Effects of the Mediterranean diet adherence on body composition, blood parameters and quality of life in adults

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ABSTRACT

Background It has been reported that Mediterranean diet (MD) may improve quality of life and may reduce the risk of chronic diseases such as metabolic syndrome, type 2 diabetes, cardiovascular diseases (CVD), some neurodegenerative diseases and cancer. Therefore, this study aimed to determine adults' adherence to the MD and evaluate the effect of the adherence to the MD on anthropometric measurements, specific biochemical parameters and quality of life.

Methods A total of 142 volunteer adults were included. Food frequency questionnaire, MD adherence with 14-item scale, quality of life, anthropometric measurements via bioelectrical impedance analysis and certain blood parameters were evaluated.

Results Out of 14 points, the mean MD adherence score of the participants was 6.89. The mean fat mass was significantly higher in those with low MD adherence (p=0.024). The results of other anthropometric measurements (except height) were higher in those with low MD adherence, though results were non-significant. The participants with high adherence to the MD had lower levels of fasting blood glucose (FBG) (p=0.041), insulin (p=0.019) and triglyceride (TG) (p=0.012) compared with those with lower adherence. No significant relationship was found between the MD and quality of life and other blood parameters.

Conclusion According to our study, MD adherence was associated with decreased fat mass, FBG, insulin and TG levels which suggests that the MD may be useful in the treatment of some chronic diseases such as obesity, diabetes, metabolic syndrome and CVD. However, more clinical trials may be performed to determine the relationship between MD and chronic diseases.

INTRODUCTION

Turkey is located in the Mediterranean region. The geography of the Mediterranean Region, especially its climate and other various features, has shaped countries situated within its borders. The countries in the Mediterranean region share a common dietary culture due to their geographical location despite their religious, cultural, economic and ethnic differences. The geographical characteristics of the Mediterranean region as well as the interaction between civilisations, culture and nature herein have shaped food sources in the Mediterranean region. The nutritional model of the Mediterranean countries is called Mediterranean diet (MD).[1]

The MD includes high amount of fruits, vegetables, cereals and legumes with moderate amount of fish and alcohol (especially red wine), low to moderate amount of dairy products (preferably yoghurt and cheese), low amount of saturated fats (mainly olive oil) and red meat.[2] The MD pyramid, which categorised the food groups to be consumed daily, weekly or less frequently, was first introduced in 1995. Since then, it has evolved to the present day and has become a guide for the MD.[3]

The popular Western-style diet, which is rich in processed foods with high levels of meat and sugar consumption, leads to a decreased adherence to the MD, especially among younger generations. Slightly obese and obese population along with the associated nutritional diseases are constantly increasing in developed and developing countries. Today, nutritional diseases remain a major problem of our age. It is highly important to transition towards sustainable diets to reduce these diseases. The MD is one of the best examples of a sustainable diet.[4] Many studies have shown that the MD has curative effects on certain blood parameters, especially lipid and glucose profiles, and reduces the risk of metabolic syndrome, type 2 diabetes, cardiovascular diseases (CVD), certain neurodegenerative diseases and cancer.[5–8]

The quality of life scale consists of 36 items that assess eight health concepts. Higher scores obtained from the questionnaire indicate a better health level. Studies have also reported that adherence to the MD is associated with a better quality of life.[9 10] The present study aimed to determine the adherence of adults to the MD and to investigate its effects on anthropometric measurements, specific blood parameters and quality of life.

MATERIALS AND METHODS

This study was conducted between November 2017 and July 2018 in adult volunteers of Family Health Centres in Edirne. In factor analysis, it is recommended to include 10–20 individuals for each item. A total of 142 volunteer adults were included in the study as a sample size of 140–280 individuals would be sufficient for the 14-item questionnaire of MD adherence. Volunteers aged 18–65 years who were not pregnant, not on dialysis treatment, did not use a heart beat regulator or did not have any medical devices attached were included in the study. Individuals below 18 or above 65 years of age, pregnant women, patients on dialysis, patients who use a heart rate regulator and those with any medical devices attached were excluded from the study. Informed consent was obtained from the participants through the form. Ethical approval for the

study was obtained from Trakya University Faculty of Medicine Scientific Research Ethics Committee with the decision dated 08.11.2017 and numbered 19/12. Permission was obtained from the Ministry of Health to conduct the study in the Family Health Centres in Edirne. The study was carried out with financial support provided by Trakya University Scientific Research Projects.

Study protocol

A questionnaire including socio-demographics, nutritional and physical activity habits prepared by the researchers was applied to the participants. The 41-item form questioned individuals' general information such as marital status, educational status, age, gender, occupation, smoking and alcohol use, chronic diseases and drug use as well as nutritional information such as number of meals consumed, snacks of preference and physical activity habits.

Anthropometric measurements were performed by the researchers using bioelectrical impedance analysis (BIA). Individuals' body weight (kg), body fat ratio (%), fat mass (kg), body muscle mass (kg), bone mass (kg), lean mass (kg) and body mass index (BMI) (kg/m^2) was evaluated using BIA by 'Tanita DC 360'. Before the measures, participants were asked to remove any metal objects, refrain intense physical activity in the last 24–48 hours, avoid alcohol consumption in the last 24 hours and refrain food and excessive intake of liquids in the last 4 hours.

Participants' adherence to the MD was assessed with the MD adherence scale, a 14-item scale that was designed to provide immediate feedback on adherence to the MD. It was developed by Martinez-Gonzalez *et al* in 2012.[11] The scale includes a total of 14 questions, with 12 questions on food consumption frequency and 2 questions on food intake habits. Each question is scored 0 or 1. The MD adherence questionnaire has a score range of 0–14 points. Higher total scores denote higher adherence to the MD.

Individuals' food intake habits were questioned with a food frequency questionnaire. The food frequency questionnaire was used to assess how often and how much of selected food items were consumed in the last 1 month. Reliability and validity of the Turkish version of the scale was performed by Gunes *et al* in 2015.[12]

Individuals' quality of life was questioned with Quality of Life Scale (SF-36). The scale was developed by Ware and Sherbourne.[13] Reliability and validity of the Turkish version of the scale was performed by Kocyigit *et al* in 1999.[14] It is a 36-item questionnaire that assesses eight health concepts, with higher scores denoting better health. It comprises scales of physical functioning, physical role, physical bodily pain, general health, vitality, social functioning and emotional role.

Participants were invited to Trakya University Medical Faculty Hospital for evaluation of blood tests. Blood was drawn from the participants after 12 hours of fasting and fasting blood glucose (FBG), total cholesterol (TC), triglyceride (TG), HDL cholesterol (HDL-C), LDL cholesterol (LDL-C), blood insulin levels, vitamin B_{12}, ferritin, haemoglobin (HGB) and iron-binding capacity values were measured. The analyses were performed in the Central Laboratory of Trakya University Medical Faculty Hospital.

Statistical analysis

Statistical analyses were performed by using SPSS 20.0 (Licence No. 10 240 642) package program in Biostatistics and Medical Informatics Department of Trakya University Faculty of Medicine. Normal distribution of the quantitative data was tested using the Kolmogorov–Smirnov test. Nominal variables were expressed as frequencies and percentages. The Student's t-test was used for pairwise comparisons of variables with normal distribution, and the Mann Whitney-U tests were used for pairwise comparisons of variables with non-normal distribution. The level of statistical significance was set as $p<0.05$.

RESULTS

Of the 142 participants 81.7% were female. The mean age was 33.97±11.33 years. Out of 14 points, the mean MD adherence scores of the participants was 6.89±1.69. The individuals were divided into groups according to the MD adherence scores. Those with low MD score (below the median value) were categorised as 'Group 1' and those with high MD score (above the median value) were categorised as 'Group 2'. The analyses were performed according to these two groups (table 1). Socio-demographics factors, smoking status and alcohol consumption of the participants are shown in table 2. Of those 14% with low MD score and of those 22.4% with high MD score exercised regularly. Frequency of exercising, of those 72.8% with a high MD score and of those 66.7% with low MD score was at least 3 days a week.

Table 1 Group distributions of participants according to median value of Mediterranean diet score

Classification of Mediterranean diet score according to median value	Mediterranean diet score ranges	n (%)
Median and lower values (Group 1)	≤7	93 (65.5)
Values higher than the median (Group 2)	>7	49 (34.5)
Total		142 (100)

Table 2 Distribution of the average income, person, education and marital status of participants

	Mediterranean diet score		
	Group 1 (n=93) n (%)	Group 2 (n=49) n (%)	Total (n=142) n (%)
Average monthly income			
Very low	40 (43)	14 (28.6)	54 (38)
Low	10 (10.8)	1 (2)	11 (7.7)
Medium	39 (41.9)	27 (55.1)	66 (46.5)
High	4 (4.3)	7 (14.3)	11 (7.7)
Marital status			
Married	46 (49.5)	22 (44.9)	68 (47.9)
Single	43 (46.2)	25 (51)	68 (47.9)
Widow	2 (2.2)	0	2 (1.4)
Divorced	2 (2.2)	2 (4.1)	4 (2.8)
Smoking status			
Yes	25 (26.9)	14 (28.6)	39 (27.5)
No	61 (65.6)	30 (61.2)	91 (64.1)
Quit	7 (7.5)	5 (10.2)	12 (8.5)
Alcohol consumption			
Yes	21 (22.6)	19 (38.8)	40 (28.2)
No	72 (77.4)	30 (61.2)	102 (71.8)

Of the participants, 41.6% consumed milk moderately whereas 69.7% consumed yoghurt/buttermilk frequently and 83.1% consumed cheese frequently. Red meat consumption was moderate by the 48.6% of the participants. Of the participants, 47.1% consumed chicken and turkey moderately. Fish (85.2%), offal (95.8%) and processed meat products (61.3% of the participants) were rarely consumed. Most of the participants consumed eggs more frequently than legumes and oil seeds. White bread (68.3%) was the most commonly consumed in the cereal group. Dark green leafy vegetables (54.2%) and fresh fruits (62%) were frequently consumed by most of the participants. Oils were frequently consumed by 88% of the participants. Solid margarine (85.2%), soft margarine (78.2%), butter (42.2%) and internal/tail fat (97.9%) were rarely consumed by the participants. Sugar was rarely consumed by half of the participants, while 37.3% of the participants consumed it frequently. Most of the participants rarely consumed honey, jam, molasses, chocolate cream, hazelnuts, peanut butter, pastry, sweets, jelly beans, Turkish delight and pudding (table 3).

Participants' anthropometric measurements are shown in table 4. The mean fat mass was significantly higher in those with low MD adherence (19.51±7.95 kg) than those with high adherence (16.96±7.73 kg; p=0.024). The results of the other anthropometric measurements (except height) were higher in those with low MD adherence, though results were non-significant.

The participants with high adherence to the MD had lower levels of FBG (p=0.041), insulin (p=0.019) and TG (p=0.012) compared with those with lower adherence. Additionally, individuals with high MD adherence had lower TC, LDL-C, HGB, ferritin and iron-binding capacities than those with low adherence, whereas the mean HDL-C and vitamin B_{12} levels were higher, though results were non-significant (table 5).

The mean pain score of the participants with low adherence was 81.45±24.42, whereas those with high adherence scored 77.09±19.74 (p=0.041). No significant correlation was found between the other domains and adherence to the MD (table 6).

Table 3 Distribution of the participants according to their frequency of food consumption

Nutrients	Frequent n (%)	Moderate n (%)	Rare n (%)
Diary group			
Milk	35 (24.6)	59 (41.6)	48 (33.8)
Yoghurt, buttermilk	99 (69.7)	36 (25.3)	7 (5)
Cheese	118 (83.1)	15 (10.6)	9 (6.3)
Meat group			
Red meat	36 (25.3)	69 (48.6)	37 (26.1)
Poultry	44 (31)	67 (47.1)	31 (21.9)
Fish	6 (4.2)	15 (10.6)	121 (85.2)
Offal	2 (1.4)	4 (2.8)	136 (95.8)
Processed meat products	20 (14)	35 (24.7)	87 (61.3)
Egg	119 (83.8)	23 (16.2)	10 (7)
Legumes	21 (14.8)	89 (62.7)	32 (22.5)
Oil seeds	47 (33.1)	52 (36.6)	43 (30.3)
Cereal group			
White bread	97 (68.3)	9 (6.3)	36 (25.4)
Whole grain bread	58 (40.9)	25 (17.6)	59 (41.5)
Macaroni, rice, noodles, etc.	55 (38.7)	67 (47.2)	20 (14.1)
Biscuits	30 (21.1)	51 (35.9)	61 (43)
Breakfast cereals	11 (7.7)	18 (12.7)	113 (79.6)
Pasta	14 (9.9)	36 (25.3)	92 (64.8)
Turkish bagel	20 (14.1)	42 (29.6)	80 (56.3)
Vegetable and fruit group			
Dark green leafy vegetables	77 (54.2)	49 (34.5)	16 (11.3)
Yellow vegetables	41 (28.9)	48 (33.8)	53 (37.3)
Other vegetables	64 (45)	60 (42.3)	18 (12.7)
Fresh legumes	29 (20.4)	58 (40.9)	55 (38.7)
Dried vegetables	7 (5)	5 (3.5)	130 (91.5)
Fresh/100% fruit juice	5 (3.5)	13 (9.2)	124 (87.3)
Fresh fruits	88 (62)	36 (25.3)	18 (12.7)
Dried fruits	25 (17.6)	21 (14.8)	86 (60.6)
Oil group			
Liquid oil	125 (88)	12 (8.5)	5 (3.5)
Solid margarine	11 (7.8)	10 (7)	121 (85.2)
Soft margarine	13 (9.1)	18 (12.7)	111 (78.2)
Butter	40 (28.2)	42 (29.6)	60 (42.2)
Internal fat/tail fat	3 (2.1)	0	139 (97.9)
Olive	89 (62.7)	36 (25.3)	17 (12)
Sweet group			
Sugar	53 (37.3)	18 (12.7)	71 (50)
Honey, jam, molasses	37 (26.1)	34 (23.9)	71 (50)
Chocolate cream	14 (9.9)	23 (16.2)	105 (73.9)
Nuts, peanut butter	9 (6.3)	11 (7.8)	122 (85.9)
Dough desserts	15 (10.6)	24 (16.9)	103 (72.5)
Confectionery, jelly beans, Turkish delight	9 (6.3)	5 (3.5)	128 (90.1)
Milky desserts	15 (10.6)	43 (30.3)	84 (59.1)
Ice cream	50 (35.2)	48 (33.8)	44 (31)
Other			
Tea, herbal teas	121 (85.2)	8 (5.6)	13 (9.2)
Turkish coffee	82 (57.8)	25 (17.6)	35 (24.6)
Nescafe	40 (28.2)	26 (18.3)	76 (53.5)
Fruit juices	17 (12)	10 (7)	115 (81)
Cola drinks	13 (9.1)	15 (10.6)	114 (80.3)

DISCUSSION

The aim of this study was to determine the MD score in adults aged 18–65 years and to determine the relationship between MD score and anthropometric measurements, specific biochemical parameters and quality of life. The study included a total of 142 adults. Individuals were evaluated according to MD score median groups. The mean MD score was 6.89 and the median value was 7.

A study reported that milk consumption was rare, whereas yoghurt and buttermilk consumption was mostly frequent and moderate in Turkish population.[15] In our study, while 41.6% of the participants reported moderate milk consumption, 69.7% had moderate yoghurt/ayran consumption and 83.1% consumed different types of cheese frequently. The same study addressed that 64.5% of the participants had frequent and moderate egg consumption. Of the participants, 26.1% had frequent and 65.3% had moderate red meat consumption. Fish and legumes were consumed rarely. Fresh fruit and vegetables, white bread, honey–jam were frequently or moderately consumed. Of the participants, 53.7% consumed olive oil, 46.5% consumed sunflower oil, 25% consumed butter, 22.9% consumed hazelnut oil, 18% consumed corn oil and 18.2% consumed soybean oil frequently. Tail fat and soft and solid margarine were consumed

Table 4 Anthropometric measurements of participants

Anthropometric measurements	Mediterranean diet score			
	Group 1 (n=93) x̄±SD	Group 2 (n=49) x̄±SD	Total (n=142) x̄±SD	P value
Height (cm)	164.78±6.44	165.88±7.45	165.16±6.80	0.365
Weight (kg)	67.43±12.32	64.33±13.09	66.36±12.63	0.166
BMI (kg/m^2)	24.70±4.19	23.43±4.99	24.26±4.51	0.111
Fat mass (kg)	19.51±7.95	16.96±7.73	18.64±7.94	0.024*
Fat ratio (%)	28.23±7.80	25.85±7.39	27.42±7.72	0.054
Bone density (kg)	2.44±0.39	2.35±0.39	2.41±0.39	0.155
Muscle mass (kg)	45.65±7.71	44.19±7.60	45.15±7.68	0.204
Lean mass (kg)	48.05±8.55	45.3±10.29	47.11±9.24	0.114

*p<0.05 statistically significant.
BMI, body mass index.

Table 5 Blood findings of participants

Blood findings	Mediterranean diet score			
	Group 1 (n=93) x̄±SD	Group 2 (n=49) x̄±SD	Total (n=142) x̄±SD	P value
FBG (mg/dL)	90±21.66	82.02±12.08	87.24±19.24	0.041*
TC (mg/dL)	188.65±42.79	180.96±38.98	186.00±41.54	0.677
TG (mg/dL)	114.04±83.14	87.31±53.86	104.82±75.24	0.012*
HDL-C (mg/dL)	49.92±12.14	50.20±11.06	50.02±11.74	0.702
LDL-C (mg/dL)	116.62±34.19	112.57±28.91	115.22±32.42	0.959
Insulin (µIU/mL)	8.41±5.37	6.27±2.65	7.67±4.72	0.019*
Haemoglobin (g/dL)	13.19±1.43	13.11±1.27	13.17±1.37	0.626
Vitamin B_{12} (pg/mL)	219.09±100.67	243.96±127.85	227.67 ±110.99	0.352
Ferritin (ng/mL)	29.67±46.32	27.69±39.46	28.99±43.94	0.947
Iron binding capacity (µg/dL)	284.52±79.13	274.47±77.54	281.05±78.46	0.307

*p<0.05 statistically significant.
FBG, fasting blood glucose; HDL-C, HDL cholesterol; LDL-C, LDL cholesterol; TC, total cholesterol; TG, triglyceride.

Table 6 Comparison of quality of life and Mediterranean diet scores

Subgroups	Mediterranean diet score			
	Group 1 (n=93) x̄±SD	Group 2 (n=49) x̄±SD	Total (n=142) x̄±SD	P value
Physical functioning	86.61±18.89	86.53±18.38	86.58±18.65	0.689
Social functioning	70.08±31.55	71.12±28.75	70.44±30.51	0.963
Physical role	80.64±36.51	85.54±31.95	82.33±34.97	0.564
Emotional role	57.70±45.61	50.33±47.69	55.16±46.30	0.447
Mental	68.49±17.19	67.57±2005	68.18±18.17	0.938
Energy	52.26±20.81	51.26±23.19	51.92±21.58	0.926
Pain	81.45±24.42	77.09±19.74	79.95±22.94	0.041*
General health	70.53±18.30	66.06±17.99	68.99±18.26	0.124
Physical dimension	74.29±17.11	73.29±14.64	73.95±16.25	0.336
Mental dimension	63.81±18.96	61.27±22.59	62.94±20.24	0.629

*p<0.05 statistically significant.

rarely.[15] Another study reported that cheese was the most frequently consumed food by 63.8% of the participants. While 37.7% of the participants did not consume any solid margarine, 46.9% reported daily olive oil consumption.[16] In our study, eggs were consumed frequently. Of the participants, 25.3% had frequent and 48.6% had moderate red meat consumption. Fish was also among the rarely consumed food groups. Fresh fruit and vegetables were frequently consumed. Oils were consumed frequently, while tail fat along with soft and solid margarine were consumed rarely. These findings were in consistent with the above-mentioned studies. In our study, half of the participants consumed honey and jam rarely while they consumed legumes moderately. This difference may be related to the fact that the sample group was selected from Edirne and that the sample had different characteristics and fewer participants compared with the other studies.

In the literature, a meta-analysis and some studies reported a negative correlation between the MD score and BMI,[17–21] while Mateo-Gallego *et al* found no correlation.[22] In our study, the mean BMI of the participants with low MD adherence was higher than those with higher adherence, though results were non-significant. The mean weight was 66.36±12.63 kg, with a mean height of 165.16±6.80 cm. Individuals with high adherence to the MD had lower fat mass (16.96±7.73 kg) than those with low adherence (19.51±7.95 kg; p=0.024). No significant correlation was found between the other anthropometric measurements and the MD score.

According to a study, MD was not correlated with FBG, TC, TG and LDL-C, while it was positively correlated with HDL-C (p<0.001).[22] A meta-analysis found that MD is the most effective dietary approach to improve glycaemic control in patients with type 2 diabetes.[23] Another current meta-analysis of observational studies suggested that MD has a conservative effect on the risk of CVD.[24] A study in which participants were asked to follow an MD and exercise programme for 12 months compared the mean values of TC, HDL-C and TG levels at baseline, 6 months and 12 months. The researchers observed a slight increase in HDL and FBG and a slight decrease in other values, but this difference was not statistically significant.[25] In our study, the participants with high adherence to the MD had lower levels of FBG (p=0.041), insulin (p=0.019) and TG (p=0.012) compared with those with lower adherence. Additionally, participants with high MD adherence had lower TC, LDL-C, HGB, ferritin and iron-binding capacities, and higher HDL-C and vitamin B_{12} levels than those with low compliance, though results were non-significant.

A study using the 17-item MD adherence questionnaire found that the quality of life was positively correlated with the MD adherence.[10] Another study revealed that there was a statistically significant positive correlation between adherence to the MD and the scores in the eight dimensions of the health-related quality of life questionnaire.[10] In contrast, no significant correlation was found between adherence to the MD and quality of life in another study.[26] The results of our study revealed that the only significant correlation was between the pain subscale of the quality of life scale and the MD score (p=0.041). However, this correlation was contrary to our assumptions. The absence of a correlation between the MD adherence and quality of life may be related to low adherence of individuals in Edirne to the MD.

CONCLUSIONS

The results of our study show that individuals living in Edirne have low-medium adherence to the MD. It was demonstrated that the individuals' MD adherence was associated with lower fat mass, which suggests that the MD may be used in the treatment of obesity. Adherence to the MD was found to be associated with lower levels of FBG, TG and insulin. Therefore, it may exhibit beneficial effects on diabetes, CVD and metabolic syndrome. However, no significant correlation was found between adherence to the MD and quality of life. The low-medium adherence of the individuals to the MD with similar scores was the main limitation of our study. A repetition of the study with a larger sample in provinces in the Mediterranean region is recommended to evaluate the effect of the MD adherence on these parameters more accurately.

Main messages

- MD adherence was associated with decreased fat mass.
- Adherence to the MD was associated with lower levels of fasting blood glucose and insulin.
- Adherence to the MD was associated with lower levels of triglycerides.

Current research questions

- How does MD adherence affect HDL-C levels?
- Does adherence to the MD affect quality of life?
- Is there a link between MD and abdominal obesity?

What is already known on the subject

- MD adherence could be associated with better lipid and glucose profile.
- MD adherence could lower the risk of some chronic diseases such as obesity, type 2 diabetes mellitus, cancer and cardiovascular diseases.

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