FOOD and HEALTH

FOOD and HEALTH
E-ISSN 2602-2834

Food and Health 10(4), 262-272 (2024) • https://doi.org/10.3153/FH24025

Research Article

The relationship between dietary polyphenol intake and adherence to the Mediterranean diet, mental health, and sleep quality among Turkish adults: A cross-sectional study

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Cite this article as:
Bayram, H.M., Aydın, A.G., Okur, H., Karalı, A.E., Öztürkcan, A. (2024). The relationship between dietary polyphenol intake and adherence to the Mediterranean diet, mental health, and sleep quality among Turkish adults: A cross-sectional study. *Food and Health,* 10(4), 262-272. https://doi.org/10.3153/FH24025

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Submitted: 29.06.2024
Revision requested: 30.07.2024
Last revision received: 30.07.2024
Accepted: 02.08.2024
Published online: 19.08.2024

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ABSTRACT

A high intake of polyphenols has been shown to benefit health, protect against the risk of mental disorders, and improve sleep quality. This study aimed to determine the relationship between polyphenol intake, sleep quality, depression, stress, and anxiety in Turkish adults. This cross-sectional study was conducted with adults aged 18-64 between December 5, 2023, and May 12, 2024, in Istanbul, Türkiye. Participants completed a questionnaire with demographic characteristics, the Mediterranean Dietary Adherence Screener (MEDAS), the Depression Anxiety Stress Scale, the Pittsburgh Sleep Quality Index, and a 7-day food consumption record. Data were analyzed using SPSS 24.0. One hundred nineteen adults (73.1% female, mean age 23.69 ± 3.76 years) participated. There was a statistically significant difference in MEDAS classification across tertiles of polyphenol intake (p: 0.015). After controlling for confounders, the depression score significantly decreased across tertiles of polyphenol intake (OR: 0.990, p: 0.001). Similar results were observed for the anxiety score (OR: 1.006, p< 0.001). MEDAS scores showed a statistically significant difference across tertiles in unadjusted and all adjusted models (p: 0.049, p: 0.030, p: 0.020, and p: 0.015, respectively). Our findings revealed that dietary polyphenols may have a beneficial effect on depression and anxiety.

Keywords: Anxiety, Depression, Dietary polyphenol, Sleep quality, Mediterranean diet

Introduction

Many people around the world suffer from mental health disorders. According to the World Health Organization (WHO), there has been a 13% increase in mental health disorders in recent years, making them the leading cause of disability worldwide (WHO, 2022).

Depressive disorder (also known as depression) involves a persistent depressed mood or a loss of enjoyment or interest in activities over a long period (WHO, 2023). Up to 350 million people worldwide suffer from depressive disorders (Skonieczna-Żydecka et al., 2018). Anxiety, while a normal feeling in various situations, can become a permanent problem in individuals with anxiety disorder. Anxiety is a leading cause of disability, alongside depression (WHO 2022, 2023).

Not much is known about the aetiology of depression. However, it has been observed that its aetiology is similar to inflammatory diseases such as cardiovascular disease, diabetes and cancer. These include reduced insulin sensitivity, endothelial dysfunction and increased proinflammatory cytokine production (Behl et al., 2022). Additionally, depression and obesity have a bidirectional relationship, with obese individuals being more likely to experience depression (Mannan et al., 2016). Evidence suggests that depression and obesity are related to inflammation (Kivimäki et al., 2014), impaired glycemic control (Kivimaki et al., 2009) and genetic predisposition (Harbron et al., 2014).

Sleep is essential for maintaining homeostasis, circadian rhythm, metabolism, organ function, and other physiological functions. It is known that sleep disorders result in psychological disorders, physical dysfunction and decreased quality of life (Hibi, 2023). Moreover, sleep deprivation is strongly related to an increased risk of depression among all age groups (Ouyang & Sun, 2019; Short et al., 2020; Liu et al., 2021). A regular sleep pattern has been linked to better diet quality, potentially mediated by body weight status and obesity-related disorders (Manna & Jain, 2015; Mousavi et al., 2022).

Over the past few years, food ingredients have been shown to affect mental health disorders and the quality of sleep. Dietary intake has been shown to affect sleep quality and depression in previous studies (Bremner et al., 2020). Fruit and vegetable intake, rich in anti-inflammatory compounds such as carotenoids and polyphenols, is inversely associated with depression (Bayes et al., 2020). Polyphenols are defined as secondary metabolites that are abundant in fruit and vegetables as well as coffee, tea, red wine and dark chocolate (Bayram et al., 2021) and may regulate oxidative stress, neuroinflammation and gut microbiota to reduce depressive behaviours (Bayes et al., 2020; Tayab et al., 2022). However, only one study has evaluated polyphenol intake and sleep quality, showing that high polyphenol intake is negatively associated with depression, stress, and sleep quality among overweight and obese women (Golmohammadi et al., 2023).

The Mediterranean diet, rich in polyphenols, has numerous health benefits, including reduced risk of chronic diseases and depression and improved sleep quality (Castro-Barquero et al., 2018). However, no study has examined how polyphenols, Mediterranean diet adherence, sleep quality, and risk of depression, stress, and anxiousness are associated with polyphenols in Turkish adults. This study aimed to calculate the average daily polyphenol intake and to determine the relationship between polyphenol intake and sleep quality, depression, stress and anxiety in Turkish adults.

Materials and Methods

Participants

This cross-sectional study was conducted on adults aged 18-64 between December 5, 2023, and May 12, 2024, in Istanbul, Turkey. A power analysis was performed for sample selection. A prevalence of 20%, a type 1 error rate (α) of 0.05, a type 2 error rate (β) of 0.20 and a power ($1-\beta$) of 0.80 were calculated. The minimum total number of participants was, therefore, set at 100.

The participants were administered a face-to-face questionnaire that included demographic characteristics, the Mediterranean Dietary Adherence Scale (MEDAS), the Depression Anxiety Stress Scale (DASS-21), the Pittsburgh Sleep Quality Index (PSQI), and a 7-day food consumption record. The participants' height and body weight values were taken in accordance with their statements. Body mass index (BMI) was calculated as body weight (kg) / height (m)^2.

The study's inclusion criteria were adults aged 18 and 64 with a normal BMI (18.5-24.9 kg/m^2) and no history of chronic disease. Exclusion criteria included adults with diabetes, cardiovascular disease, kidney or liver disease, thyroid disorders, cancer, those following a special diet, chronic alcohol consumers, menopausal women, and pregnant or lactating women. The study received ethical approval, and informed consent was obtained from the participants.

Mediterranean Dietary Adherence Screener

Schröder et al. (2011), and Martínez-González et al. (2012) developed the Mediterranean Dietary Adherence Screener (MEDAS). Pehlivanoğlu et al. (2020) established the Turkish validity and reliability of the scale. The scale consists of 14 questions, each scoring 0 or 1 point based on consumption amounts, and the total score is calculated. The interpretation of the total MEDAS score is as follows: < 7 indicates low Mediterranean diet adherence (MDA), ≥ 7 indicates moderate MDA, and ≥ 9 indicates high MDA.

Pittsburgh Sleep Quality Index

Sleep quality was determined using the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al. (1989). The PSQI consists of seven items, each measured at one-month intervals and scored between 0 and 3. The PSQI total score ranges from 0 to 21, with higher scores indicating poorer sleep quality. Poor sleep quality is indicated by a score above five (Buysse et al., 1989).

Depression, Anxiety, and Stress Scale Short Form

Depression, Anxiety and Stress Scale Short Form (DASS-21) is a 4-Likert-type scale developed by Lovibond and Lovibond (1995). The Turkish version's validity and reliability were evaluated by Sarıçam (2018). The questionnaire was designed to assess levels of depression, anxiety and stress levels and consisted of seven items for each of the three scales. Items 3, 5, 10, 13, 16, 17, and 21 represent the depression score; and according to the total score, 0 to 4 is normal, 5 to 6 is mild depression, 7 to 10 is moderate depression, 11 to 13 is severe depression and >13 is extremely severe depression. Items 2, 4, 7, 9, 15, 19, and 20 represent the anxiety score, and total scores between 0 to 3 mean normal, between 4 and 5 of mild anxiety, between 6 and 7 of moderate anxiety, between 8 and 9 of severe anxiety, and >9 of extremely severe anxiety. Additionally, items 1, 6, 8, 11, 12, 14, and 18 represent the stress score, and the total scores between 0 and 7 mean normal, between 8 and 9 of mild stress, 10 and 12 of moderate stress, 13 and 16 of severe stress, and >16 are indicative of extremely severe stress (Sarıçam, 2018).

7-Day Food-Record Method

The 7-day food recall method assessed the participants' polyphenol and nutrient intakes. Participants wrote the foods they ate for 7 days and their quantities on the food consumption record form. A photographic atlas showing the portion size of the food was used for the quantities of the foods (Rakıcıoğlu et al., 2009). Additionally, participants were contacted for each food for which quantities were not specified. Packaged products were written as brand and weight, and the contents were checked again to minimise the margin of error. The Nutrient Database (BeBIS Pro for Windows, Willstätt, Germany; Turkish version BeBiS 9) determined daily energy and nutrient intakes.

Assessment of Total Polyphenol Intake

We used a tool developed by (Hinojosa-Nogueira et al., 2021) to assess total polyphenol intake. This tool contains 302 foods, and the total polyphenol values were obtained from the Phenol Explorer database (http://phenol-explorer.eu/). Food products were classified into 16 groups: oils and olives, cocoa and derivatives, fruits and derivatives, vegetables, nuts, cereals and derivatives, legumes, soy and derivatives, infusions, tubers, processed foods, herbs, juices, alcoholic drinks, coffee, and condiments. Total polyphenol intake was divided into tertiles: <25th percentile (Tertile 1, T1), 25th-75th percentile (Tertile 2, T2), and >75th percentile (Tertile 3, T3): T1: <853.88 mg/d, T2: 853.88-1418.41 mg/d, and T3: >1418.41 mg/d.

Statistical Analyses

SPSS 24.0 was used to analyse the data. Categorical data are presented as numbers (n) and percentages (%), while quantitative data are presented as means ($\bar{X}$) and standard deviations (SD). The distribution of variables was verified using the Kolmogorov–Smirnov test. The chi-squared test was used for categorical variables, and ANOVA was used for quantitative variables. The associations between tertiles of polyphenol intake and mental health, sleep quality and MEDAS scores were assessed using multivariate logistic regression analysis. A p-value ≤ 0.05 was considered statistically significant.

Results and Discussion

Table 1 shows the general characteristics of the participants. The study included 119 adults (73.1% female; the mean age was 23.69 ±3.76 years). Most participants (50.4%) were graduated from university, and 68.9% were employed. It was found that 83.2% of the participants did not exercise regularly, and 9.2% had no regular sleep patterns.

Table 2 presents the relationship between tertiles of polyphenol intake of depression, anxiety, stress, PSQI and MEDAS scores and classification. There was no statistically significant difference in depression, stress, anxiety, PSQI and MEDAS scores by tertile of polyphenol intake. However, the difference between MEDAS classifications was statistically significant across tertiles of polyphenol intake (p: 0.015).

Table 1. General characteristics (n: 119)

Parameters	Total (n: 119) n	%
Age (Mean ± SD)	23.69 ±3.76	
Gender		
Woman	87	73.1
Male	32	26.9
Education Levels		
Primary School	1	0.8
Secondary School	1	0.8
High School	49	41.2
University	60	50.4
MA or PhD	8	6.7
Employment status		
Employee	82	68.9
Unemployed	37	31.1
Regular Physical exercise		
No	99	83.2
Yes	20	16.8
Regular sleeping		
No	11	9.2
Yes	108	90.8
Height (cm)	168.99 ±8.76	
Body weight (kg)	65.32 ±14.22	
BMI (kg/m^2)	22.75 ±3.85	

MA: Master's degree, PhD: Doctoral degree, BMI: Body mass index

Table 3 shows the total polyphenol, energy, macro and micronutrient intake among tertiles of polyphenol intake. Participants in T3 had significantly higher energy (p< 0.001), carbohydrate (p< 0.001), protein (p: 0.002), total fat (p: 0.014), fibre (p< 0.001), and MUFA (p< 0.001) intakes compared to participants in other tertiles. Additionally, significant differences were observed in micronutrient intakes, including beta-carotene (p: 0.001), vitamin A (p: 0.004), vitamin E (p: 0.030), vitamin C (p< 0.001), thiamine (p: 0.001), riboflavin (p: 0.002), vitamin B_6 (p: 0.003), folate (p< 0.001), pantothenic acid (p: 0.003), sodium (p: 0.046), potassium (p< 0.001), iron (p< 0.001), magnesium (p< 0.001), zinc (p: 0.004), and phosphorus (p: 0.006). Additionally, caffeine intake was higher in T3, with a statistical difference (p: 0.001).

There were statistical differences between tertiles in coffee, cocoa and derivatives (p: 0.004), condimental (p: 0.002), nuts (p: 0.008), infusions (p: 0.007), legumes (p< 0.001), vegetables (p< 0.001) (Figure 1).

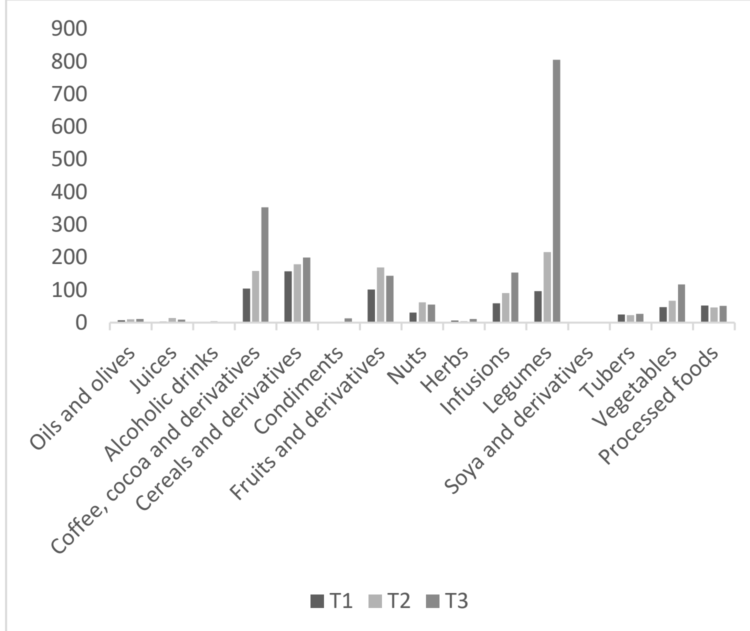

Figure 1. Total polyphenol intake (mg/d) is classified into fifteen food groups for over polyphenol tertiles

Table 4 shows the relationship between polyphenol tertiles and participants' mental health, sleep quality and Mediterranean diet adherence. In all three adjusted models, depression scores decreased significantly among tertiles of polyphenol intake (p< 0.001, p< 0.001 and p: 0.001, respectively). A similar pattern was observed for the anxiety scores (p< 0.001). MEDAS scores showed a statistically significant difference between tertiles both unadjusted (OR: 1.298, p: 0.049) and in all adjusted models for T3 (OR: 1.412, p: 0.030 for Model 1, OR: 1.472, p: 0.020 for Model 2, and OR: 1.534, p: 0.015 for Model 3, respectively) (Table 4).

A high intake of polyphenols has been shown to benefit health and protect against the risk of mental disorders. According to our results, total polyphenol intake was negatively correlated with both depression and anxiety levels, but there was no relationship between polyphenol intake and sleep quality. On the other hand, there was a significant relationship between polyphenol intake and MEDAS.

The antioxidant properties of polyphenols play a crucial role in mental health by positively affecting the brain and potentially alleviating depressive symptoms (Bayes et al., 2020; Tayab et al., 2022). The importance of dietary polyphenols in controlling pathways involved in neurogenesis and neuroprotection has been highlighted by studies that may have implications for the improvement of mental health, including depression (Huang et al., 2019; Bayes et al., 2020). Observational studies have indicated that higher dietary polyphenol intake is associated with a reduced risk of depression (Mofrad et al., 2019; Sangouni et al., 2022; Golmohammadi et al., 2023). Additionally, interventional studies have suggested that polyphenols may help decrease depressive symptoms (Fisk et al., 2020; Lin et al., 2021; Kabra et al., 2022). While our initial analysis showed no relationship between depression and tertiles of total polyphenol intake, the results changed when we adjusted for confounders. After these adjustments, we observed a significant decrease in depression scores across tertiles of polyphenol intake. This indicates that polyphenols may have a beneficial effect on depression, but this effect is only apparent when other influencing factors are taken into account. These findings highlight the significance of considering confounders in nutritional research to uncover potential health benefits.

Table 2. Relationship between tertiles of polyphenol intake of depression, anxiety, stress, PSQI and MEDAS scores and classification

	Total polyphenol intake (mg/d)			
	T1 (n: 30) (<853.88 mg)	**T2 (n: 60) (853.88-1418.41 mg)**	**T3 (n: 29) (>1418.41 mg)**	**p-value**
Depression score	7.97 ±5.49	5.73 ±4.58	7.70 ±5.72	0.232
Anxiety score	6.07 ±5.20	5.10 ±4.51	4.67 ±4.15	0.611
Stress score	8.24 ±5.33	6.67 ±4.67	7.43 ±4.65	0.290
PSQI Score	6.63 ±2.55	6.45 ±2.92	6.97 ±2.81	0.655
MEDAS Score	5.70 ±1.70	6.17 ±1.97	6.76 ±2.46	0.227
Stress classification				0.128
Normal (0-7 scores)	19 (63.3)	36 (60.0)	11 (37.9)	
Mild (8-9 scores)	3 (10.0)	8 (13.3)	10 (34.5)	
Moderate (10-12 scores)	2 (6.7)	10 (16.7)	4 (13.8)	
Severe (13-16 scores)	4 (13.3)	5 (8.3)	2 (6.9)	
Extremely severe (>16 scores)	2 (6.7)	1 (1.7)	2 (6.9)	
Anxiety classification				0.773
Normal (0-3 scores)	16 (53.3)	25 (41.7)	10 (34.5)	
Mild (4-5 scores)	3 (10.0)	10 (16.7)	5 (17.2)	
Moderate (6-7 scores)	2 (6.7)	8 (13.3)	6 (20.7)	
Severe (8-9 scores)	4 (13.3)	6 (10.0)	2 (6.9)	
Extremely severe (>9 scores)	5 (16.7)	11 (18.3)	6 (20.7)	
Depression classification				0.286
Normal (0-4. scores)	10 (33.3)	26 (43.3)	9 (31.0)	
Mild (5-6 scores)	6 (20.0)	9 (15.0)	5 (17.2)	
Moderate (7-10 scores)	5 (16.7)	17 (28.3)	5 (17.2)	
Severe (11-13 scores)	3 (10.0)	4 (6.7)	6 (20.7)	
Extremely severe (>13 scores)	6 (20.0)	4 (6.7)	4 (13.8)	
PSQI classification				0.530
Good sleep quality (<5 scores)	9 (30.0)	25 (41.7)	10 (34.5)	
Poor sleep quality (≥ 5 scores)	21 (70.0)	35 (58.3)	19 (65.5)	
MEDAS classification				**0.015***
Low MDA (<7 scores)	26 (86.7)	47 (78.3)	16 (55.2)	
Moderate MDA (7-9 scores)	4 (13.3)	11 (18.3)	8 (27.6)	
High MDA (≥9 scores)	-	2 (3.3)	5 (17.2)	

*p<0.05, PSQI: Pittsburgh Sleep Quality Index, MEDAS: Mediterranean Dietary Adherence Screener, MDA: Mediterranean diet adherence

Table 3. Total polyphenol, energy, macro and micronutrient intake among tertiles of polyphenol intake

	Total polyphenol intake (mg/d)			
	T1 (n: 30) (<853.88 mg)	**T2 (n: 60) (853.88-1418.41 mg)**	**T3 (n: 29) (>1418.41 mg)**	**p-value**
Total polyphenol intake (mg)	692.28 ±129.19[a,b]	1047.21 ±160.46[a,c]	1953.18 ±404.60[b,c]	**<0.001****
Energy (kcal)	1264.69 ±206.71[b]	1321.06 ±234.07	1583.00 ±366.41[b]	**<0.001***
Protein (g)	51.55 ±11.38[a,b]	60.03 ±10.55[a]	62.01 ±16.50[b]	**0.002***
Protein (E %)	16.90 ±4.19[a]	18.93 ±3.88[a,c]	16.14 ±2.91[c]	**0.002***
Carbohydrate (g)	136.00 ±30.70[b]	141.54 ±30.88	176.56 ± 45.05[b]	**<0.001****
Carbohydrate (E %)	43.73 ±4.65	43.87 ±5.11	45.69 ±5.96	0.529
Total fat (g)	55.85 ±10.98[b]	55.33 ±14.64[c]	66.80 ±17.25[b,c]	**0.014***
Total fat (E %)	39.23 ±3.96	36.98 ±4.98	37.62 ±5.06	0.093
Fibre (g)	14.88 ±4.30[b]	16.59 ±3.78[c]	19.56 ±4.39[b,c]	**<0.001****
SFA (g)	19.17 ±3.76	18.70 ±5.20	21.43 ±5.95	0.113
MUFA (g)	18.31 ±3.76[b]	18.47 ±4.98	24.13 ±5.80[b]	**<0.001****
PUFA (g)	13.02 ±5.20	12.74 ±5.28	15.37 ±5.60	0.190
Cholesterol (mg)	257.97 ±108.72[a]	314.74 ±104.49[a]	274.41 ±106.17	**0.030***
n-3 (g)	1.28 ±0.63	1.48 ±0.58	1.25 ±0.49	0.091
Linolenic acid (mg)	0.98 ±0.46	1.06 ±0.50	1.06 ±0.45	0.688
n-6 (g)	11.45 ±5.27	10.92 ±5.00	13.75 ±5.72	0.116
Sodium (mg)[¥]	1823.72 ±540.03[b]	1997.65 ±644.54	2333.45 ±807.37[b]	**0.046***
Potassium (mg)	1636.92 ±287.70[b]	1851.68 ±307.80[c]	2222.69 ±647.16[b,c]	**<0.001****
Vitamin A (mcg)	543.90 ±168.94[b]	642.75 ±503.39	1057.99 ±472.52[b]	**0.004***
Beta carotene (mg)	1.64 ±0.93[b]	1.80 ±1.16	3.05 ±2.37[b]	**0.001****
Vitamin C (mg)	48.48 ±17.61[b]	60.98 ±22.19	82.84 ±38.09[b]	**<0.001****
Calcium (mg)	473.07 ±170.23[a]	599.72 ±205.89[a]	508.50 ±133.57	**0.007***
Iron (mg)	7.49 ±1.65[b]	8.39 ±1.76[c]	10.42 ±3.30[b,c]	**<0.001****
Vitamin E (mg)	12.27 ±6.80[b]	11.87 ±5.38[c]	17.02 ±8.29[b,c]	**0.030***
Thiamine (mg)	0.64 ±0.14[b]	0.74 ±0.17	0.84 ±0.27[b]	**0.001****
Riboflavin (mg)	1.01 ±0.34[a,b]	1.27 ±0,32[a]	1.12 ±0.41[b]	**0.002***
Niacin (mg)	19.56 ±4.14[a]	22.11 ±4.11[a]	24.44 ±8.37	**0.008***
Vitamin B6 (mg)	0.97 ±0.24[a,b]	1.13 ±0.24[a]	1.27 ±0.42[b]	**0.003***
Folate (mcg)	175.62 ±41.40[b]	207.66 ±46.05[c]	256.04 ±97.84[b,c]	**<0.001****
Vitamin B_{12} (mcg)	3.63 ±2.26	4.91 ±2.20	4.40 ±5.26	0.181
Biotin (mcg)	30.51 ±9.54[a,b]	38.14 ±10.97[a]	38.01 ±14.11[b]	**0.004***
Pantothenic acid (mg)	3.40 ±0.75 [a,b]	3.98 ±0.75[a]	4.23 ±1.37[b]	**0.003***
Vitamin K (mcg)	47.33 ±24.76[b]	61.72 ±40.63[c]	90.85 ±66.51[b,c]	**0.002***
Magnesium (mg)	192.26 ±39.01[a,b]	217.01 ±36.78[a,c]	257.12 ±62.61[b,c]	**<0.001****
Zinc (mg)	7.46 ±2.05[a,b]	8.78 ±1.70[a]	9.23 ±2.38[b]	**0.004***
Phosphorus (mg)	837.88 ±215.36[a,b]	994.69 ±206.56[a]	970.75 ±233.13[b]	**0.006***
Caffeine (mg)	27.56 ±26.16[b]	41.57 ±3.033	68.14 ±63.31[b]	**0.001****

*p<0.05, **p< 0.001. ANOVA test was used. [a]Differences between T1 and T2, [b] Differences between T1 and T3, [c] Differences between T2 and T3. [¥] only from foods. SFA: Saturated fatty acids, MUFA: Monounsaturated fatty acids, PUFA: Polyunsaturated fatty acids, n-3: Omega-3, n-6: Omega-6.

Table 4. The relationship between polyphenol intake and mental health, sleep quality, and adherence to Mediterranean diet in participants

	Tertiles	UOR (95% CI)	p-value	Model 1 AOR[a] (95% CI)	p-value	Model 2 AOR[b] (95% CI)	p-value	Model 3 AOR[c] (95% CI)	p-value
Depression score	T1	1.000 (referans)		1.000 (referans)		1.000 (referans)		1.000 (referans)	
	T2	0.943 (0.864-1.029)	0.140	0.933 (0.848-1.026)	0.247	0.939 (0.854-1.033)	0.196	0.946 (0.856-1.046)	0.282
	T3	1.027 (0.933-1.130)	0.584	1.009 (0.900-1.130)	**<0.001****	0.994 (0.883-1.119)	**<0.001****	0.990 (0.873-1.123)	**0.001****
Anxiety score	T1	1.000 (referans)		1.000 (referans)		1.000 (referans)		1.000 (referans)	
	T2	1.023 (0.924-1.132)	0.661	1.024 (0.919-1.141)	0.669	1.033 (0.925-1.154)	0.125	1.048 (0.930-1.181)	0.442
	T3	1.108 (0.954-1.197)	0.249	1.105 (0.977-1.273)	**<0.001****	1.103 (0.965-1.265)	**<0.001****	1.006 (0.956-1.283)	**<0.001****
Stress score	T1	1.000 (referans)		1.000 (referans)		1.000 (referans)		1.000 (referans)	
	T2	0.996 (0.881-1.060)	0.467	0.966 (0.878-1.063)	0.480	0.971 (0.882-1.070)	0.551	0.977 (0.885-1.079)	0.649
	T3	1.034 (0.932-1.146)	0.532	1.054 (0.937-1.186)	0.383	1.034 (0.915-1.169)	0.593	1.031 (0.909-1.172)	0.633
PSQI score	T1	1.000 (referans)		1.000 (referans)		1.000 (referans)		1.000 (referans)	
	T2	0.976 (0.833-1.144)	0.767	0.991 (0.837-1.173)	0.913	0.998 (0.840-1.184)	0.169	1.033 (0.862-1.239)	0.723
	T3	1.044 (0.868-1.255)	0.647	1.072 (0.869-1.324)	0.516	1.036 (0.831-1.290)	0.755	1.089 (0.861-1.377)	0.477
MEDAS score	T1	1.000 (referans)		1.000 (referans)		1.000 (referans)		1.000 (referans)	
	T2	1.122 (0.901-1.398)	0.305	1.141 (0.892-1.460)	0.294	1.150 (0.893-1.480)	0.278	1.175 (0.903-1.529)	0.230
	T3	1.298 (0.999-1.685)	**0.049***	1.412 (1.034-1.927)	**0.030***	1.472 (1.063-2.040)	**0.020***	1.534 (1.086-2.167)	**0.015***

*p< 0,05, **p< 0,001. Model 1: adjusted for age, BMI, gender and energy, Model 2: Model 1 + education level + physical activity, Model 3: Model 2 + linolenic acid + caffeine intake. The reference group was tertile 1 of polyphenol intake.

Anxiety disorders are very common and have been associated with an increased risk of coronary heart disease. However, the link between diet and anxiety has received less attention. Vegetarian and traditional diets rich in phytochemicals are related to a lower prevalence of anxiety (Jacka et al., 2010; Mofrad et al., 2019). Contrary to these findings, Golmohammadi et al. (2023) reported no relationship between polyphenol intake and anxiety. Our findings revealed a noteworthy relationship between anxiety and polyphenol intake after adjusting for confounders. This suggests that polyphenol consumption may have a positive impact on reducing anxiety levels, but this effect becomes evident only when other influencing factors are controlled for. These results suggest that dietary polyphenol intake positively affects mental health and emphasise the importance of considering confounding variables in such studies to reveal true associations.

The risk of mental disorders such as depression can be increased by stress. A study reported that a higher dietary phytochemical index was associated with a decreased risk of stress in women (Mofrad et al., 2019). Similarly, Golmohammadi et al. (2023) found that higher dietary polyphenol intake was negatively associated with stress after adjusting for various factors. However, our findings showed no association between stress and polyphenol intake. In previous studies, the effects of stress and polyphenol intake were observed in women (Mofrad et al., 2019; Golmohammadi et al., 2023). Including both men and women in this study may have influenced the results in this way. Furthermore, polyphenols might not have a direct mechanism of action affecting stress levels, or the effects may not be significant enough to produce observable changes.

Additionally, polyphenols, commonly found in the Mediterranean diet, have been linked to a lower prevalence of mental disorders, especially depression and anxiety (Bayes et al., 2020; Dominguez et al., 2021; Melguizo-Ibáñez et al., 2023). Furthermore, polyphenol-rich foods have been associated with improvements in depressive symptoms (Fisk et al., 2020). According to our study, the difference between MEDAS classification was statistically significant in tertiles of polyphenol intake. In both unadjusted and adjusted models, MEDAS scores showed a statistically significant difference between tertiles. This suggests that dietary polyphenol intake may be important in influencing MEDAS scores, potentially impacting overall dietary quality and health outcomes.

Short sleep duration is associated with obesity, hypertension, type 2 diabetes, cardiovascular disease, and all-cause mortality compared to normal sleep duration (Yin et al., 2017). These associations are thought to be partly mediated by changes in nutritional intake, including fruit and vegetables, which affect body weight and risk of chronic disease (Noorwali et al., 2018). Total polyphenol intake was reported to be inversely associated with sleep duration (Noorwali et al., 2018). Similarly, Golmohammadi et al. (2023) found that higher dietary polyphenol intake was inversely associated with sleep quality after adjusting for multiple factors. Additionally, it has been shown that individuals following the Mediterranean diet are less likely to experience poor sleep quality, insufficient sleep duration, excessive daytime sleepiness or insomnia symptoms (Scoditti et al., 2022; Godos et al., 2024). We found no relationship between sleep quality and polyphenol intake despite investigating the potential link. This suggests that, within the scope of our research, polyphenol consumption does not appear to significantly impact sleep quality, and factors other than polyphenol intake may play a more important role in influencing how well people sleep.

There are several limitations to the study. Firstly, the study was cross-sectional, meaning we cannot establish a cause-and-effect relationship or the direction of the findings. Second, the sample size is small and predominantly female, which may limit the generalizability of the results to the entire population. Third, residual confounders in our study, including categorical variables (employment status, marital status, educational status, physical activity, etc.), may have been a factor. Despite these limitations, the study has several strengths. First, we used the 7-day Food Record Method, considered the best method for analysing food consumption (FAO, 2018). Second, the study controls for a wide range of confounders. Third, the Phenol Explorer database accurately calculated total polyphenol intake.

Conclusion

After controlling for confounders in this study, depression and anxiety scores were significantly reduced across tertiles of polyphenol intake, but no association was found between polyphenol intake and sleep quality. Furthermore, there was a significant association between polyphenol intake and MEDAS. In conclusion, our findings revealed that dietary polyphenols may have a beneficial effect on mental health disorders such as depression and anxiety. However, dietary polyphenols were not associated with sleep quality. Future prospective studies with larger sample sizes are needed compared with current results.

Compliance with Ethical Standards

Conflict of interest: The author(s) declares that they have no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: The Istanbul Gelisim University Ethics Committee approved the study during meeting number 2023/09 on 20.11.2023.

Data availability: Data will be made available on request.

Funding: This project was supported by TUBITAK, the Scientific and Technical Research Council of Turkey (project ID: TUBITAK2209A-1919B012307441).

Acknowledgements: -

Disclosure: -

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