



Diet, Sleep and Depression: Does Adherence to the Mediterranean Diet Matter?

Diyet, Uyku ve Depresyon: Akdeniz Diyetine Uyum Önemli mi?

Hande Bakırhan, Merve Pehlivan, Fatmanur Özyürek, Volkan Özkaya, Neda Yousefirad

Istanbul Medipol University Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Turkey

Abstract

Objective: The objective of this research is to examine the relationship between Mediterranean diet pattern, depression, and sleep quality.

Materials and Methods: Mediterranean diet adherence score, Beck depression inventory, and Pittsburgh sleep quality index have been applied to volunteering participants (n=250) to examine their adherence to the Mediterranean diet, sleep quality, depression status, and the correlations between these variables have been analysed.

Results: Those following the Mediterranean diet pattern at a high level were found to have significantly higher sleep quality and less depression symptoms than those following this diet pattern at poor and moderate level ($p<0.001$). The Mediterranean diet pattern was found to be positively correlated with sleep quality and negatively correlated with BMI and depression symptoms ($r=-0.349$, $p<0.01$, $r=-0.135$, $p<0.05$, $r=-0.294$, $p<0.01$). Low levels of depression were found to be associated with more daily consumption of vegetables, fruits, olive oil, less consumption of red meat, sugary/carbonated beverages, and sweet/pastry products, and consumption of sauce types with olive oil/tomato/garlic and olive oil being the most frequently consumed oil types ($r=-0.140$, $r=-0.156$, $r=-0.169$, $r=-0.236$, $r=-0.160$, $r=-0.160$, $r=-0.130$, $r=-0.184$, $p<0.05$). Daily consumption of vegetables, fruits, olive oil, reduced consumption of red meat and sweet/bakery products, weekly consumption of hazelnuts/pistachios/almonds/walnuts, and olive oil being the most frequently consumed type of oil are associated with good sleep quality ($r=-0.202$, $r=-0.173$, $r=-0.244$, $r=-0.149$, $r=-0.191$, $r=-0.171$, $r=-0.225$, $p<0.05$).

Conclusion: Mediterranean diet pattern can be integrated into strategies of sleep quality and mental health improvement, as it has been associated with good sleep quality and lower depression levels.

Keywords: Mediterranean diet, depression, sleep, nutrition

Öz

Amaç: Bu çalışmada Akdeniz diyeti paterni, depresyon durumu ve uyku kalitesi arasındaki ilişkinin saptanması amaçlanmıştır.

Gereç ve Yöntem: Rastgele örnekleme yöntemiyle seçilmiş gönüllülere (n=250) Akdeniz diyeti bağlılık ölçeği, Beck depresyon envanteri ve Pittsburgh uyku kalitesi indeksi uygulanarak Akdeniz diyeti paternini sergileme durumu, uyku kalitesi ve depresyon durumu saptanmış ve aralarındaki korelasyon değerlendirilmiştir.

Bulgular: Akdeniz diyeti paternini iyi düzeyde sergileyenlerin kötü ve orta düzeyde sergileyenlere göre uyku kalitesi anlamlı şekilde daha yüksek ve depresyon belirtileri daha az bulundu ($p<0,001$). Akdeniz diyeti paterni uyku kalitesi ile pozitif, beden kitle indeksi ve depresyon durumu ile negatif yönde anlamlı derecede ilişkili idi ($r=-0,349$, $p<0,01$, $r=-0,135$, $p<0,05$, $r=-0,294$, $p<0,01$). Günlük sebze, meyve, zeytinyağı tüketimi, azaltılmış kırmızı et, şekerli/gazlı içecekler tüketimi ve tatlı/pastane ürünler tüketimi, zeytinyağlı/domatesli/sarımsaklı sos tüketimi ve en çok kullanılan yağ türünün zeytinyağı olması ile düşük depresyon seviyeleri ilişkili bulundu ($r=-0,140$, $r=-0,156$, $r=-0,169$, $r=-0,236$, $r=-0,160$, $r=-0,160$, $r=-0,130$, $r=-0,184$, $p<0,05$). Günlük sebze, meyve, zeytinyağı tüketimi, azaltılmış kırmızı et ve tatlı/pastane ürünler tüketimi, haftalık fındık/fıstık/badem/ceviz tüketimi ve en çok kullanılan yağ türünün zeytinyağı olması iyi uyku kalitesi ile ilişkili idi ($r=-0,202$, $r=-0,173$, $r=-0,244$, $r=-0,149$, $r=-0,191$, $r=-0,171$, $r=-0,225$, $p<0,05$).

Sonuç: Akdeniz diyeti paterni, iyi uyku kalitesi ve daha düşük depresyon durumu ile ilişkili bulunduğundan, uyku kalitesi ve mental sağlığı geliştirmeye yönelik stratejilere entegre edilebilir.

Anahtar Kelimeler: Akdeniz diyeti, depresyon, uyku, beslenme

Address for Correspondence/Yazışma Adresi: Asst. Fatmanur Özyürek, Istanbul Medipol University Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Turkey

Phone: +90 444 85 44 E-mail: fozyurek@medipol.edu.tr ORCID-ID: orcid.org/0000-0002-3157-8257

Received/Geliş Tarihi: 05.01.2022 Accepted/Kabul Tarihi: 28.03.2022

©Copyright 2022 by Turkish Sleep Medicine Society / Journal of Turkish Sleep Medicine published by Galenos Publishing House.

Introduction

A healthy lifestyle is the most important key to physical and mental wellbeing. In addition to sleep quality, a healthy diet is beneficial for physical health (1), as well as mental health, for example, for reducing depressive symptoms (2).

It is known that the Mediterranean diet has a protective effect on various diseases such as diabetes, obesity, and cancer (3). At the same time, it is also known that it is a healthy nutrition model in terms of mental health and its functions due to its positive effects on endothelial function (4).

In addition to nutrition, adequate sleep is also important for good health. Sleep is an important part of a healthy life and it is a basic necessity for both physical and mental health (5,6). Low sleep quality is associated with obesity as well as some psychological disorders such as depression. Sleep quality has been reported to be an important indicator of mental health and well-being, and physical activity and healthy diet are also important factors for maintaining a good mental health (7). For this reason, in addition to a healthy diet, sleep quality and mental health need to be examined in detail.

There are not many studies examining the relationships between Mediterranean diet, sleep quality, and mental health status all together. This study has been carried out to investigate the relationship between sleep quality and depressive symptoms

and Mediterranean diet pattern. It is predicted that the study will be of original value and contribute to the literature as it examines 3 basic factors, diet, sleep, and mental health, with a holistic approach.

Materials and Methods

General plan of the research and sample selection

This research was carried out with an online questionnaire with 250 individuals selected by random sampling between the ages of 19-64 between April 2021 and June 2021. The questionnaire form contains questions about the demographic characteristics and basic diet of the participants, their anthropometric measurements (height, body weight) based on declaration, Mediterranean diet pattern, sleep quality, and depressive symptoms. Those with chronic diseases such as hypertension, cardiovascular diseases, diabetes, cancer, hepatic and renal diseases, those with a mental disorder diagnosis and sleep apnea, those who follow a special diet program, individuals under the age of 19 and over the age of 64, and pregnant and lactating individuals were not included in the study. A flowchart of participants recruitment in line with the inclusion and exclusion criteria is given in Figure 1. As it is a human experiment, it complies with the provisions of the 1964 Declaration of Helsinki (revised in Edinburgh, 2013)

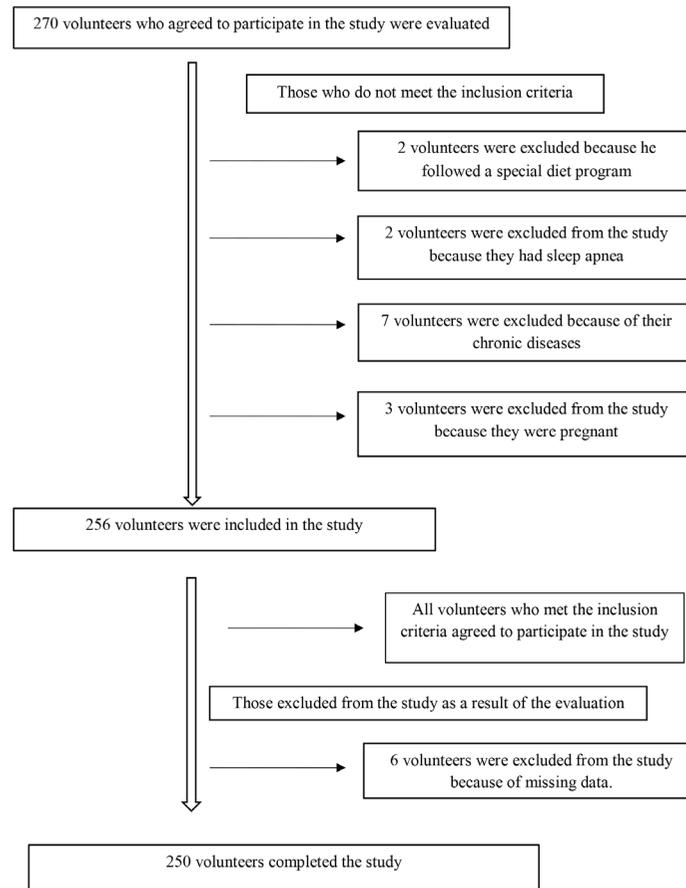


Figure 1. Participant recruitment flow chart

and the study participants gave informed consent. The study protocol was approved by the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee on March 18, 2021 with decision number 303.

Examining the Mediterranean diet pattern

Mediterranean diet pattern characteristics of the participants were identified through the Mediterranean diet adherence score (MEDAS). A MEDAS score of <5 was considered poor adherence, 6-9 moderate adherence, and ≥ 10 good adherence (8). The validity and reliability study of the Turkish version was conducted by Özkan Pehlivanoğlu et al. (9).

Determining the severity of depression

Beck depression inventory (BDI) was used to analyze the symptoms and severity of depression in the participants. The scale measures the emotional, cognitive, and motivational symptoms of depression. A total score between 0-9 points is interpreted as "minimum depression", 10-16 points as "mild depression", 17-29 points as "moderate depression", and 30-63 points as "severe depression" (8,10). The reliability and validity study of the Turkish version was conducted by Hisli (11).

Determining the quality of sleep

The Pittsburgh sleep quality index (PSQI) was used to determine sleep quality (12). A total PSQI score between the range of 0-4 points is considered "good sleep quality" and a score in the range of 5-21 points is considered "bad sleep quality" (13). The validity and reliability study of the Turkish version was conducted by Ağargün et al. (14).

Statistical Analysis

SPSS 22.0 was used for the statistical analysis of the data obtained through the research. Mean, standard deviation, lower and upper values were used for quantitative variables. For categorical variables, frequency and percentage values were used. Chi-square test was used to analyze the categorical variables, and the sample size and normal distribution were examined with the Shapiro-Wilk test in the analysis of quantitative variables. In the case of normal distribution, "Student's t-independent test" was used to compare the two groups. If the data were not normally distributed, the "Mann-Whitney U test" was used for paired groups and the "Kruskal-Wallis test" was used for triple groups. "Pearson correlation analysis" was used to identify the relationship between the two values. ANCOVA was used to test the main effects of the dependent variable on independent variables, controlling for the effects of confounding factors. Appropriate adjusted regression analyses were used to assess the relationship of the main factors as dependent and independent variables in the presence of confounding factors. In the statistical analysis results, the level of significance was accepted as " $p < 0.05$ ".

Results

The general characteristics of the participants are given in Table 1. 65.2% of the participants in the study were found to be within normal range, 26.4% found to be overweight, and 2.0%

found to be obese. The mean body mass index (BMI) score of the participants is 23.3 ± 3.62 kg/m² and the BMI scores of women are significantly lower than that of men (22.5 ± 3.71 kg/m² and 24.8 ± 2.81 kg/m², $p < 0.05$). 83.2% of the participants reported that their mealtimes were not regular and 32.4% reported that they did not have regular sleep patterns.

The Mediterranean diet pattern, sleep quality, and depressive symptoms' severity levels of the participants are given in Table 2. It was found that 53.2% of the individuals had a moderate level of Mediterranean diet pattern, 28.0% a good level, and 18.8% a bad Mediterranean diet pattern, and with an average score of 7.9 ± 2.54 , the Mediterranean diet pattern level of the participants has been observed to be moderate in general. The rate of women who poorly adhered to the Mediterranean diet pattern was significantly lower than men (14.6% vs. 25.8%, $p < 0.05$). The MEDAS score of women was significantly higher than that of men (8.1 ± 2.32 vs. 7.4 ± 2.72 , $p < 0.05$). The sleep quality of 52.0% of the participants was found to be at a good level, 48.0% at a poor level. It was found that there was mild level of depressive symptoms in the general population (mean BDI score: 12.2 ± 2.24). When the severity of depressive symptoms was examined, it was seen that 51.2% of the participants had minimal depressive symptoms, 22.0% had mild, 20.4% had moderate, and 6.4% had severe depressive symptoms.

The distribution of BMI, PSQI, and BDI scores by the Mediterranean diet pattern characteristics of the participants is given in Table 3. According to MEDAS scores, it was found that the BMI of women at bad and moderate level was higher than those who were at good level (22.4 ± 4.51 kg/m², 22.8 ± 3.92 kg/m² and 21.7 ± 2.71 kg/m², respectively, $p < 0.05$). Similarly, men with a good Mediterranean diet pattern had lower BMI scores compared to those with a poor and moderate diet, and this difference was statistically significant (23.9 ± 1.51 kg/m², 24.9 ± 3.83 kg/m², 25.3 ± 2.82 kg/m², respectively, $p < 0.05$).

When the sleep quality was examined, it was found that those with a good Mediterranean diet pattern had significantly lower PSQI scores compared to those with a poor and moderate level (3.5 ± 2.72 , 5.9 ± 3.02 , and 5.3 ± 2.62 , respectively, $p < 0.05$). A similar situation was observed between women and men, and those with a good Mediterranean diet pattern had statistically significantly lower PSQI scores ($p < 0.05$) (Table 3).

Focusing on the severity of depressive symptoms, it was observed that the BDI scores of the participants who adhered to the Mediterranean diet pattern at a good level were significantly lower compared to those who adhered to the Mediterranean diet at a moderate level, and the scores of the participants who adhered to the Mediterranean diet pattern at a moderate level were significantly lower compared to those who adhered to the Mediterranean diet at a low level in both genders (8.6 ± 9.71 , 12.4 ± 8.92 , and 17.3 ± 11.73 , $p < 0.05$).

The correlation between the MEDAS total and sub-dimension scores of the participants and their BMI, PSQI, and BDI scores are given in Table 4. There is a significant negative correlation between MEDAS total score and BMI, PSQI, and BDI

	Female (n=157)		Male (n=93)		Total (n=250)		p
	n	%	n	%	n	%	
Education							
Primary school	3	1.9	1	1.1	4	1.6	0.482 ^a
Secondary school	7	4.5	1	1.1	8	3.2	
High school	51	32.5	31	33.3	82	32.8	
Under/postgraduate	96	61.1	60	64.5	156	62.4	
Alcohol							
Yes	44	28.0	33	35.5	77	30.8	0.217 ^a
No	113	72.0	60	64.5	173	69.2	
Smoking							
Yes	19	12.1	31	33.3	50	20.0	0.001 ^a
No	138	87.9	62	66.7	200	80.0	
Regular sleep							
Yes	115	73.2	54	58.1	169	67.6	0.013 ^a
No	42	26.8	39	41.9	81	32.4	
Regular meal							
Yes	19	12.1	23	24.7	42	16.8	0.010 ^a
No	138	87.9	70	75.3	208	83.2	
BMI level							
Underweight	12	7.6	4	4.3	16	6.4	0.020 ^a
Normal	111	70.7	52	55.9	163	65.2	
Overweight	32	20.4	34	36.6	66	26.4	
Obese	2	1.3	3	3.2	5	2.0	
BMI (kg/m²) $\bar{X} \pm SD$	22.5±3.71		24.8±2.81		23.3±3.62		0.001 ^b

^a: Chi-square test, ^b: Two independent samples t-test, SD: Standard deviation, BMI: Body mass index

	Female (n=157)		Male (n=93)		Total (n=250)		p
	n	%	n	%	n	%	
MEDAS level							
Poor	23	14.6	24	25.8	57	18.8	0.040 ^a
Moderate	92	58.6	41	44.1	133	53.2	
Good	42	26.8	28	30.1	70	28.0	
PSQI level							
Good	79	50.3	51	54.8	130	52.0	0.489 ^a
Poor	78	49.7	42	45.2	120	48.0	
BDI level							
Minimal depression	83	52.9	45	48.4	128	51.2	0.733 ^a
Mild depression	31	19.7	24	25.8	55	22.0	
Moderate depression	33	21.0	18	19.4	51	20.4	
Severe depression	10	6.4	6	6.5	16	6.4	
	$\bar{X} \pm SD$		$\bar{X} \pm SD$		$\bar{X} \pm SD$		
MEDAS score	8.1±2.32		7.4±2.72		7.9±2.54		0.020 ^b
PSQI score	4.9±2.82		4.9±2.93		4.9±2.84		0.827 ^c
BDI score	12.3±2.22		12.1±2.33		12.2±2.24		0.971 ^c

^a: Chi-square test, ^b: Two independent samples t-test, ^c: Mann-Whitney U test, SD: Standard deviation, BMI: Body mass index, PSQI: Pittsburgh sleep quality index, MEDAS: Mediterranean diet adherence score, BDI: Beck depression inventory

			BMI	PSQI	BDI
Female	Poor	$\bar{X} \pm SD$	22.4±4.51	6.2±2.6	18.5±9.7
		Min-max	16.9-37.7	1.0-12.0	1.0-42.0
	Moderate	$\bar{X} \pm SD$	22.8±3.92	5.1±2.7	11.9±9.3
		Min-max	16.9-32.9	1.0-13.0	0.0-58.0
	Good	$\bar{X} \pm SD$	21.7±2.71	3.8±2.7	9.7±11.2
		Min-max	16.5-27.5	1.0-10.0	1.0-56.0
	p	<0.05	<0.05	<0.05	
Male	Poor	$\bar{X} \pm SD$	24.9±3.83	5.7±3.5	16.2±13.4
		Min-max	18.0-33.3	2.0-14.0	1.0-61.0
	Moderate	$\bar{X} \pm SD$	25.3±2.82	5.7±2.2	13.2±8.0
		Min-max	17.5-34.1	1.0-10.0	0.0-36.0
	Good	$\bar{X} \pm SD$	23.9±1.51	3.0±2.6	6.9±6.9
		Min-max	21.4-29.1	1.0-13.0	0.0-29.0
	p	<0.05	<0.05	<0.05	
Total	Poor	$\bar{X} \pm SD$	23.7±4.33	5.9±3.02	17.3±11.73
		Min-max	16.9-37.7	1.0-14.0	1.0-61.0
	Moderate	$\bar{X} \pm SD$	23.6±3.83	5.3±2.62	12.4±8.92
		Min-max	16.9-34.1	1.0-13.0	0.0-58.0
	Good	$\bar{X} \pm SD$	22.6±2.54	3.5±2.72	8.6±9.71
		Min-max	16.5-29.1	1.0-13.0	0.0-56.0
	p	<0.05	<0.05	<0.05	

SD: Standard deviation, BMI: Body mass index, PSQI: Pittsburgh sleep quality index, BDI: Beck depression inventory

	BMI		PSQI		BDI	
	r	p	r	p	r	p
MEDAS total score	-0.135	0.033	-0.349	0.001	-0.294	0.001
Subscores						
Olive oil (the most used oil)	-0.023	0.720	-0.225	0.001	-0.184	0.004
Daily use of olive oil	0.074	0.246	-0.244	0.001	-0.169	0.008
Daily consumption of vegetables	0.034	0.593	-0.202	0.001	-0.140	0.027
Daily consumption of fruits	0.018	0.778	-0.173	0.006	-0.156	0.014
Daily consumption of red meat	-0.121	0.057	-0.149	0.018	-0.236	0.001
Daily consumption of butter/margarine	-0.198	0.002	0.031	0.626	0.018	0.773
Daily consumption of sweet/carbonated drinks	-0.232	0.001	-0.105	0.098	-0.160	0.011
Weekly vine consumption	0.069	0.276	-0.121	0.056	-0.002	0.969
Weekly legumes consumption	0.006	0.928	-0.060	0.345	0.004	0.955
Weekly fish and seafood consumption	0.072	0.255	-0.104	0.100	-0.051	0.423
Weekly non-homemade dessert or pastry products consumption	-0.156	0.013	-0.191	0.002	-0.160	0.011
Weekly hazelnuts/peanuts/almonds/walnuts consumption	-0.070	0.272	-0.171	0.007	-0.085	0.182
Preferring white meat over red meat	0.103	0.104	-0.091	0.150	-0.100	0.115
Consuming olive oil/tomato/tomato paste/onions/garlic sauces	-0.234	0.001	-0.109	0.085	-0.130	0.040

Pearson correlation test, p<0.05, BMI: Body mass index, PSQI: Pittsburgh sleep quality index, MEDAS: Mediterranean diet adherence score, BDI: Beck depression inventory

scores ($r=-0.135$, $p<0.05$, $r=-0.349$, $p<0.05$, $r=-0.294$, $p<0.05$, respectively).

When focusing on MEDAS sub-dimensions, there was a negative and statistically significant relationship between daily consumption of vegetables, fruits, red meat, olive oil, weekly ready-made desserts/patisserie products, and hazelnut/pistachio/almond/walnut score and olive oil being the most frequently used oil type score, and PSQI scores ($r=-0.202$, $r=-0.173$, $r=-0.149$, $r=-0.244$, $r=-0.191$, $r=-0.171$, $r=-0.225$, respectively, $p<0.05$). When depression scores are examined, a statistically significant negative correlation was found in between subcomponent scores of daily consumption of vegetables, fruits, red meat, olive oil, sugary/carbonated beverages, weekly consumption of ready-made desserts/patisserie products, consumption of olive oil/tomato/garlic sauce, and olive oil being the most used type of oil differed and BDI scores ($r=-0.140$, $r=-0.156$, $r=-0.236$, $r=-0.169$, $r=-0.160$, $r=-0.160$, $r=-0.130$, $r=-0.184$, respectively, $p<0.05$).

Mediterranean diet's effects on sleep quality and depressive symptoms with adjustments on confounding factors related with the effects including age, sex, education, depressive symptoms were conducted using regression analyses as $R^2=0.173$, $F(5, 244)=10.211$, $p<0.001$. Mediterranean diet was significantly related to PSQI score ($p=0.001$), depressive symptoms ($p=0.028$) and sex ($p=0.007$). Participants with high PSQI score significantly had low Mediterranean diet score, $t(248)=-3.274$, $p=0.001$, $B=-1,198$, 95% confidence interval (CI) (-1.918, -0.477); Participants with high depressive symptoms score significantly had low Mediterranean diet score, $t(248)=-2.213$, $p=0.028$, $B=-0,427$, 95% CI (-0.807, -0.047) and male participants significantly had low Mediterranean diet score, $t(248)=-2.703$, $p=0.007$, $B=-0.812$, 95% CI (-1.404, -0.220).

Discussion

Assessment of the relationship between Mediterranean diet pattern and depressive symptoms

Adopting a healthy diet style can prevent depression and its negative consequences (15). Little data is available on the effects of the Mediterranean diet on specific psychopathological problems (16). It is suggested that there is a significant negative relationship between Mediterranean diet and the probability and incidence of depression (17-19). Research on mental health and the Mediterranean diet has revealed that a healthy diet pattern results in positive outcomes in reducing depressive symptoms and remission rates (20-22). In a multinational MEDIS study ($n=2,718$), participants who had mild or severe depression reported less adherence to the Mediterranean diet (23). In a meta-analysis study ($n=23,026$), which analyzed six cohort studies, a higher Mediterranean diet pattern was found to be significantly correlated with a lower risk of depression [odds ratio (OR): 0.88, $p<0.05$] (24). In this study, it was observed that the depressive symptoms' severity of those with a good Mediterranean diet pattern was significantly lower than those with moderate level, and

those with moderate level compared to those with poor level ($p<0.05$). In addition, Mediterranean diet pattern and daily consumption of olive oil, vegetables and fruits and olive oil/tomato/garlic sauce were associated with lower severity of depressive symptoms ($p<0.05$). Similarly, Sadeghi et al. (25) found in their study in which they investigated mental health status and the Mediterranean diet pattern ($n=3,172$), high level of fruit and vegetable intake was associated with lower probability of depression, anxiety, and psychological distress. Because the Mediterranean diet pattern provides adequate levels of nutrients such as antioxidants, selenium and omega-3 fatty acids, and contains a balanced amount of fish, fruits, vegetables, grains, nuts, and legumes (20,26), it is considered to be associated with the maintenance and protection of mental health. Mediterranean diet patterns and consequent consumption of vegetables, nuts, and olive oil was found to be associated with milder depressive symptoms (20). A systematic review elucidated the relationship between polyphenol consumption and risk of depression and revealed that polyphenols can effectively alleviate depressive symptoms (27). The Mediterranean diet should be highlighted as a crucial public health strategy to reduce the risk of cognitive disorders and depression, as a higher level of Mediterranean diet pattern is found to be strongly associated with less depressive symptoms and better cognitive functions (28).

Assessment of the relationship between Mediterranean diet pattern and sleep quality

While an unhealthy diet pattern is associated with low sleep quality and sleep duration (29), there is some evidence about the role of certain dietary patterns and nutrients in promoting good quality sleep (30). In a recent study investigating the sleep quality and diet of adults ($n=172$), a negative correlation was found between the PSQI and the prevention with Mediterranean diet scores ($p<0.05$), and it was observed that those with good sleep quality adhered to the Mediterranean diet pattern better than those with poor sleep quality (31). In a cohort study ($n=1,596$) with follow-up (2.8 years), high Mediterranean diet scores was associated with good sleep quality and sleep duration. In this study, Mediterranean diet pattern was found to reduce the probability of poor sleep quality and large changes in sleep duration by 56.0% (32). Naja et al. (33) reported in their study of young adults that those who had good adherence to the Mediterranean diet were more likely to have a good sleep quality (OR: 0.35; 95% CI: 0.21-0.59; $p<0.001$). Ateş Özcan et al. (34) found that each point increase in the Mediterranean diet score resulted in a decrease of 1.4 in the PSQI score. Furthermore, Godos et al. (35) found that a one-point increase in the Mediterranean diet score increases the chance of having adequate sleep quality by 10.0%. Consistent with the literature, the results of this study confirm the possible relationship between the Mediterranean dietary pattern and sleep quality. In the gestation and fitness project, Mediterranean diet patterns, more fruit and olive oil intake, and lower red meat intake was associated with better sleep quality (36). In prospective cohort study ($n=432$) women

were followed up for one year and in this study, Mediterranean diet patterns were associated with sleep efficiency, better sleep quality, and less sleep disturbances (37). In parallel with the findings in the literature, this study also revealed that adherence to the Mediterranean diet pattern at a good level, daily consumption of vegetables, fruits and olive oil, weekly nuts/peanuts/almonds/walnuts consumption, lower red meat consumption, and olive oil being the most frequently used type of oil were significantly associated with better sleep quality ($p < 0.05$). Although the mechanisms mediating the negative effects of insufficient and poor-quality sleep on health are not fully known, hormonal and metabolic deterioration and inflammatory processes are likely to affect this process (38). It is known that antioxidant defense responses, are impaired in case of sleep deprivation, and it is thought that increased neuro-inflammation leads to poor sleep quality (39,40). Since the Mediterranean diet is rich in bioactive components with antioxidant, anti-inflammatory, and neuroprotective properties, it can reduce oxidative damage and cerebral ischemia. Therefore, the Mediterranean diet pattern may be helpful in improving sleep quality (33). It has been shown that sleep duration and quality can be mediated by carotenoids and some vitamins such as vitamins C and D (41,42). Mediterranean diet pattern has beneficial effects on sleep, cognition, mood, and mental health, and this effect is considered to be due to components such as polyunsaturated fatty acids and polyphenols that improve structural and functional brain plasticity (43,44). In this study, it is not possible to make a clear judgment since sleep quality and dietary characteristics are based on self-evaluations, perceptions, and memories of individuals. Comprehensive studies should be carried out that investigate the possible metabolic pathways of the relationship between Mediterranean diet and sleep quality.

Conclusion

The findings of this study can provide an insight that the Mediterranean diet may be a key to better sleep quality and lower depressive symptoms. It is thought that the Mediterranean diet, one of the healthy eating patterns, may have a role in improving sleep quality and reducing depressive symptoms, and this effect may be due to bioactive components. However, further research should be conducted with larger samples and interventions that explore this relationship in more detail. Since sleep quality, depressive symptoms, and dietary characteristics are based on self-evaluations, perceptions, and memories of individuals in this study, this relationship should be clarified with metabolism-based studies that can eliminate this limitation.

Ethics

Ethics Committee Approval: The study protocol was approved by the İstanbul Medipol University Non-Interventional Clinical Research Ethics Committee on March 18, 2021 with decision number 303.

Informed Consent: The study participants gave informed consent.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: H.B., Design: H.B., Data Collection or Processing: M.P., F.Ö., Analysis or Interpretation: M.P., F.Ö., Literature Search: H.B., V.Ö., N.Y., Writing: H.B., F.Ö., V.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Chin MK, Anderson E, de Ridder JH, Uvinha RR, Durstine JL. BRICS to BRICSCESS-A perspective for practical action in the promotion of healthy lifestyles to improve public health in five countries. *J Sport Health Sci* 2019;8:520-3.
2. Francis HM, Stevenson RJ, Chambers JR, Gupta D, Newey B, Lim CK. A brief diet intervention can reduce symptoms of depression in young adults - A randomised controlled trial. *PLoS One* 2019. doi: 10.1371/journal.pone.0222768.
3. Donovan MG, Selmin OI, Doetschman TC, Romagnolo DF. Mediterranean Diet: Prevention of Colorectal Cancer. *Front Nutr* 2017;4:59.
4. Beyhan Y, Taş V. Mental sağlık ve beslenme. *Zeugma Health Res* 2019;1:31-6.
5. Hu Z, Zhu X, Kaminga AC, Zhu T, Nie Y, Xu H. Association between poor sleep quality and depression symptoms among the elderly in nursing homes in Hunan province, China: a cross-sectional study. *BMJ Open* 2020. doi: 10.1136/bmjopen-2019-036401.
6. Li W, Yin J, Cai X, Cheng X, Wang Y. Association between sleep duration and quality and depressive symptoms among university students: A cross-sectional study. *PLoS One* 2020. doi: 10.1371/journal.pone.0238811.
7. Wickham SR, Amarasekara NA, Bartonicek A, Conner TS. The Big Three Health Behaviors and Mental Health and Well-Being Among Young Adults: A Cross-Sectional Investigation of Sleep, Exercise, and Diet. *Front Psychol* 2020;11:579205.
8. Martínez-González MA, García-Arellano A, Toledo E, Salas-Salvadó J, Buil-Cosiales P, Corella D, Covas MI, Schröder H, Arós F, Gómez-Gracia E, Fiol M, Ruiz-Gutiérrez V, Lapetra J, Lamuela-Raventós RM, Serra-Majem L, Pintó X, Muñoz MA, Wärnberg J, Ros E, Estruch R; PREDIMED Study Investigators. A 14-Item Mediterranean diet assessment tool and obesity indexes among high-risk subjects: the PREDIMED Trial. *PLoS One* 2012. doi: 10.1371/journal.pone.0043134.
9. Özkan Pehlivanoğlu EF, Balcıoğlu H, Ünlüoğlu İ. Turkish validation and reliability of Mediterranean Diet Adherence Screener. *Osmangazi Journal of Medicine* 2020;42:160-4.
10. Kılınc S, Torun F. Türkiye’de Klinikte Kullanılan Depresyon Değerlendirme Ölçekleri. *Dirim Tıp Gazetesi* 2011;86:39-47.
11. Hisli N. Beck Depresyon Envanteri’nin üniversite öğrencileri için geçerlilik, güvenilirliği. *Psikoloji Dergisi* 1989; 23:3-13.
12. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193-213.
13. Kacaroğlu Vicdan A. Kronik obstrüktif akciğer hastalarının uyku kalitesinin değerlendirilmesi. *DEUHFED* 2018;11:14-8.
14. Ağargün MY, Kara H, Anlar Ö. The validity and reliability of the Pittsburgh Sleep Quality Index. *Türk Psikiyatri Dergisi* 1996;7:107-15.
15. Tolken K, Bradburn S, Murgatroyd C. An anti-inflammatory diet as a potential intervention for depressive disorders: A systematic review and meta-analysis. *Clin Nutr* 2019;38:2045-52.

16. Ventriglio A, Sancassiani F, Contu MP, Latorre M, Di Slavatore M, Fornaro M, Bhugra D. Mediterranean Diet and its Benefits on Health and Mental Health: A Literature Review. *Clin Pract Epidemiol Ment Health* 2020;16(Suppl 1):156-64.
17. Altun A, Brown H, Szoeki C, Goodwill AM. The Mediterranean dietary pattern and depression risk: A systematic review. *Neurol Psychiatry Brain Res* 2019;33:1-10.
18. Shafiei F, Salari-Moghaddam A, Larijani B, Esmailzadeh A. Adherence to the Mediterranean diet and risk of depression: a systematic review and updated meta-analysis of observational studies. *Nutr Rev* 2019;77:230-9.
19. Lassale C, Batty GD, Baghdadli A, Jacka F, Sánchez-Villegas A, Kivimäki M, Akbaraly T. Healthy dietary indices and risk of depressive outcomes: a systematic review and meta-analysis of observational studies. *Mol Psychiatry* 2019;24:965-86.
20. Oliván-Blázquez B, Aguilar-Latorre A, Motrico E, Gómez-Gómez I, Zabaleta-Del-Olmo E, Couso-Viana S, Clavería A, Maderuelo-Fernandez JA, Recio-Rodríguez JJ, Moreno-Peral P, Casajuana-Closas M, López-Jiménez T, Bolibar B, Llobera J, Sarasa-Bosque C, Sanchez-Perez Á, Bellón JÁ, Magallón-Botaya R. The Relationship between Adherence to the Mediterranean Diet, Intake of Specific Foods and Depression in an Adult Population (45-75 Years) in Primary Health Care. A Cross-Sectional Descriptive Study. *Nutrients* 2021. doi: 10.3390/nu13082724.
21. Parletta N, Zarnowiecki D, Cho J, Wilso A, Bogomolova S, Villani A, Itsiopoulos C, Niyonsenga T, Blunden S, Meyer B, Segal L, Baune BT, O'Dea K. A Mediterranean-style dietary intervention supplemented with fish oil improves diet quality and mental health in people with depression: A randomized controlled trial (HELFIMED). *Nutr Neurosci* 2019;22:474-87.
22. Jacka FN, O'Neil A, Opie R, Itsiopoulos C, Cotton S, Mohebbi M, Castle D, Dash S, Mihalopoulos C, Chatterton ML, Brazionis L, Dean OM, Hodge AM, Berk M. A randomised controlled trial of dietary improvement for adults with major depression (the 'SMILES' trial). *BMJ Med* 2017;15:23.
23. Masana MF, Haro JM, Mariolis A, Piscopo S, Valacchi G, Bountziouka V, Anastasiou F, Zeimbeki A, Tyrovolas D, Gotsis E, Metallinos G, Polystiopi A, Tur J, Matalas AL, Lionis C, Polychronopoulos, Sidossis LS, Tyrovolas S, Panagiotakos DB. Mediterranean diet and depression among older individuals: The multinational MEDIS study. *Exp Gerontol* 2018;110:67-72.
24. Nicolaou M, Colpo M, Vermeulen E, Elstgeest L, Cabout M, Gibson-Smith D, Knuppel A, Sini G, Schoenaker D, Mishra GD, Lok A, Penninx B, Bandinelli S, Brunner EJ, Zwiderman AH, Brouwer IA, Visser M. Association of *a priori* dietary patterns with depressive symptoms: a harmonised meta-analysis of observational studies. *Psychol Med* 2020;50:1872-83.
25. Sadeghi O, Keshteli AH, Afshar H, Esmailzadeh A, Adibi P. Adherence to Mediterranean dietary pattern is inversely associated with depression, anxiety and psychological distress. *Nutr Neurosci* 2021;24:248-59.
26. Sánchez-Villegas A, Delgado-Rodríguez M, Alonso A, Schlatter J, Lahortiga F, Serra Majem L, Martínez-González MA. Association of the Mediterranean dietary pattern with the incidence of depression: the Seguimiento Universidad de Navarra/University of Navarra follow-up (SUN) cohort. *Arch Gen Psychiatry* 2009;66:1090-8.
27. Bayes J, Schloss J, Sibbritt D. Effects of Polyphenols in a Mediterranean Diet on Symptoms of Depression: A Systematic Literature Review. *Adv Nutr* 2020;11:602-15.
28. Mantzourou M, Vadikolias K, Pavlidou E, Tryfonos C, Vasios G, Serdari A, Giaginis C. Mediterranean diet adherence is associated with better cognitive status and less depressive symptoms in a Greek elderly population. *Aging Clin Exp Res* 2021;33:1033-40.
29. Peuhkuri K, Sihvola N, Korpela R. Diet promotes sleep duration and quality. *Nutr Res* 2012;32:309-19.
30. St-Onge MP, Mikic A, Pietrolungo CE. Effects of Diet on Sleep Quality. *Adv Nutr* 2016;7:938-49.
31. Muscogiuri G, Barrea L, Aprano S, Framondi L, Di Matteo R, Laudisio D, Pugliese G, Savastano S, Colao A; on behalf of the OPERA PREVENTION Project. Sleep Quality in Obesity: Does Adherence to the Mediterranean Diet Matter?. *Nutrients* 2020. doi: 10.3390/nu12051364.
32. Campanini MZ, Guallar-Castillón P, Rodríguez-Artalejo F, Lopez-García E. Mediterranean Diet and Changes in Sleep Duration and Indicators of Sleep Quality in Older Adults. *Sleep* 2017;40.
33. Naja F, Hasan H, Khadem SH, Buanq MA, Al-Mulla HK, Aljassmi AK, Faris ME. Adherence to the Mediterranean diet and its association with sleep quality and chronotype among youth: a cross-sectional study. *Front Nutr*. 2022;8:805955.
34. Ateş Özcan B, Yeşilkaya B, Özgün Yılmaz H, Günel AM, Özdemir AA. Effects of adherence to the Mediterranean diet on depression, anxiety, and sleep quality during the Covid-19 pandemic in Turkey. *International Journal of Innovative Research and Reviews (INJRR)* 2021;5:39-44.
35. Godos J, Ferri R, Caraci F, Cosentino F, Castellano S, Galvano F, Grosso G. Adherence to the Mediterranean Diet is Associated with Better Sleep Quality in Italian Adults. *Nutrients* 2019;11:976.
36. Flor-Aleman M, Nestares T, Aleman-Arrebola I, Marín-Jiménez N, Borges-Cosic M, Aparicio VA. Influence of Dietary Habits and Mediterranean Diet Adherence on Sleep Quality during Pregnancy. The GESTAFIT Project. *Nutrients* 2020. doi: 10.3390/nu12113569.
37. Zuraikat FM, Makarem N, St-Onge MP, Xi H, Akkapeddi A, Aggarwal B. A Mediterranean Dietary Pattern Predicts Better Sleep Quality in US Women from the American Heart Association Go Red for Women Strategically Focused Research Network. *Nutrients* 2020;12:2830.
38. Irwin MR. Whysleepisimportantforhealth: a psychoneuroimmunology perspective. *Annu Rev Psychol* 2015;66:143-72.
39. Clark IA, Vissel B. Inflammation-sleep interface in brain disease: TNF, insulin, orexin. *J Neuroinflammation* 2014;11:51.
40. Everson CA, Laatsch CD, Hogg N. Antioxidant defense responses to sleep loss and sleep recovery. *Am J Physiol Regul Integr Comp Physiol* 2005;288:R374-R83.
41. Kanagasabai T, Ardern CI. Contribution of Inflammation, Oxidative Stress, and Antioxidants to the Relationship between Sleep Duration and Cardiometabolic Health. *Sleep* 2015;38:1905-12.
42. Kanagasabai T, Ardern CI. Inflammation, Oxidative Stress, and Antioxidants Contribute to Selected Sleep Quality and Cardiometabolic Health Relationships: A Cross-Sectional Study. *Mediators Inflamm* 2015. doi: 10.1155/2015/824589.
43. MMurphy T, Dias GP, Thuret S. Effects of diet on brain plasticity in animal and human studies: mind the gap. *Neural Plast* 2014. doi: 10.1155/2014/563160.
44. Maruszak A, Pilarski A, Murphy T, Branch N, Thuret S. Hippocampal neurogenesis in Alzheimer's disease: is there a role for dietary modulation?. *J Alzheimers Dis* 2014;38:11-38.