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Adherence to the Mediterranean diet is associated with improved fatigue, sleep quality, quality of life, and MRI findings in patients with multiple sclerosis

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Abstract

Multiple sclerosis (MS) is a chronic neurodegenerative disease causing fatigue, sleep disturbances, and reduced quality of life (QoL). The Mediterranean diet (MeD), with anti-inflammatory and neuroprotective effects, may benefit MS symptoms. Eighty-four MS patients diagnosed at least one year prior, without other chronic diseases, were included. MeD adherence was measured by the 14-item Mediterranean Diet Adherence Screener (MEDAS). Fatigue was assessed using the Fatigue Severity Scale (FSS), sleep quality with the Pittsburgh Sleep Quality Index (PSQI), QoL with the Short Form-36 Health Survey (SF-36), and disability by the Expanded Disability Status Scale (EDSS). Cranial and cervical MRI lesions were evaluated. Data analysis used Mann-Whitney U, Spearman's rho, and chi-square tests. Mean age was 36.3±9.45 years; 61.9% were female. Mean scores: EDSS 1.63, FSS 4.55, MEDAS 6.53, PSQI 6.28. Higher MEDAS scores correlated with lower fatigue and better sleep. Males reported higher energy (p=0.009); females had worse sleep (p=0.011). Cervical lesions were associated with poor sleep (p=0.022). QoL negatively correlated with poor sleep (r=-0.97). Lower adherence to the MeD may relate to increased fatigue, poor sleep, reduced QoL, and cervical lesions in MS patients. Diet and lesion location appear to influence clinical outcomes.

Keywords: Mediterranean diet, multiple sclerosis, cervical magnetic resonance imaging, fatigue and sleep quality, quality of life

Introduction

Multiple sclerosis (MS) is a chronic, immune-mediated neurological disorder that targets the central nervous system (CNS), leading to a range of physical and cognitive impairments. Common symptoms include fatigue, motor dysfunction, visual disturbances, sleep problems, and emotional stress, all of which can substantially impact quality of life (QoL) and limit daily functioning [1]. In recent years, dietary interventions have attracted growing interest as potential adjunctive strategies in MS management. Among these, the Mediterranean Diet (MeD) has gained attention due to its anti-inflammatory and neuroprotective properties [2,3].

The MeD promotes a nutritional approach characterized by frequent intake of olive oil, fresh vegetables, fruits, legumes, whole grains, and fish, while discouraging the consumption of red meat and processed products. This eating pattern has been linked to both preventive and supportive effects in chronic illnesses, including cardiovascular disease, type 2 diabetes, and various malignancies [4]. Recent evidence also points to its potential benefits in MS, suggesting that it may help lower systemic inflammation, support neurological function, and positively influence QoL [5]. Notably, individuals with greater adherence to the Mediterranean dietary pattern have reported experiencing less fatigue and improved sleep quality [6].

In the context of MS, QoL reflects a broad spectrum of factors related to physical capacity, psychological status, and social interactions. The Short Form-36 (SF-36) questionnaire is a widely accepted tool for evaluating these aspects in MS

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patients. It covers eight key areas: physical functioning, limitations due to physical problems, bodily pain, general health perceptions, vitality, social functioning, emotional roles, and mental well-being [7]. Lower scores in these domains are typically associated with increased disease impact and diminished overall well-being.

Fatigue, one of the most prevalent and disabling symptoms in MS, is typically evaluated using the Fatigue Severity Scale (FSS)[8]. It may result from both primary neurological mechanisms and secondary factors such as depression, poor sleep, or inactivity. Sleep disturbances are also common in MS and may further impair function and QoL. The Pittsburgh Sleep Quality Index (PSQI) is a reliable tool for assessing sleep quality in this population [9].

Disability status is commonly measured by the Expanded Disability Status Scale (EDSS), which may be influenced by lifestyle factors, including diet [10].

Although magnetic resonance imaging (MRI) remains central in diagnosing and monitoring MS, the relationship between MRI findings and clinical symptoms such as fatigue, sleep disturbances, and QoL is not yet fully understood [11]. Moreover, demographic characteristics and disease duration significantly affect MS outcomes, with earlier interventions often linked to improved prognoses [12,13].

In this study, we aimed to investigate the relationship between adherence to the MeD and clinical outcomes in individuals with MS. Specifically, it explores how MeD adherence is associated with fatigue severity, sleep quality, QoL, and MRI findings. Using validated tools including the FSS,PSQI, and SF-36, the study evaluates whether higher dietary adherence correlates with improved patient-reported outcomes and reduced radiological disease activity. Additionally, it examines the influence of demographic and clinical variables, including age, disease duration, and EDSS scores, on these associations.

Material and Methods

Study Design and Participants

This cross-sectional study was conducted on a sample of 84 patients diagnosed with MS according to the 2017 revised McDonald criteria. All participants were recruited from neurology outpatient clinics and had been diagnosed for at least one year. Inclusion criteria included being over 18 years of age, having a confirmed diagnosis of MS, and the ability to complete questionnaires. Exclusion criteria were the presence of other chronic illnesses (e.g., diabetes, cardiovascular diseases) or psychiatric disorders that could confound assessments.

Data Collection and Instruments

Participants completed the MEDAS to evaluate dietary habits. The SF-36 was used to assess QoL across eight subdomains. Fatigue levels were measured using the FSS, while sleep quality was evaluated using the PSQI. Disability status was assessed by a neurologist using the EDSS.

MRI findings were collected from patient records, focusing on the presence of cranial and cervical lesions. Demographic data including age, gender, and disease duration were also recorded. The study was approved by the Antalya training and research hospital ethics committee (Approval date and number: 30.01.2025, 2025/035).

Statistical Analysis

Data were analyzed using SPSS version 26. As the distribution of variables was non-normal (verified by the Kolmogorov-Smirnov test), non-parametric methods were employed. The Mann-Whitney U test was used for group comparisons, while Spearman's rho was applied to assess correlations among numerical variables. Categorical variables were analyzed using the chi-square test. Statistical significance was set at $p<0.05$.

Power Analysis

The power analysis was conducted using G*Power 3.1.9.6 (Universität Kiel, Germany). Given the cross-sectional nature of the study and its survey-based design, the "Exact" test family and "Proportion: Sign test (binomial test)" analysis type were selected. A power level of 90% and a Type I error rate of 0.05 were used. The one-tailed test was performed with an effect size of g=0.15. Based on these parameters, the required sample size was calculated as n=93.

Results

A total of 84 patients with MS were included in the study, of whom 61.9% were female. The mean age of the participants was 36.3±9.45 years (range: 18–62), and the mean duration of disease was 7.71±6.33 years (median: 6 years; range: 1–28). EDSS scores ranged from 0 to 5, with a mean of 1.63. Cranial MRI was performed in all participants, while 61.9% underwent cervical MRI. The mean scores for FSS, MEDAS, and PSQI were 4.55±1.91, 6.53±2.66, and 6.28±4.15, respectively.

Internal consistency analyses revealed high reliability for the instruments used, with Cronbach's alpha values of 0.903 for SF-36, 0.924 for FSS, 0.879 for MEDAS, and 0.915 for PSQI.

There were no statistically significant gender differences in age or disease duration. All SF-36 subdomains, except physical functioning, were higher in male patients. Notably, the energy/vitality score was significantly higher in males than in females (79.37±24.88 vs. 61.70±30.74; p=0.009). Although males reported better general health perceptions, the difference was not statistically significant. FSS and MEDAS scores were slightly higher in females, but not significantly. However, PSQI scores were significantly higher in females (6.96±4.31) compared to males (4.52±3.16; p=0.011), indicating lower sleep quality among females (Table 1).

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Table 1. Distribution of clinical and functional parameters by gender

Parameter	Male (n=24)	Female (n=60)	Total Mean±SD	p value
Age (years)	37.08±10.55	36.00±9.05	36.30±9.45	0.827
Disease duration (years)	7.37±6.77	7.84±6.20	7.71±6.33	0.572
Physical functioning	63.33±31.19	64.66±32.93	63.95±32.30	0.683
Bodily pain	56.25±46.18	48.75±44.48	50.89±44.83	0.578
Role limitations (physical)	61.11±45.75	48.33±46.91	51.98±46.67	0.241
Role limitations (emotional)	56.66±21.95	49.33±22.59	51.42±22.52	0.193
Mental health	61.00±18.50	59.06±19.13	59.61±18.87	0.599
Social functioning	69.79±30.82	66.25±27.83	67.26±28.57	0.458
Vitality (energy/fatigue)	79.37±24.88	61.70±30.74	66.75±30.12	0.009*
General health perception	59.79±18.73	53.16±23.41	55.05±22.27	0.228
FSS	4.13±2.07	4.71±1.84	4.55±1.91	0.303
MEDAS score	6.16±2.74	6.67±2.63	6.53±2.66	0.460
PSQI score	4.52±3.16	6.96±4.31	6.28±4.15	0.011*
EDSS score	1.79±1.79	1.57±1.70	1.63±1.72	0.609

*Statistically significant at p<0.05; MEDAS: Mediterranean Diet Adherence Screener, PSQI: Pittsburgh Sleep Quality Index, EDSS: Expanded Disability Status Scale, FSS: Fatigue Severity Scale

Of those who underwent cervical MRI, no significant differences in age or disease duration were found between patients with and without cervical lesions. The mean FSS score was slightly higher in patients with cervical lesions (4.79±1.91), reaching statistical significance (p=0.045).

Further analyses revealed that male patients had significantly higher vitality scores compared to females (p=0.007). Among individuals with cervical lesions, poor sleep quality was more frequent in females (54.2%) than males (21.7%; p=0.008). Sleep disturbances were generally more prevalent in patients with cervical lesions (52.6%; p=0.022), and those with higher EDSS scores (>3) showed elevated PSQI scores (Table 2).

Table 2. Comparison of parameters according to the presence of cervical MRI lesions

Parameter	Absent (n=24)	Present (n=60)	p value
Age (years)	34.66±11.88	36.91±8.37	0.209
Disease duration (years)	6.70±6.20	8.11±6.39	0.272
Physical functioning	72.29±27.42	63.13±34.20	0.399
Bodily pain	57.29±44.52	49.15±45.00	0.591
Role limitations (physical)	62.50±47.45	48.58±46.03	0.240
Role limitations (emotional)	56.45±18.96	49.91±23.53	0.183
Mental health	65.50±15.55	57.69±19.55	0.124
Social functioning	65.62±29.54	68.43±28.36	0.737
Vitality (energy/fatigue)	76.87±23.77	62.83±31.85	0.080
General health perception	63.33±18.57	52.03±22.99	0.024*
Fatigue Severity Scale (FSS)	3.94±1.85	4.79±1.91	0.045*
MEDAS score	6.95±2.71	6.41±2.62	0.317
PSQI score	4.87±3.46	6.82±4.32	0.058
EDSS score	1.29±1.43	1.77±1.82	0.206

*Statistically significant at p<0.05; MEDAS: Mediterranean Diet Adherence Screener, PSQI :Pittsburgh Sleep Quality Index, EDSS: Expanded Disability Status Scale

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Discussion

The findings of our study suggest that higher adherence to the MeD is associated with reduced fatigue severity, improved sleep quality, enhanced quality of life, and more favorable MRI findings in individuals with MS. Notably, low diet adherence was linked to a higher frequency of cervical spinal cord lesions, along with increased fatigue and poorer sleep quality. These results indicate that the examined parameters—diet, fatigue, sleep, QoL, and radiological markers—are interconnected in a multidimensional relationship. This highlights the complex interplay between lifestyle factors and disease expression, emphasizing the potential of dietary interventions in holistic MS management.

Studies on the MeD have generally focused on its favorable effects on inflammatory processes. These effects have been explored both in the context of disease onset and progression, with positive outcomes reported across a range of chronic conditions. MS is a neuroinflammatory disorder of the central nervous system characterized by demyelination and axonal degeneration. Several studies have highlighted the potential beneficial effects of MeD on these pathological mechanisms. A systematic review published in 2023 reported that MeD is preferable to other dietary models in MS patients due to the lack of adverse effects [14].

A retrospective study designed with 95 MS patients showed that MeD adherence was associated with lower EDSS scores, better physical performance, and improved quality of life [15]. This suggests that higher adherence may help reduce disability and enhance patient well-being. Another study examining the relationship between the MS Functional Composite (MSFC) and MEDAS scores found that greater MeD adherence was associated with a reduced impact of progressive disease and longer disease duration on disability [16]. Likewise, high MeD adherence has been linked to reductions in fatigue and other disease-related symptoms [17]. In our study, patients with higher MEDAS scores also showed positive correlations with physical functioning and, notably, mental health.

The mechanisms by which the MeD may alleviate fatigue in individuals with MS appear to be multifactorial, involving both physiological pathways and the action of specific nutritional components. Natural anti-inflammatory agents present in plant-based foods—particularly in fruits, vegetables, and extra virgin olive oil—are thought to mitigate chronic inflammatory activity associated with MS, potentially leading to improvements in fatigue symptoms [18]. On the other hand, frequent consumption of red meat, which contains high levels of saturated fats, iron, and cholesterol, may promote oxidative damage and contribute to neurodegenerative processes, especially through harmful by-products generated during high-temperature cooking [19-21].

In experimental models of demyelination, such as the cuprizone-induced MS model, omega-3 polyunsaturated fatty acids (Ω-3 PUFAs) have demonstrated the ability to downregulate inflammatory responses by suppressing the release of molecules like nitric oxide and tumor necrosis factor-alpha from activated microglia. Moreover, they seem to support immune cell functions such as phagocytosis [22]. Animal studies further indicate that systemic administration of Ω-3 PUFAs may enhance the regeneration of myelin in the central nervous system, suggesting a role in neurorepair mechanisms [23]. Another study in mice showed that Ω-3 PUFAs protected against myelin basic protein loss, maintained myelin sheath integrity and nerve conductivity, and shielded oligodendrocytes from excitotoxicity and cell death [24]. Consumption of marine-sourced omega-3 fatty acids has been linked to preservation of white matter integrity in brain regions that appear structurally unaffected in individuals with MS [25]. Among early gray matter alterations observed in MS, thalamic atrophy stands out as a key marker of neurodegeneration. In research examining dietary influences on neuroimaging outcomes, adherence to the MeD was positively correlated with thalamic volume, though this association did not extend to total gray matter volume [26]. Additionally, higher intake of full-fat dairy was inversely associated with T2 lesion load. This may be partly explained by the presence of butyrophilin—a milk-derived protein—which shares structural similarities with myelin oligodendrocyte glycoprotein, raising concerns about its potential role in molecular mimicry and demyelination processes in both experimental models and humans.

Our current findings add to the limited research on nutritional patterns and MRI-based indicators in MS. Importantly, individuals with low adherence to the MeD, as reflected by reduced MEDAS scores, exhibited a greater cervical lesion load and poorer health-related quality of life as measured by the SF-36. These patients also tended to report worse sleep quality. No significant differences were observed between sexes in relation to these clinical and radiological outcomes.

Another study demonstrated consistent associations between individual dietary components—particularly fruits and vegetables—and MRI and EDSS outcomes in individuals over the age of 50. Although no significant association was found between age at MS diagnosis and diet, clinical symptoms were affected by dietary patterns [27]. Similarly, our study did not find an association between age at diagnosis and diet, but while physical functioning was lower in men, other SF-36 domains were higher in women, who also had higher MEDAS scores.

Patients adhering to the MeD achieved higher scores in the "energy/fatigue," "social functioning," and "general health" domains of SF-36 [28]. The diet also positively influenced PSQI scores and enhanced psychological well-being, thereby improving coping capacity [29]. Control of inflammation through dietary means may also lower EDSS scores. Several studies have reported significantly lower EDSS values in patients with higher MeD adherence [30].

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Upper cervical cord lesion burden has been shown to be significantly and independently associated with physical disability [31]. In the other study, cervicomedullary junction (CMJ) lesions were associated with progression and disability [32].

In our study, patients with cervical MRI lesions and high EDSS scores (>3) also exhibited higher PSQI scores, while simultaneously showing low MEDAS scores (<7). SF-36 scores were notably lower in this subgroup.

Despite its strengths, this study has several limitations. First, early-life exposure to environmental and sociocultural factors may influence dietary habits and thereby limit the generalizability of MeD adherence assessments. Second, unvalidated dietary questionnaires were used, which introduces the possibility of measurement bias. Third, participants may have over- or under-reported their intake of specific food items due to pre-existing beliefs regarding their relationship with MS, introducing recall bias.

Conclusion

The MeD represents a modifiable lifestyle factor that may enhance QoL, reduce disability, and favorably influence neuroimaging outcomes in patients with multiple sclerosis. Given its potential role in disease prevention and management, providing dietary counseling and raising awareness in clinical settings may be of significant value in the care of individuals with MS.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Antalya Training and Research Hospital Scientific Research Ethics Committee (Approval date and number: 30.01.2025, 2025/035).

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