57.70
	Retired	4	5.60
Income status	Income is less than expenses	22	31.00
	Income equal to expense	32	45.10
	Income is more than expenses	17	23.90
Smoking status	Yes	6	8.40
	No	65	91.60
Alcohol use status	Yes	4	5.60
	No	67	94.40
Health Information			
Hereditary diseases in the family	Diabetes	28	39.40
	Insulin resistance	15	21.10
	Blood pressure	17	23.90
	Cancer	10	14.10
	Cholesterol	7	9.90

	Joint diseases	9	12.70
	Cardiovascular diseases	10	14.10
	Digestive system diseases	2	2.80
	Kidney diseases	8	11.30
	Other (Psychiatric diseases, Thyroid disease)	2	2.80
Having any diagnosed disease other than insulin resistance	Not	71	100
Medication for insulin resistance	Yes	26	36.60
	No	45	63.40
Regularly used medication or vitamin/mineral supplements	Yes	28	39.40
	No	43	60.60

The average age of the participants was 43±11. When the education levels of the participants were analysed, it was found that only 45.07% of them had university education and above.

When their income status was questioned, it was observed that only 23.9% of them had 'income more than expenses'. In a study conducted by Ogunyemi et al. it was observed that the income and education levels of female individuals diagnosed with insulin resistance with HOMA-IR parameter above 5 were low similar to this study [35]. Pan et al. reported that there was a negative correlation between education level, income level, alcohol consumption and IR, but no statistically significant difference was found between smoking and education level, family income adequacy and IR [36]. Meşe Yavuz and Başyiğit reported that alcohol intake was positively correlated with daily energy intake [37]. In this study, it was determined that 80.3% of the participants did not smoke and 94.4% did not consume alcohol.

The distribution and comparisons of the participants according to anthropometric measurements before and after MNT are shown in Table 2.

Table 2: Distribution and comparison of participants according to anthropometric measurements before and after MNT

	Before MNT		**After MNT**		
Anthropometric Measurements	**Aver.±sd. (Median)**	**Min.-Max.**	**Aver.±sd. (Median)**	**Min.-Max.**	**p**
Body weight (kg)	90.12±10.82 (90)	70.00-124.80	85.66±11.05 (86.2)	66.45-120.70	0.000*

BMI (kg/m^2)	35.23±4.62 (34.9)	30.00-52.10	33.43±4.70 (33.51)	27.20-51.10	0.000*
Waist Circumference (cm)	111.50±15.95 (110)	82.00-158.00	106.86±15.10 (106)	81-153	0.000*

*p<0.05, Wilcoxon Sign Rank Test

It was found that body weight, BMI and waist circumference measured before MNT were higher than those measured after MNT (p>0.05). This is an expected result due to the effect of nutritional therapy.

Biochemical measurements of the participants before MNT are shown in Table 3.

Table 3: Biochemical measurements of participants before MNT

Biochemical Measurements	**Before MNT**	
	Aver.±sd. (Median)	**Min.-Max.**
Fasting plasma glucose (mg/dl)	103.55±12.86 (101)	77.00-150.00
Fasting plasma insulin (uIU/mL)	13.58±3.62 (12.72)	8.1-24.38
HOMA-IR	3.41±0.81 (3.23)	2.57-5.38
Total cholesterol (mg/dl)	194.24±34.27 (193)	122.18-271.54
LDL cholesterol (mg/dl)	107.87±28.92 (102.63)	57.63-173.75
HDL cholesterol (mg/dl)	57.34±14.28 (55)	31.73-99.20
Triglyceride (mg/dl)	148.29±67.38 (135)	35.82-307.00

When the biochemical data of the participants were evaluated, the mean HOMA, total cholesterol, and LDL cholesterol values were above the reference value, fasting plasma glucose was within the risky range for prediabetes, and the mean triglyceride and HDL cholesterol values were within the normal reference value range. The mean fasting blood glucose of the participants was determined as 103.55±12.86 mg/dl in the impaired fasting glucose range, and the mean HOMA-IR value was 3.41±0.81, which was above the reference value.

Ozkan et al. revealed that BMI, body fat amount/percentage, waist circumference, and waist/hip ratio were significantly higher in individuals with IR, and HOMA was above >2.5. Calculating and monitoring HOMA value before type 2 Diabetes (T2DM) is an important parameter to prevent the development of type 2 diabetes [38]. Martinez et al. stated that HOMA-IR increased as BMI increased, and higher body fat levels were associated with higher HOMA-IR levels [39]. Similarly, in a study conducted on 78 people, 78.2% of whom were female T2DM patients,

the participants' BMI and mean waist circumference were found to be in the risky range in terms of obesity [40]. A positive correlation has been reported between insulin resistance and waist circumference [12]. Waist circumference above 88 cm in women is considered to be a risk for abdominal obesity [41]. Similarly, in this study, a positive correlation was also found between IR and waist circumference ($p<0.05$). While the mean waist circumference was 111.50 ±15.95 cm at the beginning of the study, it was 106.86 ±15.10 cm after the diet. Another study reported that the families of individuals diagnosed with IR had hereditary IR, T2DM, and cardiovascular disease [42].

In a study examining the effect of body weight management education on obese university students, a decrease was found in body weight, BMI, waist circumference, and waist-hip ratio following the reduction of energy intake of the participants [43]. Similarly, in this study, waist circumference decreased with the effect of nutritional information about IR during MNT. In the results of the survey conducted by using ASHN in this study, an increase was observed in the scale scores as the level of knowledge increased with MNT.

The distribution and comparison of the scores belonging to the Attitude Towards Healthy Eating scale and Three-Factor Nutrition scale sub-dimensions of the participants before and after MNT are shown in Table 4.

Table 4: Distribution and comparison of the participant's scores on the Attitudes Towards Healthy Eating Scale and the Three-Factor Nutrition Scale and its sub-dimensions before and after MNT

Healthy Nutrition Attitude Scale and its Sub-Dimensions	**Before MNT**		**After MNT**		**p**
	Aver.±sd. (Median)	**Min.-Max.**	**Aver.±sd. (Median)**	**Min.-Max.**	
Information About Nutrition	7.30±2.24 (7)	5-13	21.56±2.58 (22)	15-25	**0.000***
Emotion Towards Nutrition	11.70±2.59 (11)	6-20	26.10±2.95 (27)	18-30	**0.000***
Positive Nutrition Habits	12.76±3.03 (12)	5-19	21.77±2.55 (22)	15-25	**0.000***
Bad Eating Habits	10.18±2.83 (10)	5-18	21.77±2.50 (22)	11-25	**0.000***
SBITO Total Score	41.94±6.32	29-58	91.21±8.23	64-102	**0.000***

	(42)		(93)		
Three-Factor Nutrition Scale and its Sub-Dimensions	**Before MNT**		**After MNT**		**p**
	Aver.±sd. (Median)	**Min.-Max.**	**Aver.±sd. (Median)**	**Min.-Max.**	
Uncontrolled Eating	14.61±2.31 (15)	6-19	8.69±2.12 (9)	5-16	**0.000***
Emotional Eating	8.97±2.29 (9)	5-12	6.13±2.28 (6)	3-12	**0.000***
Cognitive Restriction	10.58±1.98 (11)	7-15	20.45±2.11 (20)	13-24	**0.000***
Susceptibility to Hunger	11.25±2.21 (11)	7-15	6.65±1.73 (7)	4-14	**0.000***
Three Factor Nutrition Scale	45.41±4.77 (46)	31-56	41.92±4.25 (42)	34-51	**0.000***

*p<0.05, Wilcoxon Sign Rank Test

Statistically significant differences were found between the scores of the Attitude Towards Healthy Eating scale and its sub-dimensions before and after MNT ($p<0.05$). Post-MNT scores were higher than pre-MNT scores.

Uncontrolled Eating, Emotional Eating and Hunger Sensitivity sub-dimensions and Three-Factor Nutrition scale total scores before MNT were higher than the scores after MNT. Post-diet Cognitive Restriction subscale scores were higher than pre-MNT scores ($p<0.05$).

The correlation of the Attitude Towards Healthy Eating scale and its sub-dimensions before and after MNT is given in Table 5.

Table 5: Correlation of the participants' Attitudes Towards Healthy Nutrition scale and its sub-dimensions before and after MNT

Attitude Towards Healthy Nutrition scale and its sub-dimensions	**Emotion Towards Nutrition**		**Positive Nutrition Habits**		**Bad Eating Habits**		**SBITO Total Score**	
Before MNT	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Information About Nutrition	-0.185	0.122	0.183	0.126	0.212	0.076	0.417	0.000*

Emotion Towards Nutrition	1.000	-	0.122	0.311	0.0189	0.115	0.486	0.000*
Positive Nutrition Habits			1.000	-	0.172	0.152	0.666	0.000*
Bad Eating Habits					1.000	-	0.700	0.000*
After MNT	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Information About Nutrition	0.289	0.015*	0.374	0.001*	0.135	0.260	0.632	0.000*
Emotion Towards Nutrition	1.000	-	0.330	0.005*	0.331	0.005*	0.620	0.000*
Positive Nutrition Habits			1.000	-	0.400	0.001*	0.790	0.000*
Bad Eating Habits					1.000	-	0.599	0.000*

*p<0.05, ¶: Pearson Correlation and Spearman Correlation r: Correlation Coefficient

The correlation coefficients calculated between the total score of the Attitude Towards Healthy Eating scale and the sub-dimensions of Knowledge About Nutrition, Emotion Towards Nutrition, Positive Eating Habits and Poor Eating Habits before and after MNT showed statistically significant, moderate and positive relationships ($p<0.05$). The results revealed a statistically significant, moderate, and positive correlation between the sub-dimension of positive eating habits and the sub-dimensions of knowledge about nutrition and attitude towards nutrition, with correlation coefficients of 0.374 and 0.330, respectively, after MNT ($p< 0.05$).

The relationships between the Three-Factor Nutrition scale and its sub-dimensions before and after MNT are given in Table 6.

Table 6.: The relationships between the Three-Factor Nutrition scale and its sub-dimensions before and after MNT of the participants

Three-Factor Nutrition scale and its sub-dimensions	**Emotional Eating**		**Conscious Restraint**		**Susceptibility to Hunger**		**Three Factor Nutrition Scale**	
Before MNT	**r**	**p**	**r**	**P**	**r**	**p**	**r**	**p**
Uncontrolled Eating	-0.022	0.859	0.281	0.018*	0.290	0.014*	0.457	0.000*
Emotional Eating	1.000	-	0.159	0.185	0.206	0.084	0.684	0.000*
Cognitive Restriction			1.000	-	0.051	0.674	0.260	0.029*
Susceptibility to Hunger					1.000	-	0.662	0.000*
After MNT	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**

Uncontrolled Eating	0.300	0.011*	-0.398	0.001*	0.415	0.000*	0.565	0.000*
Emotional Eating	1.000	-	-0.141	0.239	0.444	0.000*	0.800	0.000*
Cognitive Restriction			1.000	-	-0.128	0.287	0.101	0.401
Susceptibility to Hunger					1.000	-	0.707	0.000*

*p<0.05,Spearman Correlation r: Correlation Coefficient

The correlation coefficients calculated between the total score of the Three-Factor Eating Questionnaire and the Uncontrolled Eating, Emotional Eating, Cognitive Restrain and Sensitivity to Hunger sub-dimensions in the pre-MNT period showed statistically significant, low and moderate, positive relationships ($p<0.05$).

In the post-MNT period, statistically significant, moderate and high positive correlations were found in the correlation coefficients calculated between the total score of the Three-Factor Eating Questionnaire and the Uncontrolled Eating, Emotional Eating and Sensitivity to Hunger sub-dimensions ($p<0.05$).

In a study examining eating attitudes and behaviors in individuals who underwent weight control, according to TFEQ results, the three-factor eating questionnaire score of obese individuals was found to be higher than normal and mildly obese individuals, but the difference was not statistically significant [44]. In this study, it was observed that the cognitive restraint score increased due to the restriction of dietary fat intake and energy intake after MNT. In 2019, the eating attitudes of 385 participants in Hungary were examined using the Three-Factor Eating Questionnaire (TFEQ-R21), and it was reported that only one-fifth of the adult Hungarian population was classified as cognitive restraint, while the rest were classified as indifferent, emotional and uncontrolled eating [45]. In another study, a positive correlation was detected between participants' uncontrolled eating behavior and BMI [46]. Similarly, in this study, the rate of uncontrolled eating was found to be high before MNT, and it was determined that BMI decreased with the increase in nutrition-related knowledge level.

Scores of cognitive restraint, one of the sub-dimensions of the three-factor eating questionnaire, was found to be higher after MNT. On the other hand, there was a decrease in the scores of uncontrolled eating, emotional eating, and sensitivity to hunger sub-dimensions after MNT, which was attributed to the information about the IR-specific diet applied to the participants during the MNT period.

According to the ASHN, the pre-MNT score was found to be higher than the post-MNT score, which was attributed to the increase in scores resulting from switching to a healthier diet.

4. Conclusion

Seventy-one female individuals diagnosed with insulin resistance and admitted to the Kar Nutrition and Diet clinic with a mean age of 43±11 years were included in the study. The study aimed to evaluate the habits and nutritional status of individuals with insulin resistance before and after medical nutrition therapy.

Studies reveal that the prevalence of insulin resistance is gradually increasing. It is reported that individuals at risk of IR can be treated by screening and diagnosing. According to the results of the two scales used in this study, it was observed that the participants had insufficient information before the MNT intervention and did not eat appropriately for IR. It was observed that there was an increase in the level of nutritional knowledge and a decrease in body weight and waist circumference in the participants with the positive effect of the one-month MNT application process on lifestyle change. As a result, the necessity of MNT for both weight control and blood sugar regulation in IR treatment has been confirmed.

While studies confirm that individuals with insulin resistance should receive MNT with the recommendation of a dietitian, they emphasize the importance of increasing their nutritional knowledge and management. Weight management is also considered important for normalizing waist circumference, which is a risk factor for IR. According to recent guidelines, MNT is expected to be balanced and regular, contain simple carbohydrates, saturated fat, trans fat, and salt restriction, as well as complex carbohydrates with high fiber content and sufficient vitamins and minerals.

This study also confirms that dietitians have an important role in the treatment of IR by establishing a correct nutrition program with MNT, informative training, weekly follow-ups and correct food choices.

Ethics in Publishing

Before starting the study, an application was made to Istanbul Okan University Non-Interventional Clinical Research Ethics Committee and ethics committee approval numbered 133/9 and dated 18/10/2023 was obtained.

Author Contributions

Both authors are contributed to design the study, collect the data, evaluating the results, and writing the article.

Acknowledgements

This article was prepared by using the findings of Nur Nagehan Kar’s master’s thesis that was advised by Asst. Prof. Aylin Seylam Küşümler.

References

Amadou A, Ferrari P, Muwonge R, Moskal A, Biessy C, Romieu I, Hainaut P., (2013). Overweight, obesity and risk of premenopausal breast cancer according to ethnicity: a systematic review and dose-response meta-analysis, *Obes Rev, 14*(8):665-78.

[1] Demiray G, Yorulmaz F., (2023). Halk Sağlığı Bakışıyla Obezite Yönetimi. *SABD.*;13(1):147-55.

[2] Ahmed B, Sultana R, Greene MW., (2021). Adipose tissue and insulin resistance in obese. *Biomed Pharmacother*. May;137:111315.

[3] Petersen MC, Shulman GI., (2018). Mechanisms of ınsulin action and ınsulin resistance. *Physiol Rev.* Oct 1;98(4):2133-2223.

[4] Ježek P, Jabůrek M, Holendová B, Plecitá-Hlavatá L., (2018). Fatty Acid-Stimulated Insulin Secretion vs. Lipotoxicity. *Molecules*. Jun 19;23(6):1483.

[5] Fahed M, Abou Jaoudeh MG, Merhi S, Mosleh JMB, Ghadieh R, Al Hayek S, El Hayek Fares JE.,(2020). Evaluation of risk factors for insulin resistance: a cross sectional study among employees at a private university in Lebanon. *BMC Endocr Disord.*, Jun 10;20(1):85.

[6] Hostalek U., (2019). Global epidemiology of prediabetes - present and future perspectives. *Clin Diabetes Endocrinol*. May 9;5:5.

[7] Salihefendic D., (2023). Eating and Lifestyle Habits in Underweight Patients with Insulin Resistance. *Mater Sociomed*. Mar;35(1):18-22.

[8] Ekpenyong C., (2018). Micronutrient deficiency, a novel nutritional risk factor for insulin resistance and Syndrom X, *Archives of Food and Nutritional Science*,; 2:16-30

[9] Blonde L, Umpierrez GE, Reddy SS, McGill JB, Berga SL, Bush M, Chandrasekaran S, DeFronzo RA, Einhorn D, Galindo RJ, Gardner TW, Garg R, Garvey WT, Hirsch IB, Hurley DL, Izuora K, Kosiborod M, Olson D, Patel SB, Pop-Busui R, Sadhu AR, Samson SL, Stec C, Tamborlane WV Jr, Tuttle KR, Twining C, Vella A, Vellanki P, Weber SL., (2022). American Association of Clinical Endocrinology Clinical Practice Guideline: Developing a Diabetes Mellitus Comprehensive Care Plan-2022 Update. *Endocr Pract*., Oct;28(10):923-1049.

[10] Madeira FB, Silva AA, Veloso HF, Goldani MZ, Kac G, Cardoso VC, Bettiol H, Barbieri MA., (2013). Normal weight obesity is associated with metabolic syndrome and insulin resistance in young adults from a middle-income country. *PLoS One*.;8(3):e60673.

[11] Badawy Y, Aljohani NH, Salem GA, Ashour FM, Own SA, Alajrafi NF., (2017). Predictability of the Development of Insulin Resistance Based on the Risk Factors Among Female Medical Students at a Private College in Saudi Arabia. *Cureus.* 2023 May 16;15(5):e39112.

[12] Mearns G. J., Chepulis L., Britnell S., Skinner K., (2017). Health and Nutritional Literacy of New Zeland Nursing Students, *The Journal of Nursing Education*, 56(1), 43-48

[13] Baban B, Thorell A, Nygren J, Bratt A, Ljungqvist O., (2015). Determination of insulin resistance in surgery: the choice of method is crucial. *Clin Nutr*. Feb;34(1):123-8.

[14] Freeman, A. M., Acevedo, L. A., & Pennings, N., (2023). Insulin Resistance. In *StatPearls*. StatPearls Publishing.

[15] Okita K, Iwahashi H, Kozawa J, Okauchi Y, Funahashi T, Imagawa A, Shimomura I., (2013). Homeostasis model assessment of insulin resistance for evaluating insulin sensitivity in patients with type 2 diabetes on insulin treatment. *Endocr J.;*60(3):283-90.

[16] Gutch M, Kumar S, Razi SM, Gupta KK, Gupta A., (2015). Assessment of insulin sensitivity/resistance. *Indian J Endocrinol Metab.* Jan-Feb;19(1):160-4.

[17] Vieira-Lara, M. A., Reijne, A. C., Koshian, S., Ciapaite, J., Abegaz, F., Talarovicova, A., van Dijk, T. H., Versloot, C. J., Bandsma, R. H. J., Wolters, J. C., Groen, A. K., Reijngoud, D. J., van Dijk, G., & Bakker, B. M., (2023). Age and Diet Modulate the Insulin-Sensitizing Effects of Exercise: A Tracer-Based Oral Glucose Tolerance Test. *Diabetes,*; 72(7), 872–883.

[18] Raschke, S., & Eckel, J. (2013). Adipo-myokines: two sides of the same coin--mediators of inflammation and mediators of exercise. *Mediators of inflammation*, *2013*, 320724.

[19] Han X, Yang Y, Liu S, Niu Y, Shao H, Fu L., (2023). Aerobic exercise ameliorates insulin resistance in C57BL/6 J mice via activating Sestrin3. *Biochim Biophys Acta Mol Basis Dis.* Jan 1;1869(1):166568.

[20] Gower BA, Bergman R, Stefanovski D, Darnell B, Ovalle F, Fisher G, Sweatt SK, Resuehr HS, Pelkman C., (2016). Baseline insulin sensitivity affects response to high-amylose maize resistant starch in women: a randomized, controlled trial. *Nutr Metab (Lond)*. Jan 13;13:2.

[21] Baysal Yusuf, D.F., (2017). Obezitede Diyetin Düzenlenmesi. *Klinik Tıp Bilimleri,*;5(5):1-4.

[22] Angelico F, Baratta F, Coronati M, Ferro D, *Del Ben M.,* (2023). Diet and metabolic syndrome: a narrative review. *Intern Emerg Med.* Jun;18(4):1007-1017.

[23] Skow SL, Jha RK., (2023). A Ketogenic Diet is Effective in Improving Insulin Sensitivity in Individuals with Type 2 Diabetes. *Curr Diabetes Rev*.;19(6):e250422203985.

[24] *Diyabet Tanı ve Tedavi Rehberi*, (2021)

[25] Özenoğlu, A., Gün, B., Karadeniz, B., Koç, F., vd. (2021). Yetişkinlerde Beslenme Okuryazarlığın Sağlıklı Beslenmeye İlişkin Tutumlar ve Beden Kütle İndeksi İle İlişkisi. *Life Sciences*, 16(1), 1-18.

[26] Tekkurşun Demir, G., & Cicioğlu, H. İ. (2019). Sağlıklı Beslenmeye İlişkin Tutum Ölçeği (SBİTÖ): Geçerlik ve Güvenirlik Çalışması. *Gaziantep Üniversitesi Spor Bilimleri Dergisi*, 4(2), 256-274.

[27] Stunkard, A. J., & Messick, S. (1985*).* The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of psychosomatic research,* 29(1), 71–83.

[28] Duarte, P.A.S., Palmeira, L. & Pinto-Gouveia, J., (2020). The Three-Factor Eating Questionnaire-R21: a confirmatory factor analysis in a Portuguese sample. *Eat Weight Disord* 25, 247–256,

[29] Kıraç, D., Kaspar, E.Ç., Avcılar, T., Çakır, Ö.K., Ulucan, K., Kurtel, H., Deyneli, O., Güney, A.İ., (2015). Obeziteyle İlişkili Beslenme Alışkanlıklarının Araştırılmasında Yeni Bir Yöntem "Üç Faktörlü Beslenme Anketi*", MÜSBED*;5(3):162-169.

[30] Taş, E., Kabaran, S., (2020). Sezgisel Yeme, Duygusal Yeme Ve Depresyon: Antropometrik Ölçümler Üzerinde Etkileri Var Mı?*, Sağlık ve Toplum Yıl*:*20, Sayı: 3.*

[31] Yeşil, E., Özdemir, M., Arıtıcı Çolak, G., Aksoydan, E., (2019). Bel/Boy Oranı ve Diğer Antropometrik Ölçümlerin Kronik Hastalık Riski ile İlişkisinin Değerlendirilmesi, *ACU Sağlık Bil Derg*; 10(2):241-246.

[32] Metabolik Sendrom Kılavuzu, (2009). *Türkiye Endokrinoloji ve Metabolizma Derneği*

[33] *International Diabetes Federation.* IDF Diabetes Atlas, 7th ed.; International Diabetes Federation: Brussels, Belgium, (2015).

[34] Ogunyemi, D., Whitten, A., Mahesan, A.M., Paul, A.B.M. and Boura, J., (2016). Nutritional Correlates of Women with a History of Gestational Diabetes and Insulin Resistance in the National Health and Nutrition Examination Survey (NHANES) 2000-2010. *Journal of Diabetes Mellitus*,;6, 69-76.

[35] Pan SY, de Groh M, Aziz A, Morrison H., (2016). Relation of insulin resistance with social-demographics, adiposity and behavioral factors in non-diabetic adult Canadians. *J Diabetes Metab Disord.* Aug 11;15:31.

[36] Meşe Yavuz, C., Başyiğit, N., (2022). Beslenme ve sağlıkla ilgili davranışların makro besin öğesi alımı üzerine etkisi. *SYBD* [Internet],;4(3):279-84.

[37] Öztürk Özkan G, Ersoy G, Dayan A., (2013). İnsülin Direnci Olan Hastaların Antropometrik Ölçümleri ve Biyokimyasal Bulgularının Değerlendirilmesi, *Bes Diy Derg* [Internet].; 41(2):124-31

[38] Martinez KE, Tucker LA, Bailey BW, LeCheminant JD., (2017). Expanded Normal Weight Obesity and Insulin Resistance in US Adults of the National Health and Nutrition Examination Survey. *J Diabetes Res*.;2017:9502643.

[39] Cengiz, S.S., Karaca, K.E., İnce, Palamutoğlu, M., (2022). Tip 2 diyabetli bireylerde kardiyovasküler risk faktörlerinin bazı adipozite indeksleri ve diyetsel faktörler ile değerlendirilmesi, *Izmir Democracy University Health Sciences Journal*,;5(1), 251-269.

[40] Frett, A.M., Follis, J.L., Nettleton, J.A., Lemaitre, R.N., Ngwa, J.S., Wojczynski, M.K.et al., (2015). Consumption of meat is associated with higher fasting glucose and insulin concentrations regardless of glucose and insulin genetic risk scores: a meta-analysis of Caucasians *Am J Clin Nutr*. *50,345*

[41] Bulantekin, Ö. Bulantekin Düzalan, Ö., Kuşçu, A., (2020). Meyve Sebze Tüketiminin Diyabette Önemi, *Avrasya Sağlık Bilimleri Dergisi*.; 3(2): 55-61.

[42] Onbaşı, Z. Ç., (2022). Ağırlık yönetimi beslenme bilgisi ölçeğinin Türkçe'ye uyarlanması ve hafif şişman/şişman üniversite öğrencilerine verilen ağırlık yönetimi eğitiminin çeşitli parametreler üzerindeki etkisinin değerlendirilmesi, Doktora Tezi, *Sağlık Bilimleri Enstitüsü / Health Science Institute*

[43] Bekiroğlu, K, (2018). Ağırlık kontrolü yapan bireylerde yeme tutum davranışı ve duygusal iştahın değerlendirilmesi. (Yayınlanmamış yüksek lisans tezi), *İstanbul Medipol Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul*.

[44] Szakály Z, Kovács B, Szakály M, T Nagy-Pető D, Gál T, Soós M., (2020). Examination of the Eating Behavior of the Hungarian Population Based on the TFEQ-R21 Model. Nutrients. Nov 15;12(11):3514.

[45] Verzijl CL, Ahlich E, Lang B, Rancourt D., (2018). Body mass index as a moderator of the association between weight status misperception and disordered eating behaviors. *Eat Behav*. Aug;30:98-103.