Adherence to the Mediterranean Diet and Its Association with Disability and Quality of Life in Subjects with Multiple Sclerosis: A Cross-Sectional Study

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SUMMARY

Nutritional habits are key environmental factors in multiple sclerosis (MS). This study aimed to investigate the association between adherence to the Mediterranean diet and disability, and quality of life in MS. A total of 103 people with MS were included. Adherence to the Mediterranean diet was assessed with the Mediterranean Diet Adherence Scale (MEDAS), disability with the Expanded Disability Status Scale (EDSS), and quality of life with the Multiple Sclerosis International Quality of Life Scale (MusiQoL). Secondary outcome measure was walking ability (12-item MS Walking Scale (MSWS-12)). The mean age of study subjects was 36.26±9.92 years. There was a negative correlation between MEDAS and EDSS (p=0.025, r=-0.221) and positive correlation between MEDAS and MusiQoL total score (p=0.044, r=0.199). Higher MEDAS scores were significantly associated with lower EDSS scores (R^2=0.362, 95% CI=-0.419 to -0.036, p=0.020) and better walking ability (lower MSWS-12 scores) (R^2=0.350, 95% CI=-0.399 to -0.028, p=0.024). Additionally, a positive association was observed between MEDAS and MusiQoL (R^2=0.122, 95% CI=0.067-0.501, p=0.011). In conclusion, Mediterranean diet may play a significant role in reducing disability and improving quality of life.

KEYWORDS

Multiple sclerosis; Mediterranean diet; Disability; Quality of life

Introduction

Multiple sclerosis (MS) is a chronic neurologic disorder characterized by inflammation, demyelination, and axonal damage[1], affecting millions of individuals worldwide[2]. MS can lead to varying degrees of disability in functional activities, impose limitations on social and professional life, and significantly impact quality of life (QoL)[3]. Nutritional habits have been suggested to influence clinical outcomes and QoL in people with MS (pwMS)[4].

Although no specific diet has been definitely proven to alter the course of MS[5], certain dietary models have been reported to exert beneficial effects on disability levels in pwMS to some extent[6,7]. The Mediterranean diet is widely recognized for its health-promoting properties and its potential role in the prevention and management of chronic diseases[8]. This dietary pattern emphasizes consumption of vegetable oils, fish over red meat, low-fat or non-fat dairy products, limited intake of refined carbohydrates and simple sugars, and an abundance of fiber- and antioxidant-rich fruits and vegetables. These dietary components are hypothesized to exert favorable effects on the progression of MS[9-11]. Additionally, the Mediterranean diet is rich in monounsaturated fatty acids (particularly omega-3 fatty acids) and antioxidant vitamins and minerals (such as vitamins A, C, and E, folic acid, selenium, zinc, and calcium), which have been suggested to contribute positively to both the prevention and course of MS[8,12,13].

Studies investigating the association between dietary patterns and QoL in MS remain scarce.

The present cross-sectional study aimed to examine the relationship between adherence to the Mediterranean diet and disability, as well as QoL in pwMS.

Subjects and methods

Study design and subjects

This cross-sectional study included 103 pwMS (16 male and 87 female) who were diagnosed according to the revised McDonald criteria[14] by a specialist neurologist at the Neurology Outpatient Clinic, SANKO University. All study subjects provided informed consent. The study was conducted in line with ethical principles outlined in the Declaration of Helsinki. The study was approved by the SANKO University Non-interventional Research Ethics Committee (approval date/number: April 7, 2021/04) and was registered at ClinicalTrials.gov (NCT05777629). Our research adhered to the STROBE checklist to ensure a robust and transparent reporting of results.

Excluded were pwMS who were pregnant or in the postpartum period during the study, had an attack during the study, had an active infection, had another disease that prevented them from doing physical activity, and pwMS who had a disease that would require a special diet.

Outcomes

Sociodemographic characteristics of the pwMS (age, gender, height, body weight, education level), clinical characteristics (MS clinical type, MS duration from diagnosis, number of attacks in the last two years, application of the treatment recommended by the physician, second-line therapy), and presence of chronic disease, regular physical activity, duration of daily sitting, and status of receiving nutritional counseling from a dietitian for previous MS were recorded.

Primary outcome

Expanded Disability Status Scale (EDSS): EDSS measures disability and neurologic symptoms in pwMS. The scale is scored between 0 and 10. A score of 0 indicates no disability or disorder, while a score of 10 indicates death due to MS[15].

Mediterranean Diet Adherence Scale (MEDAS): in this scale, there are 14 questions in total, 12 of which are about frequency of food consumption and 2 are about food consumption habits. For each question, 0 or 1 point is assigned depending on the response. The total score is evaluated as ≤5 (low compliance), 6-9 (moderate compliance), and ≥10 (high compliance)[16]. The Turkish validity and reliability study of the scale was performed by Pehlivanoğlu *et al.*[17].

Multiple Sclerosis International Quality of Life (MusiQoL): there are 9 subscales on the Likert type scale consisting of 31 questions: Activities of daily living (ADL), Psychological well-being, Symptoms, Relationships with friends, Relationships with family, Sentimental and sexual life, Rejection, Coping, and Relationship with the healthcare system. The patient answers the questions according to his/her status in the last 4 weeks. Each question scores between 0 and 4. The increase in the total score obtained from the scale is associated with higher QoL[18]. The validity and reliability study for the Turkish population was carried out and completed simultaneously in 20 countries including Turkey and in 14 different languages[19].

Secondary outcome measurements

12-item MS Walking Scale (MSWS-12): MSWS-12 questions difficulties pwMS have experienced during walking activity in the last 2 weeks. Each item is scored 1-5 points (1=not effected at all, 5=totally effected). A low total score indicates less walking effect involvement[20]. The Turkish validity and reliability study was performed by Dib *et al.*[21].

Statistical analysis

Descriptive analysis of pwMS focused on providing a detailed summary of the collected data. Continuous variables were assessed for normality using the Shapiro-Wilk test. Based on this assessment, variables following a normal distribution were summarized with means and standard deviations, while those with a skewed distribution were described using medians and interquartile ranges (IQR). Categorical variables were depicted as frequencies and percentages. Correlations were determined by the Spearman correlation test. To determine relevant covariates that might influence the relationship between the MEDAS and EDSS, MSWS-12 and MSQoL, we conducted bivariate analyses. Variables (age, gender, education level, body mass index (BMI), smoking status, regular physical activity, disease duration, receiving nutritional counseling and second-line medical therapy) were evaluated for their unadjusted association with both MEDAS and EDSS, MSWS-12 and MSQoL. Covariates that exhibited a significant correlation ($p<0.20$) with the outcomes or were clinically relevant were selected for inclusion in the multivariable models.

Multivariable linear regression analyses were performed to investigate the association of MEDAS with each of the EDSS, MSWS-12 and MSQoL adjusting for the selected covariates. Prior to inclusion, covariates were assessed for multicollinearity through the examination of variance inflation factor values, with a commonly accepted cutoff point of 5 indicating significant collinearity.

The adjusted R-squared statistic was reported for each model to quantify the proportion of variability in the outcomes explained by MEDAS after accounting for covariates. Standardized beta coefficients were also presented, offering a metric for the comparative strength of association between MEDAS and each outcome variable.

All statistical tests were two-tailed, with a 5% alpha level considered indicative of statistical significance. Analyses were conducted using the R

statistical package (version 3.6.0), with the lm() function for regression modeling, and the sandwich package for robust standard errors.

Based on the study by Hadgkiss *et al.*[22], the sample size was calculated using a correlation coefficient r=0.30, an alpha level 0.05, and a power 0.80, resulting in a minimum required sample size of 84 participants.

Results

The mean age of the 103 pwMS (16 male (15.5%), 87 female (84.5%)) was 36.26±9.92 years. The pwMS data on clinical characteristics are given in Table 1. Sixty (58.3%) pwMS stated that they did not perform regular physical activity in the last three months. The mean daily sitting duration of the pwMS was 6.94±3.34 hours. Ninety-one (88.3%) pwMS stated that they had not received nutritional counseling

Table 1. Descriptive characteristics of multiple sclerosis patients

Feature		N=103
Age (years), $\bar{X}$ (SD)		36.26 (9.928)
Gender, n (%)	Male	16 (15.5)
Education, n (%)	Literate	1 (1.0)
	Elementary school	14 (13.6)
	Secondary school	8 (7.8)
	High school	20 (19.4)
	University and over	60 (58.3)
BMI (kg/m^2) $\bar{X}$ (SD)		26.04 (5.75)
BMI classification (%)	Normal	53 (51.5)
	Overweight	34 (33.0)
MS clinical type, n (%)	RRMS	88 (85.3)
	SPMS	10 (9.7)
	PPMS	5 (4.8)
MS diagnosis, n (%)	Less than 5 years	46 (44.5)
	6-10 years	30 (29.2)
	11-20 years	22 (21.4)
	21-30 years	5 (4.8)
Number of attacks (past 2 years), n (%)	0	34 (33.3)
	1	46 (44.4)
	2	15 (14.8)
	3 and above	8 (7.4)

Table 1. [Continued]

Feature		N=103
Disease modifying therapy	No	6 (5.8)
	Interferon-beta 1a (SC)	27 (26.2)
	Interferon-beta 1a (IM)	6 (5.8)
	Interferon-beta 1b (SC)	1 (1.0)
	Glatiramer acetate	3 (2.9)
	Teriflunomide	10 (9.7)
	Dimethyl fumarate	8 (7.8)
	Fingolimod	12 (11.7)
	Cladribine	9 (8.7)
	Ocrelizumab	16 (15.5)
	Rituximab	1 (1.0)
	Natalizumab	3 (2.9)
	Other	1 (1.0)
Application of treatment, n (%)	Yes	89 (86.4)
	No	3 (2.9)
	I am not sure	11 (10.7)
Chronic disease*, n (%)	Yes	33 (32.0)
	No	70 (68.0)
Regular physical activity*** (past 3 months), n (%)	Yes	43 (41.7)
	No	60 (58.3)
Daily sitting (hour), $\bar{X}$ (SD)		6.94 (3.34)
Receiving nutritional counseling (for MS) n (%)	Yes	12 (11.7)
	No	91 (88.3)
MEDAS, $\bar{X}$ (SD)		6.97 (2.01)
MEDAS Mediterranean diet compliance by MEDAS score, n (%)	Low compliance (≤5 points)	24 (23.3)
	Moderate compliance (6-10 points)	68 (66.0)
	High compliance (≥10 points)	11 (10.7)

*Thyroid diseases, depression, hypertension, hyperlipidemia, diabetes, cardiovascular diseases, asthma/chronic obstructive pulmonary disease; osteoporosis
**Personal perception for the last 1 month
***Walking, cycling, weight lifting, pilates
MS = multiple sclerosis; BMI = body mass index; MEDAS = Mediterranean Diet Adherence Scale; RRMS = relapsing-remitting MS; SPMS = secondary-progressive MS; PPMS = primary-progressive MS; SD = standard deviation

for MS before. The mean MEDAS was 6.97±2.01 and 68 (66.0%) pwMS were moderately adherent to the Mediterranean diet (Table 1).

The EDSS, MSWS-12, MusiQoL total and MusiQoL subscale means of the pwMS are given in Table 2.

Table 2. EDSS, MSWS-12, MusiQoL total and MusiQoL subscales in study pwMS

Feature (N=103)	$\bar{X}$ ± SD (min-max)
EDSS	1.67±1.50 (0.5-8)
MSWS-12	27.47±14.14 (11-60)
MusiQoL	71.33±15.54 (31.22-98.96)
MusiQoL-Activity of Daily Living	64.80±26.81 (0-100)
MusiQoL-Psychological Well-being	68.81±29.13 (0-100)
MusiQoL-Symptoms	69.64±24.00 (0-100)
MusiQoL-Rejection	77.47±23.08 (0-100)
MusiQoL-Coping	80.10±22.64 (0-100)
MusiQoL-Relationships with Friends	57.73±41.46 (0-100)
MusiQoL-Relationships with Family	75.62±31.16 (0-100)
MusiQoL-Sentimental and Sexual Life	58.33±33.32 (0-100)
MusiQoL- Relationship with the Healthcare system	89.46±21.15 (0-100)

EDSS = Expanded Disability Status Scale; MSWS-12 = Multiple Sclerosis Walking Scale-12; MusiQoL = Multiple Sclerosis International Quality of Life Scale; PwMS = people with MS

There was significant negative correlation (p=0.025, r=-0.221) between MEDAS and EDSS. There was no correlation between MEDAS and MSWS-12 (p=0.056, r=-0.189). Significant positive correlation was observed between MEDAS and MusiQoL total score (p=0.044, r=0.199), MusiQoL-ADL (p=0.012, r=0.247), MusiQoL-Symptoms (p=0.048, r=0.633) and MusiQoL-Rejection (p=0.001, r=0.311). There was no correlation between MEDAS and BMI (p=0.249, r=-0.015). There was significant positive correlation between EDSS and MSWS-12 (p<0.001, r=0.497), strong negative correlation with MusiQoL total score (p<0.001, r=-0.384). There was significant positive correlation (p=0.002, r=0.306) between EDSS and BMI (Table 3).

Negative significant correlation (p<0.001, r=-0.412) was observed between MSWS-12 and MusiQoL total score. In addition, there were also negative significant correlations between MSWS-12 and MusiQoL subscales MusiQoL-ADL (p<0.001, r=-0.821), MusiQoL- Psychological well-being (p<0.001, r=-0.427), MusiQoL-Coping (p=0.016, r=-0.237) (Table 3).

Negative significant correlation (p=0.009, r=-0.256) was found between MusiQoL-ADL and BMI (Table 3).

Initially, our analysis included 103 pwMS. However, regression analysis was performed on 85 samples after removing data other than relapsing-remitting MS, patients over 65 years of age, and with BMI over 30 kg/m^2, as these would influence the results. The mean age of pwMS was 35.7±9.15 years and they were predominantly females (n=85, 84.2%). A comprehensive descriptive analysis is shown in Table 4.

In our bivariable analysis to identify potential covariates for inclusion in the regression model assessing the impact of diet on MS outcomes, we observed several notable associations. Age demonstrated a consistently significant association across different outcomes, with standardized estimates suggesting varying degrees of influence. Particularly, age showed a positive and significant relationship with EDSS (estimate: 0.433, p<0.001), MSWS-12 (estimate: 0.303, p=0.005), and MSQoL (estimate: -0.0919, p=0.403), although the latter did not reach statistical significance. Engagement in exercise was not a significant predictor in any of the models, and receiving nutritional counseling was marginally

Table 3. Correlations between MEDAS, EDSS, MSWS-12, MusiQoL and BMI means

Feature (N=103)		MEDAS	EDSS	MSWS-12	MusiQoL	MusiQoL-ADL	MusiQoL-Well-being	MusiQoL- Symptoms	MusiQoL- RsFriends	MusiQoL- FamilyRs	MusiQoL- Emot. Sexual	MusiQoL- Coping	MusiQoL- Rejection	MusiQoL- Health System	BMI (kg/m^2)
MEDAS	p	1													
	r														
EDSS	p	0.025*	1												
	r	-0.221													
MSWS-12	p	0.056	<0.001*	1											
	r	-0.189	0.497												
MusiQoL	p	0.044*	<0.001*	<0.001*	1										
	r	0.199	-0.384	-0.412											
MusiQoL-ADL	p	0.012*	0.029	<0.001*	<0.001*	1									
	r	0.247	-0.215	-0.821	0.495										
MusiQoL-Well-being	p	0.134	0.089	<0.001*	<0.001*	<0.001*	1								
	r	0.149	-0.168	-0.427	0.603	0.532									
MusiQoL-Symptoms	p	0.048*	0.725	0.130	<0.001*	0.002*	0.002*	1							
	r	0.633	-0.035	-0.150	0.458	0.298	0.295								
MusiQoL-RsFriends	p	0.056	0.588	0.954	<0.001*	0.787	0.275	0.002*	1						
	r	0.572	-0.054	0.006	0.564	-0.027	0.109	0.296							
MusiQoL-FamilyRs	p	0.195	0.264	0.380	<0.001*	0.305	0.026*	0.006*	<0.001*	1					
	r	0.129	-0.111	-0.087	0.677	0.102	0.219	0.269	0.579						
MusiQoL-Emot.Sexual	p	0.609	0.538	0.439	<0.001*	0.407	0.082	0.242	0.637	0.005*	1				
	r	0.051	-0.061	-0.077	0.492	0.083	0.172	0.116	0.047	0.275					
MusiQoL-Coping	p	0.118	0.090	0.016*	<0.001*	0.002*	<0.001*	0.121	0.181	0.043*	0.151	1			
	r	0.155	-0.168	-0.237	0.516	0.305	0.415	0.154	0.133	0.200	0.143				
MusiQoL-Rejection	p	0.001*	0.092	<0.001*	<0.001*	<0.001*	<0.001*	0.707	0.099	0.001*	0.013*	<0.001*	1		
	r	0.311	-0.167	-0.342	0.558	0.351	0.402	0.037	0.164	0.311	0.245	0.498			
MusiQoL-HealthSystem	p	0.922	0.133	0.724	<0.001*	0.625	0.107	0.356	0.315	0.002*	0.002	0.022*	0.016*	1	
	r	0.010	0.149	-0.035	0.441	0.049	0.160	0.092	0.100	0.299	0.303	0.226	0.237		
BMI (kg/m^2)	p	0.249	0.002	0.135	0.476	0.009	0.402	0.128	0.263	0.419	0.765	0.719	0.892	0.151	1
	r	-0.115	0.306	0.148	-0.071	-0.256	-0.083	-0.151	0.111	-0.080	0.030	-0.036	0.013	0.143	

BMI = body mass index; MEDAS = Mediterranean Diet Adherence Scale; EDSS = Expanded Disability Status Scale; MSWS-12 = Multiple Sclerosis Walking Scale-12; MusiQoL = Multiple Sclerosis International Quality of Life Scale

Table 4. EDSS, MSWS-12, MusiQoL total and MusiQoL subscale means in PwMS

Feature (N=85)		
Age, years	$\bar{X}$ ± SD	35.1±8.88
Female,	n (%)	70 (82.4)
Highest education achieved, years	Median (25^{th}-75^{th} percentile)	18.0 (13.0-18.0)
BMI	$\bar{X}$ ± SD	24.0±3.16
Smoking	n (%)	20 (23.5)
Exercise	n (%)	38 (44.7)
Duration of MS	Median (25^{th}-75^{th} percentile)	8.0 (2.0-13.0)
Receiving nutritional counseling	n (%)	9 (10.6)
Second-line therapy*	n (%)	37 (43.5)
MEDAS	$\bar{X}$ ± SD	7.01±2.00

BMI = body mass index; MS = multiple sclerosis; MEDAS = Mediterranean Diet Adherence Scale; EDSS = Expanded Disability Status Scale; MSWS-12 = Multiple Sclerosis Walking Scale-12; MusiQoL = Multiple Sclerosis International Quality of Life Scale
*second-line therapy: fingolimod, cladribine, ocrelizumab, rituximab, natalizumab

associated with EDSS (estimate: -0.378, p=0.084), indicating a potential reduction in disability with nutritional intervention that approached but did not reach statistical significance. The duration of MS showed a positive correlation with MSWS-12 (estimate: 0.221, p=0.042), suggesting that longer disease duration may be associated with walking difficulties. The utilization of second-line therapy emerged as a significant covariate across all models with pronounced standardized estimates, particularly noting an extremely strong association with MSQoL (estimate: 0.998, p<0.001) and MSWS-12 (estimate: 0.745, p<0.001), signifying that second-line therapies might substantially impact these outcomes. BMI was another significant factor, positively associated with EDSS (estimate: 0.300, p=0.005) and negatively, though not significantly, with MSQoL (estimate: -0.042, p=0.697). Smoking status revealed a negative relationship with MSQoL (estimate: -0.579, p=0.023), indicating that smokers might experience lower QoL. Higher education levels showed a tendency towards a negative association with MSWS-12 (estimate: -0.243, p=0.025), implying that pwMS with higher educational attainment might have better walking abilities (Supplementary Table 1).

Our multivariable regression models delineated the relationship between MEDAS and key clinical outcomes in MS while adjusting for a constellation of potential confounding factors outlined in the Supplementary Table 1. In Model 1, after controlling for confounders, an inverse relationship was observed between MEDAS and EDSS, with a standardized estimate of -0.223 (95% CI: -0.419 to -0.036, p=0.020), accounting for 36.2% of the variance in EDSS scores. Similarly, Model 2 presented an inverse association between MEDAS and MSWS-12, with a standardized estimate of -0.214 (95% CI: -0.399-0.028, p=0.024) and R^2=0.350, indicating that greater adherence to the Mediterranean

Table 5. Linear regression analysis data: effect of MEDAS on EDSS, MSWS-12 and MusiQoL

Model	Outcome	MEDAS			
		R^2	Standardized estimate	95% CI (lower-upper)	p
Model 1	EDSS	0.362	-0.223	-0.419 – -0.036	0.020
Model 2	MSWS-12	0.350	-0.214	-0.399 – -0.028	0.024
Model 3	MusiQoL	0.122	0.284	0.067 – 0.501	0.011

Model 1 and Model 2 were adjusted for age, highest education achieved, BMI, Duration of MS and Second-line therapy
Model 3 was adjusted for smoking, Receiving nutritional counseling, duration of MS and second-line therapy

CI = confidence interval; p = probability; MEDAS = Mediterranean Diet Adherence Score; EDSS = Expanded Disability Status Scale; MSWS-12 = Multiple Sclerosis Walking Scale-12; MusiQoL = Multiple Sclerosis International Quality of Life Scale

diet could correspond to better walking ability in pwMS. Model 3 revealed a positive relationship between MEDAS and MSQoL scores, marked by a standardized estimate of 0.284 (95% CI: 0.067-0.501, p=0.011) and explaining 12.2% of the variability in MSQoL (Table 5).

Discussion

This cross-sectional study demonstrated that adherence to the Mediterranean diet was associated with reduced disease severity and improved QoL in pwMS. Furthermore, after adjusting for confounding variables (age, gender, education level, BMI, smoking status, regular physical activity, disease duration, receiving nutritional counseling, and second-line medical therapy), adherence to the Mediterranean diet was found to influence disease severity, and QoL.

The majority of pwMS in this study exhibited moderate to high adherence to the Mediterranean diet. This finding is consistent with a previous study conducted in Turkey, which has reported a moderate level of adherence to the Mediterranean diet among pwMS[23]. The study was conducted in the Gaziantep region, where local dietary habits such as widespread consumption of olive oil, legumes, and tomato-based dishes align with the principles of the Mediterranean diet. It is hypothesized that these regional dietary patterns contributed to the relatively high adherence levels observed among the study participants.

Notably, most pwMS included in this study had not previously received nutritional counseling for MS. While diet is considered a potential modifiable factor influencing inflammatory processes in MS, there is currently insufficient scientific evidence to support the superiority of any specific dietary approach in altering the disease course[24]. Following diagnosis, referring pwMS to a dietitian for nutritional assessment, deficiency prevention, and individualized dietary planning may enhance disease management.

Given the unpredictable and progressive nature of MS, functional impairments and activity limitations can emerge suddenly and worsen rapidly. While regular physical activity has been reported to positively influence cognitive and physical function, as well as QoL in pwMS, symptom burden often leads to reduced physical activity levels[25]. Insufficient physical activity exacerbates mobility

and balance impairments, further deteriorating QoL[26]. In the present study, increased disability was associated with worsening gait impairments. Moreover, higher disability and greater gait disturbances correlated with lower QoL. A systematic review concludes that reducing disability is crucial for improving QoL in pwMS[27]. A longitudinal study examining the effects of disability severity on walking ability and QoL in pwMS reports that interventions targeting gait improvement contribute positively to QoL[28]. Consequently, strategies aimed at reducing disability and enhancing walking ability in pwMS are likely to yield significant improvements in their overall QoL.

More than half of the pwMS in our study reported that they had not engaged in regular physical exercise in the past three months. Similarly, a study investigating different MS subtypes found that more than half of pwMS did not participate in regular physical activity[29]. Another study reports that 60.5% of pwMS were physically inactive[30]. It is possible that pwMS reduce their physical activity due to concerns about worsening symptoms[31]. However, insufficient physical activity may contribute to increased disability and gait impairments, ultimately leading to a decline in QoL[32]. Current evidence indicates that physical activity enhances functional capacity and QoL in pwMS, emphasizing the importance of encouraging regular physical activity following diagnosis[25].

Obesity induces a chronic, low-grade inflammatory state, which is associated with a poor prognosis in diseases characterized by active proinflammatory processes, such as MS[33]. Several studies have reported that elevated BMI levels correlate with greater disease severity and an increased risk of disability in pwMS[34-37]. Consistent with the literature, our findings indicate that higher BMI levels were associated with increased disability status in pwMS. Additionally, as BMI increased, ADL score and QoL subscale decreased. In parallel with our findings, a previous study has reported that obese pwMS had higher disability levels and lower QoL scores[38]. Providing nutritional counseling to pwMS is crucial for managing gastrointestinal symptoms, preventing malnutrition, and maintaining BMI within the normal range. Furthermore, engaging in regular physical activity according to functional capacity may help pwMS sustain a healthy BMI. Given the potential risk-benefit ratio of dietary and exercise interventions in MS, a multidisciplinary approach, including neurologists, dietitians, and physiotherapists, may offer additional benefits in MS management.

A cross-sectional study examining the association between Mediterranean diet and EDSS in pwMS concluded that Mediterranean diet may be an effective dietary approach for reducing disability in this population[6]. Similarly, a study involving 435 pwMS from a southern Italy cohort reports that adherence to the Mediterranean diet was associated with lower disability status[11]. Another study found that pwMS who consumed higher amounts of whole-grain products and low-fat dairy, both key components of the Mediterranean diet, had lower disability levels[39]. Additionally, a long-term follow-up study demonstrated a statistically significant reduction in EDSS scores among pwMS adhering to the Mediterranean diet[4]. In line with these findings, our study revealed that pwMS with higher adherence to the Mediterranean diet exhibited lower disability status. If future studies with larger sample sizes confirm these results, the Mediterranean diet could be recommended as a dietary approach to mitigate disability in pwMS.

Our findings also indicate that both total QoL and specific QoL subscales (ADL, Symptoms, and Rejection) improved with increasing adherence to the Mediterranean diet. A study investigating dietary habits of pwMS reports that a high intake of fruits and vegetables, along with low consumption of processed foods, was associated with better QoL[22]. A cross-sectional study further suggested that adherence to the Mediterranean diet may enhance QoL in pwMS[6]. Additionally, a long-term follow-up study in pwMS with secondary-progressive MS

found that adherence to the Mediterranean diet, combined with synbiotic supplementation, contributed to reduced serum inflammatory markers and improved QoL[40]. Given that MS is known to negatively affect multiple QoL dimensions — including functional capacity, psychological well-being, and daily living activities — dietary interventions targeting these domains may be of particular clinical relevance[41]. Furthermore, a meta-analysis of randomized controlled trials examining the effects of dietary interventions on fatigue and QoL in MS concluded that the Mediterranean diet was more effective in improving QoL compared to control diets[27]. These findings suggest that the Mediterranean diet holds promise as a dietary intervention for enhancing QoL in pwMS. If further research supports these results, the Mediterranean diet may emerge as a key nutritional model in the dietary management of MS.

Limitations

This study had certain limitations. The pwMS included in the study were not homogeneous in terms of MS subtypes. Additionally, due to the cross-sectional design of the study, causal relationships between dietary adherence and clinical outcomes could not be established.

Conclusion

Our study provides strong evidence that adherence to the Mediterranean diet is linked to favorable clinical outcomes in pwMS. Higher Mediterranean diet adherence correlates with lower disability severity and improved QoL, highlighting its potential role in MS management. Given the limited research on diet and MS progression, these findings are significant.

Our adjusted models reveal an inverse relationship between Mediterranean diet adherence and both EDSS and MSWS-12, while positive correlation with MusiQoL suggests dietary patterns may enhance QoL. Although no definitive dietary treatment exists for MS, our results indicate that Mediterranean diet adherence may help reduce disability and improve QoL. Maintaining a normal BMI also appears crucial in disability management.

A multidisciplinary approach involving neurologists, dietitians, and physiotherapists is recommended for comprehensive care. Early dietary and physiotherapy interventions may further benefit pwMS. Future research should assess the long-term effects of Mediterranean diet adherence across MS subtypes to confirm its potential as a dietary intervention.

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SAŽETAK

Pridržavanje mediteranske prehrane i njezina povezanost s invalidnošću i kvalitetom života u osoba s multiplom sklerozom: presječna studija

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Prehrambene navike su ključni okolišni čimbenici u multiploj sklerozi (MS). Cilj ovog istraživanja bio je ispitati povezanost između pridržavanja pravila mediteranske prehrane i invalidnosti te kvalitete života u MS. Uključene su 103 osobe s MS. Pridržavanje mediteranske prehrane procijenjeno je pomoću Ljestvice pridržavanja mediteranske prehrane (*Mediterranean Diet Adherence Scale*, MEDAS), invalidnost pomoću *Expanded Disability Status Scale* (EDSS), a kvaliteta života pomoću *Multiple Sclerosis International Quality of Life Scale* (MusiQoL). Sekundarna mjera ishoda bila je mogućnost hodanja, tj. Ljestvica hodanja u MS u 12 točaka (*12-item MS Walking Scale*, MSWS-12). Srednja dob osoba u istraživanju bila je 36,26±9,92 godine. Zabilježena je negativna korelacija između ljestvica MEDAS i EDSS (p=0,025, r=-0,221), a pozitivna korelacija između MEDAS i ukupnog zbroja MusiQoL (p=0,044, r=0,199). Viši zbroj na ljestvici MEDAS bio je značajno povezan s nižim zbrojem na ljestvici EDSS (R^2=0,362, 95% CI=-0,419 do -0,036, p=0,020) i boljom sposobnosti hodanja (niži zbroj MSWS-12) (R^2=0,350, 95% CI=-0,399 do -0,028, p=0,024). Usto, zabilježena je pozitivna povezanost između MEDAS i MusiQoL (R^2=0,122, 95% CI=0,067-0,501, p=0,011). Zaključujemo da bi mediteranska prehrana mogla imati važnu ulogu u smanjivanju invalidnosti i poboljšanju kvalitete života.

KLJUČNE RIJEČI

Multipla skleroza; Mediteranska prehrana; Invalidnost; Kvaliteta života

Supplementary Table 1. Bivariate linear regression analyses of models in which outcome were EDSS, MSWS-12 and MusiQoL

Variable		Standardized estimate	p
EDSS	Age	0.433	<0.001
	Sex	0.205	0.474
	Highest education achieved	-0.191	0.080
	BMI	0.300	0.005
	Smoking	-0.0639	0.804
	Exercise, n (%)	-0.0698	0.751
	Receiving nutritional counseling	-0.118	0.739
	Duration of MS	0.365	<0.001
	Second-line medical therapy	0.745	<0.001
MSWS-12	Age	0.303	0.005
	Sex	0.0403	0.888
	Highest education achieved	-0.243	0.025
	BMI	0.188	0.085
	Smoking	-2.864	0.999
	Exercise, n (%)	0.021	0.923
	Receiving nutritional counseling	0.0372	0.917
	Duration of MS	0.221	0.042
	Second line medical therapy	0.998	<0.001
MusiQoL	Age	-0.0919	0.403
	Sex	-0.142	0.621
	Highest education achieved	-0.005	0.961
	BMI	-0.042	0.697
	Smoking	-0.579	0.023
	Exercise, n (%)	-0.540	0.806
	Receiving nutritional counseling	-0.378	0.084
	Duration of MS	-0.141	0.198
	Second line medical therapy	-0.378	0.084

BMI = body mass index; MS = multiple sclerosis; EDSS = Expanded Disability Status Scale; MSWS-12 = Multiple Sclerosis Walking Scale-12; MusiQoL = Multiple Sclerosis International Quality of Life Scale