

ASSOCIATION BETWEEN EXPANDED DISABILITY STATUS SCALE SCORE AND MEDITERRANEAN DIET ADHERENCE ACCORDING TO DISEASE DURATION IN PATIENTS WITH MULTIPLE SCLEROSIS

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ABSTRACT

Background. Multiple sclerosis (MS) is a long-term condition in which the immune system attacks the brain and spinal cord, affecting approximately 2.9 million people worldwide. Among the dietary patterns studied in MS, the Mediterranean diet has attracted the most research attention for its potential to reduce inflammation and slow the progression of disability.

Objective. This study used a survey-based approach to collect data from one hundred MS patients across three countries – Slovakia, Italy, and the United Kingdom/international cohort to explore the association between disability levels, Mediterranean diet adherence, and disease duration. The main aim was to examine how Expanded Disability Status Scale (EDSS) scores and length of time living with MS were associated with how closely patients followed the Mediterranean diet. Secondary aims included looking at how often patients consumed specific food groups, whether they were taking vitamin D or omega-3 supplements, whether their eating habits had changed since their MS diagnosis, and how many patients had received formal nutrition advice from their healthcare team, with results broken down by country and level of disability.

Material and Methods. This cross-sectional study explored the relationship between disability level, Mediterranean diet adherence measured using the validated 14-item Mediterranean Diet Adherence Screener (MEDAS), and disease duration in 100 MS patients from Slovakia ($n = 47$), Italy ($n = 36$), and a UK/international cohort ($n = 17$).

Results. The overall mean MEDAS score was 3.96 ± 2.26 , reflecting predominantly poor dietary adherence across the entire sample: 77% of patients fell into the low-adherence range (score 0-5), 22% into the moderate range (6-9), and only one patient (1%) reached high adherence (10-14). MEDAS scores were highest in patients with the lowest disability (mean 4.73 at EDSS 0-2) and declined across higher EDSS groups, with the proportion of low-adherence patients rising from 63.6% at EDSS 0-2 to 90.0% at EDSS 6-8. Vegetable consumption, the most important food component of the Mediterranean diet, declined modestly from 4.64 to 4.33 times per week across the disability spectrum. Regarding disease duration, the lowest mean MEDAS scores were observed in patients diagnosed for 1-5 years (3.75) and those living with MS for 20 or more years (3.69), the latter group also showing the highest rate of low adherence (85.7%). Italian patients had the highest mean MEDAS score (4.56), compared with 4.12 in the UK/international group and 3.45 in Slovakia. A notable discrepancy was found between the 24% of patients who self-identified as following the Mediterranean diet and the objective MEDAS results, in which only one patient achieved high adherence. Only 26% of patients had received formal dietary advice from their doctor, despite 47% having changed their eating habits independently after diagnosis.

Conclusions. These findings show that higher disability and longer disease duration are both linked to poorer Mediterranean diet adherence when assessed with a validated tool and highlight the need to include structured nutritional support as a regular part of MS care.

Keywords: multiple sclerosis, Expanded Disability Status Scale, Mediterranean diet, disability progression, dietary adherence

INTRODUCTION

Multiple sclerosis (MS) is a long-term condition in which the immune system attacks the brain and spinal cord, gradually damaging nerve fibres and leading to worsening neurological symptoms over time. According to Walton et al. [1], the condition

affects more than 2.9 million people globally, though its prevalence differs considerably from one region to another, with higher rates observed in countries further from the equator. The condition works by causing the immune system to mistakenly attack and destroy the cells responsible for protecting nerve fibres, which gradually leads to worsening neurological problems

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over time. Although modern treatments have greatly improved the lives of people with the relapsing form of MS, managing the progression of disability in the later stages of the disease remains difficult and there is still no fully effective solution [2].

The Expanded Disability Status Scale Score (EDSS) is a widely used scale developed by Kurtzke [3] to measure disability in MS patients (the scoring criteria are described in detail in the Methods). Because it is so commonly used in research and clinical settings, the EDSS serves as the main tool for measuring how various factors, including lifestyle choices, affect the disease. This has led to growing interest in understanding how things like physical activity, body weight, and diet may influence how disability develops over time. Over the last ten years, researchers have become increasingly interested in the connection between the gut, the brain, and the immune system as a possible way through which diet may affect inflammation in MS. What we eat plays an important role in shaping the types of bacteria living in our gut and the substances they produce. For example, fibre-rich foods encourage the growth of certain beneficial bacteria that produce compounds known as short-chain fatty acids, including butyrate, propionate, and acetate. These compounds interact with immune cells in ways that help reduce inflammation and may help keep the immune system better balanced [4, 5].

Diet is one of the lifestyle factors that researchers have been paying increasing attention to when looking at how disability and quality of life develop in MS, with the Mediterranean diet receiving the most focus. This eating pattern is mainly built around foods such as vegetables, legumes, whole grains, olive oil, and fish, while limiting red meat, processed meats, and refined carbohydrates. Over recent years, several studies have found meaningful links between following the Mediterranean diet and better disability outcomes in MS. For example, Sand et al. [6] found in a real-world study that people who followed the Mediterranean diet more closely tended to have lower disability scores. A large Italian study involving 435 patients similarly found that greater adherence to the Mediterranean diet was linked to lower levels of both disability and disease severity [7]. Tryfonos et al. [8] found that patients who followed the Mediterranean diet less closely were approximately twice as likely to reach more advanced stages of disability. More recently, a review and analysis of multiple studies by Kong et al. [9] confirmed that closer adherence to the Mediterranean diet was associated with less fatigue and a healthier body weight in people with MS.

There is now a reasonable body of evidence supporting the idea that diet can influence disability in MS. The Mediterranean diet is rich in fibre, natural plant compounds, and healthy fats, all of which help

support a healthy and diverse gut environment. This in turn encourages the growth of beneficial gut bacteria that produce compounds helping to calm the immune system and reduce the kind of inflammation that contributes to nerve damage in MS [4, 5]. On the other hand, diets that are low in plant-based foods and high in heavily processed foods can disrupt the balance of gut bacteria, weaken the gut lining, and increase inflammation throughout the body, which may worsen nerve damage and lead to greater disability over time [10]. It is also important to recognise that this relationship works in both directions – as disability worsens, it becomes harder for people to maintain a healthy diet due to physical limitations and other practical challenges, and in turn, a poorer diet may further fuel inflammation and accelerate disease progression.

Although a growing number of studies have looked at the Mediterranean diet and MS, most of this research has been carried out in Southern and Western European countries. There is still a lack of large studies that look at how closely people with MS follow the Mediterranean diet across different levels of disability and disease duration, particularly in Central European countries where eating habits tend to differ quite a lot from those in Mediterranean regions.

This study aims to fill that gap by looking at data from one hundred MS patients across three countries – Slovakia, Italy, and the UK. The main goal was to explore the relationship between disability levels, Mediterranean diet adherence, and how long patients had been living with MS. Additional goals included looking at what specific foods patients were eating, how dietary habits differed between countries, what supplements patients were taking, and how many patients had received any nutrition advice as part of their regular MS care.

MATERIALS AND METHODS

Study design and participants

A cross-sectional online survey was administered to adults with a confirmed neurologist-diagnosed MS across three national cohorts: Slovakia ($n = 47$), Italy ($n = 36$), and UK/international respondents ($n = 17$), yielding a total sample of 100 participants. Participation was voluntary and anonymous; the survey was distributed through neurological patient organisations and MS community platforms during 2023–2024. All participants provided electronic informed consent. The study adhered to the principles of the Declaration of Helsinki as revised in 2024 [11]. Inclusion criteria were age ≥ 18 years, a self-reported neurologist-confirmed diagnosis of MS, and completion of the MEDAS and EDSS survey items; responses with incomplete data on these items were excluded from

analysis. The sample was predominantly female (92%; Slovakia 91.5%, Italy 94.4%, UK/international 88.2%) with a median age band of 40-50 years across the whole sample (Slovakia skewed older, with 66.0% of participants aged ≥ 50 years, versus 27.8% in Italy and 52.9% in the UK/international group). Educational attainment was not collected as part of this survey and could therefore not be reported or adjusted for; independent confirmation of MS diagnosis (e.g., from medical records) was likewise not collected. These represent limitations of the study and are addressed further in the Discussion.

Disability assessment

Neurological disability was quantified using the EDSS [3], self-reported with reference to the most recent clinical evaluation. The EDSS ranges from 0 (no disability) to 10 (death due to MS) and is based on functional-system scores and ambulatory ability; a score of 4.0 or above indicates that walking ability in daily life is noticeably impaired, and a score above 6.0 indicates that the person requires a walking aid. Because EDSS values were self-reported rather than verified against clinical records, and because participants were not asked to specify individual symptoms, some misclassification cannot be excluded; this limitation is discussed further below. Responses were grouped into five functional bands: 0-2 (no or minimal disability), 2-4 (mild to moderate), 4-6 (moderate; ambulatory with aid), 6-8 (severe; requiring assistance), and > 8 (very severe).

Disease duration assessment

Disease duration was assessed by a direct survey question asking participants to indicate how long they had been living with a confirmed MS diagnosis. Responses were captured in six ordinal intervals: less than 1 year, 1-5 years, 5-10 years, 10-15 years, 15-20 years, and 20 or more years. Unlike previous studies that relied exclusively on EDSS as a proxy for disease duration, the present study incorporates self-reported duration as a primary variable, enabling direct examination of its relationship with both disability severity and dietary adherence.

Dietary assessment

Mediterranean diet adherence was measured using the Mediterranean Diet Adherence Screener (MEDAS), a validated 14-item questionnaire developed by Martínez-González et al. [12]. Each item is worth one point, giving a total score ranging from 0 to 14. Scores between 0 and 5 indicate low adherence, scores between 6 and 9 reflect moderate adherence, and scores between 10 and 14 represent high adherence to the Mediterranean diet. The 14 items

cover a range of dietary behaviours, including the use of olive oil as the main cooking fat, daily consumption of vegetables (≥ 2 portions) and fruit (≥ 3 portions), limited intake of red meat (< 1 portion/week), butter, and sugary drinks, as well as regular consumption of fish (≥ 3 portions/week), legumes (≥ 3 portions/week), nuts (≥ 3 times/week), and wine (≥ 7 glasses/week). It also considers preferences for leaner meats such as chicken or turkey over red or processed meats, and the use of sofrito, a sauce made from tomatoes, onions, and olive oil, at least twice per week in cooking. In addition to MEDAS scoring, self-reported dietary pattern (including self-identification with the Mediterranean diet), food group consumption frequencies, supplementation use, and receipt of dietary advice from a physician were recorded. The MEDAS was self-administered online, as part of the electronic survey, in the respondent's local language; participants were not required to have prior familiarity with the Mediterranean diet, as the instrument itself defines the relevant food groups and portion sizes for each item. Although MEDAS was originally validated in a Mediterranean population, it was selected for use across all three national samples because it is a short, freely available, and widely used screening tool that permits direct comparison with the substantial existing body of MEDAS-based MS literature; its cross-cultural applicability to non-Mediterranean dietary contexts is nonetheless a limitation of the present approach and is discussed further below. Information on whether following the Mediterranean diet had been specifically recommended by a physician was not collected.

Statistical analysis

Microsoft Office Forms and Excel were used to process input data. Quantitative data (including MEDAS scores and food-group consumption frequencies) are presented descriptively as means and standard deviations, and qualitative data as frequencies and percentages, calculated separately by country, EDSS band, and disease-duration category. Given the exploratory, hypothesis-generating nature of this pilot survey and the small and unevenly distributed size of several subgroups (e.g., $n = 3$ for EDSS > 8), formal between-group inferential statistics (e.g., ANOVA and post-hoc comparisons) are not reported in detail here; the analysis is therefore presented as descriptive rather than confirmatory, and the patterns described in the Results should be interpreted as observations warranting confirmation in adequately powered future studies rather than as evidence of statistically significant differences.

RESULTS

Sample characteristics and EDSS distribution

The study enrolled 100 patients with MS: 47 from Slovakia (mean EDSS 4.91), 36 from Italy (mean EDSS 3.33), and 17 from the UK/international cohort (mean EDSS 3.24), yielding an overall mean EDSS of 4.06. Slovak patients exhibited substantially higher mean disability, with the largest proportions in the EDSS 4-6 (38.3%) and 6-8 (27.7%) bands. Italian and UK/international participants were predominantly distributed across EDSS 0-2 and 2-4 (Table 1).

Disease duration distribution

Disease duration was reported directly by all 100 participants. The largest group (35.0%, $n = 35$) had been living with MS for 20 or more years, followed by those with 10-15 years (17.0%, $n = 17$) and 5-10 years (16.0%, $n = 16$). A further 16 patients (16.0%) had been diagnosed within 1-5 years, 10 patients (10.0%) within 15-20 years, and 6 patients (6.0%) within less than one year. Longer disease duration was associated with higher EDSS: among patients with ≥ 20 years' disease duration, 40.0% ($n = 14$) were in the EDSS 4-6 band and 25.7% ($n = 9$) in EDSS 6-8, compared with 50.0% ($n = 8$) in EDSS 0-2 among those with 1-5 years of disease (Table 2).

MEDAS score and Mediterranean diet adherence by EDSS group

The overall mean MEDAS score across the full cohort was 3.96 ± 2.26 , placing the sample firmly within the low-adherence range. The great majority of patients (77 of 100, 77.0%) scored 5 or below, 22 patients (22.0%) scored in the moderate range (6-9), and only one patient (1.0%) achieved high adherence (score of 10). No patient scored above 10.

MEDAS scores showed a general declining trend across increasing EDSS groups, with the highest mean score at EDSS 0-2 (4.73) and progressively lower values at EDSS 2-4 (3.55) and EDSS 4-6 (3.73). The proportion of patients in the low-adherence category rose from 63.6% at EDSS 0-2 to 75.9% at EDSS 2-4, 80.8% at EDSS 4-6, and 90.0% at EDSS 6-8, indicating a substantially higher burden of poor dietary adherence as disability advances. The very severe group (EDSS > 8) had a mean of 5.00, though this is based on only three patients and should be interpreted with caution.

Vegetable intake, the most central food component of the MedDiet, showed a modest declining pattern, from 4.64 times/week at EDSS 0-2 to 4.33 times/week at EDSS > 8 . Fish intake showed a modest upward trend across groups (1.05 to 1.67 times/week), while

Table 1. EDSS distribution by country ($n = 100$)

EDSS Group	Slovakia ($n = 47$)	%	Italy ($n = 36$)	%	UK/Intl ($n = 17$)	%	Total ($n = 100$)	%
0-2	2	4.3	14	38.9	6	35.3	22	22.0
2-4	13	27.7	11	30.6	5	29.4	29	29.0
4-6	18	38.3	4	11.1	4	23.5	26	26.0
6-8	13	27.7	5	13.9	2	11.8	20	20.0
> 8	1	2.1	2	5.6	0	0.0	3	3.0
Mean EDSS	4.91	—	3.33	—	3.24	—	4.06	—

EDSS – Expanded Disability Status Scale; UK/Intl – United Kingdom and international respondents.

Table 2. EDSS distribution by disease duration ($n = 100$)

Disease duration	n	EDSS 0-2 n (%)	EDSS 2-4 n (%)	EDSS 4-6 n (%)	EDSS 6-8 n (%)	EDSS > 8 n (%)	Self-reported MedDiet n (%)
< 1 year	6	2 (33.3)	4 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	3 (50.0)
1-5 years	16	8 (50.0)	5 (31.2)	2 (12.5)	1 (6.2)	0 (0.0)	6 (37.5)
5-10 years	16	5 (31.2)	4 (25.0)	3 (18.8)	3 (18.8)	1 (6.2)	4 (25.0)
10-15 years	17	2 (11.8)	7 (41.2)	4 (23.5)	3 (17.6)	1 (5.9)	2 (11.8)
15-20 years	10	2 (20.0)	1 (10.0)	3 (30.0)	4 (40.0)	0 (0.0)	2 (20.0)
≥ 20 years	35	3 (8.6)	8 (22.9)	14 (40.0)	9 (25.7)	1 (2.9)	7 (20.0)

Self-reported MedDiet – proportion of patients in each duration group who identified as following the Mediterranean diet; EDSS – Expanded Disability Status Scale.

Table 3. MEDAS score, adherence categories, and key food frequency indicators by EDSS group (n = 100)

Indicator	EDSS 0-2 (n = 22)	EDSS 2-4 (n = 29)	EDSS 4-6 (n = 26)	EDSS 6-8 (n = 20)	EDSS > 8 (n = 3)
Mean MEDAS score	4.73	3.55	3.73	3.85	5.00
Low adherence (0-5), n (%)	14 (63.6)	22 (75.9)	21 (80.8)	18 (90.0)	2 (66.7)
Moderate adherence (6-9), n (%)	8 (36.4)	7 (24.1)	4 (15.4)	2 (10.0)	1 (33.3)
High adherence (10-14), n (%)	0 (0.0)	0 (0.0)	1 (3.8)	0 (0.0)	0 (0.0)
Vegetable intake (×/week)	4.64	4.97	4.63	4.75	4.33
Fruit intake (×/week)	4.88	4.04	4.53	5.35	7.00
Fish intake (×/week)	1.05	0.98	1.20	1.21	1.67
Legume intake (×/week)	1.31	1.36	1.16	1.42	0.83
Whole grain intake (×/week)	1.08	1.62	1.84	1.80	0.17
Red meat intake (×/week)	1.14	1.12	1.14	1.08	2.17
Fast food intake (×/week)	0.50	0.37	0.56	0.25	0.33

MEDAS – Mediterranean Diet Adherence Screener; values for food frequency represent mean times/week; adherence categories: low – 0-5, moderate – 6-9, high – 10-14.

whole grain intake was lowest in the highest disability groups. Fast food intake was generally low across all groups (Table 3).

MEDAS score and Mediterranean diet adherence by disease duration

When disease duration was examined as an independent variable, MEDAS scores demonstrated a generally declining trajectory with longer disease duration. The highest mean MEDAS score was observed in the 15-20 years group (4.70), followed by the 5-10 years group (4.44) and the less-than-one-year group (4.00). The nadir was observed in patients diagnosed for 1-5 years (3.75) and those with the longest disease history of ≥ 20 years (3.69), who also recorded the highest proportion of low adherence (85.7%).

The self-reported Mediterranean diet adoption rate declined from 50.0% in patients within the first

year of diagnosis to 11.8% in the 10-15 years group, before recovering partially to 20.0% in the 15-20 and ≥ 20 years groups. Notably, the ≥ 20 -year group was the largest in the cohort and was heavily concentrated in higher EDSS bands: 65.7% of this group fell in EDSS 4-6 or above, reinforcing the interdependence of disease duration and disability severity in shaping dietary behaviour (Table 4).

MEDAS adherence by EDSS as disease stage proxy

Table 5 presents MEDAS adherence stratified by EDSS group. As already reported above (see MEDAS score and Mediterranean diet adherence by EDSS group), the proportion of patients with low MEDAS adherence rose from 63.6% at EDSS 0-2 to 90.0% at EDSS 6-8, while the proportion maintaining at least moderate adherence fell correspondingly, from 36.4% to 10.0%; these figures are not repeated in full elsewhere in this section to avoid duplication and

Table 4. MEDAS score and Mediterranean diet adherence by disease duration (n = 100)

Disease Duration	n	Mean MEDAS	Low (0-5) n (%)	Moderate (6-9) n (%)	High (10-14) n (%)	Self-reported MedDiet n (%)	Predominant EDSS band
< 1 year	6	4.00	4 (66.7)	2 (33.3)	0 (0.0)	3 (50.0)	EDSS 2-4 (66.7%)
1-5 years	16	3.75	13 (81.2)	3 (18.8)	0 (0.0)	6 (37.5)	EDSS 0-2 (50.0%)
5-10 years	16	4.44	11 (68.8)	5 (31.2)	0 (0.0)	4 (25.0)	EDSS 0-2 (31.2%)
10-15 years	17	3.82	13 (76.5)	4 (23.5)	0 (0.0)	2 (11.8)	EDSS 2-4 (41.2%)
15-20 years	10	4.70	6 (60.0)	4 (40.0)	0 (0.0)	2 (20.0)	EDSS 6-8 (40.0%)
≥ 20 years	35	3.69	30 (85.7)	4 (11.4)	1 (2.9)	7 (20.0)	EDSS 4-6 (40.0%)

MEDAS – Mediterranean Diet Adherence Screener; predominant EDSS band indicates the most frequent EDSS group within each duration category.

should instead be discussed and interpreted in the discussion.

MEDAS adherence, supplementation, and dietary guidance by country

Country-level analysis revealed substantial heterogeneity in both MEDAS scores and self-reported dietary patterns. Italian patients had the highest mean MEDAS score (4.56), followed by UK/international patients (4.12) and Slovak patients (3.45). No patient in Italy or Slovakia achieved high MEDAS adherence; the single patient with high adherence was in the UK/international group. Slovak patients had the highest proportion of low MEDAS adherence (85.1%) and the highest proportion following no specific dietary pattern (57.4%).

Vitamin D supplementation was near-universal in Slovakia (95.7%) and highly prevalent in the UK/international cohort (88.2%), with

a lower but still substantial rate in Italy (69.4%). Omega-3 supplementation was most common in UK/international patients (41.2%). Despite 47% of the total sample reporting dietary change after MS diagnosis, with the highest rate in the UK/international group (82.4%), only 26% of patients overall received formal dietary guidance from a treating physician (Table 6).

DISCUSSION

This study, which brought together data from three European countries, found that Mediterranean diet adherence, measured using the validated MEDAS questionnaire, was generally poor across the whole MS sample and tended to decline as disability increased and as patients had been living with the disease for longer. The overall mean MEDAS score of 3.96 ± 2.26 , with 77% of patients falling into the

Table 5. MEDAS adherence by EDSS group as proxy for disease stage (n = 100)

EDSS group (disease stage proxy)	Mean MEDAS score	Low adherence (0-5) n (%)	Moderate adherence (6-9) n (%)	Mean vegetable intake (×/week)
EDSS 0-2 early/mild (n = 22)	4.73	14 (63.6)	8 (36.4)	4.64
EDSS 2-4 mild-moderate (n = 29)	3.55	22 (75.9)	7 (24.1)	4.97
EDSS 4-6 moderate (n = 26)	3.73	21 (80.8)	4 (15.4)	4.63
EDSS 6-8 severe (n = 20)	3.85	18 (90.0)	2 (10.0)	4.75
EDSS > 8 very severe (n = 3)	5.00	2 (66.7)	1 (33.3)	4.33

MEDAS adherence expressed as n (%); vegetable intake in mean times/week.

Table 6. MEDAS adherence, supplementation, and dietary guidance by country (n = 100)

Indicator	Slovakia (n = 47)	Italy (n = 36)	UK/Intl (n = 17)	Total (n = 100)
Mean MEDAS score	3.45	4.56	4.12	3.96
Low MEDAS adherence, n (%)	40 (85.1)	25 (69.4)	12 (70.6)	77 (77.0)
Moderate MEDAS adherence, n (%)	7 (14.9)	11 (30.6)	4 (23.5)	22 (22.0)
High MEDAS adherence, n (%)	0 (0.0)	0 (0.0)	1 (5.9)	1 (1.0)
Self-reported MedDiet, n (%)	5 (10.6)	15 (41.7)	4 (23.5)	24 (24.0)
Anti-inflammatory diet, n (%)	2 (4.3)	2 (5.6)	1 (5.9)	5 (5.0)
Intermittent fasting, n (%)	6 (12.8)	2 (5.6)	2 (11.8)	10 (10.0)
No specific diet, n (%)	27 (57.4)	13 (36.1)	5 (29.4)	45 (45.0)
Changed diet post-diagnosis, n (%)	20 (42.6)	13 (36.1)	14 (82.4)	47 (47.0)
Vitamin D supplementation, n (%)	45 (95.7)	25 (69.4)	15 (88.2)	85 (85.0)
Omega-3 supplementation, n (%)	13 (27.7)	6 (16.7)	7 (41.2)	26 (26.0)
Received dietary advice from physician, n (%)	16 (34.0)	8 (22.2)	2 (11.8)	26 (26.0)

UK/Intl – United Kingdom and international respondents combined; MEDAS – Mediterranean Diet Adherence Screener.

low-adherence category, tells a more detailed and accurate story than simply asking patients whether they follow the Mediterranean diet. While 24% of patients said they did, very few of them scored high enough on the MEDAS to confirm this, pointing to a significant gap between what patients believe they eat and what they eat.

The pattern of declining MEDAS scores with rising disability – from a mean of 4.73 at EDSS 0-2 dropping to 3.55 at EDSS 2-4, while the proportion of poorly adherent patients climbed from 63.6% to 90.0% between the lowest and most severe disability groups – is in line with what other European studies have found. Felicetti et al. [7] found inverse links between Mediterranean diet adherence and both disability and disease severity scores in a large Italian sample. Tryfonos et al. [8] showed that patients with lower adherence were around twice as likely to reach more advanced disability thresholds. Sand et al. [6] confirmed that following the Mediterranean diet was independently linked to lower objective disability in a real-world setting. What the present study adds is the use of an objective, validated screening tool rather than relying on self-report, showing that the link between diet and disability is still visible even when dietary habits are measured more rigorously.

The disease duration results add another useful layer to understanding how diet and disability interact. MEDAS scores were lowest in patients who had been diagnosed for 1-5 years (3.75) and in those living with MS for 20 years or more (3.69), suggesting that both the early period after diagnosis and the longer-term chronic phase are associated with poor dietary habits. The slight improvement seen in the 15-20 age group (mean 4.70) might reflect a survivor effect – patients who have had the disease for a long time but whose condition has remained relatively stable and who have found ways to manage their lifestyle more effectively – though it may also simply reflect differences in who is included in that group. The fact that 65.7% of patients in the longest-duration group were in the moderate-to-severe disability bands is consistent with the interpretation that disease duration and disability level are closely associated and may, together, make it harder to maintain a healthy diet; however, as this is a cross-sectional, single-timepoint study rather than a longitudinal one, this association cannot be taken to demonstrate a causal or temporal influence of disease duration.

There is a growing body of research explaining why diet might influence disability in MS. The Mediterranean diet is rich in fibre, healthy fats, and natural plant compounds that support a healthy and varied gut bacterial environment, which in turn produces anti-inflammatory substances that help regulate the immune system and reduce the nerve

damage that drives disability in MS [4, 5]. The gradual decline in vegetable consumption seen across disability groups, from 4.64 times per week at EDSS 0-2 to 4.33 times per week at EDSS > 8, means that patients are consuming less and less of the foods that feed these beneficial gut bacteria, reducing their body's ability to control inflammation over the course of the disease [10, 13]. A cycle in which poorer diet contributes to more inflammation, which in turn may drive faster disability progression, is biologically plausible based on this existing mechanistic literature [4, 5, 10, 13]; however, as this study did not measure inflammatory biomarkers directly and its cross-sectional design precludes causal inference, this interpretation remains hypothetical and should be tested in future studies incorporating objective markers of inflammation.

Differences between countries in MEDAS scores are also worth noting. The highest scores were seen in Italian patients (mean 4.56), which is consistent with the Mediterranean diet's cultural origins in Southern Europe and has been documented in prior Italian research [7]. Slovak patients scored considerably lower (mean 3.45), which reflects the Central European dietary tradition of higher consumption of refined carbohydrates, dairy products, and red meat, alongside lower intake of fish, vegetables, and legumes. The combination of the lowest dietary quality scores and the highest mean disability level (EDSS 4.91) in the Slovak cohort fits with the broader hypothesis that diet and disability are connected, though it is important to acknowledge that differences in disease type, access to treatment, and socioeconomic conditions between countries are also likely to play a role.

It should be emphasised that this was an observational, cross-sectional survey rather than a dietary intervention study; the variable “formal dietary advice” reflects only whether a patient recalled having received such advice from a physician, not the content, nature, or duration of any advice actually given, which was not captured by the survey instrument.

The high prevalence of vitamin D supplementation observed across all three countries is broadly consistent with widely used clinical guidance in MS, reflecting evidence linking vitamin D status to relapse risk and disease activity, with recent meta-analyses of randomised controlled trials showing statistically significant, if clinically modest, reductions in EDSS scores and relapse rates with long-term (> 12 months) high-dose supplementation [14], while the lower and more variable prevalence of omega-3 supplementation likely reflects its less consistently established role; a systematic review of omega-3/fish oil supplementation in MS reported beneficial effects on relapse rate, inflammatory markers, and quality of life, supporting its more selective use [15]. However,

the present survey did not record whether these supplements were clinician-recommended or self-initiated, nor did it capture use of other vitamins or minerals; consequently, the clinical appropriateness or adequacy of the supplementation patterns observed cannot be determined from these data, and this should be addressed directly in future studies.

One of the most practically important findings of this study is the gap between patient motivation and professional support around diet. Only 26% of patients had received any formal dietary advice from their doctor, even though 47% had changed their eating habits after being diagnosed. Most strikingly, the UK/international group, where 82.4% had changed their diet independently, had the lowest rate of physician dietary guidance (11.8%). Patients are clearly motivated to make dietary changes but are largely doing so without guidance, which risks poor nutritional choices. Including registered dietitians as a standard part of multidisciplinary MS care, with particular attention to patients who have higher disability or have been living with the disease for many years, is supported by the evidence and should be a clinical priority [16-19].

Limitations of the study

This study has several important limitations that should be considered when interpreting the findings. First, its cross-sectional, single-timepoint design means that only associations, not causal or longitudinal relationships, can be inferred; in particular, the reported patterns by disease duration reflect differences between patients diagnosed at different times, not change within individuals over time, and the study is best regarded as a pilot investigation rather than a definitive test of these associations. Second, the sample was recruited through patient organisations and online community platforms using a convenience-sampling approach, and subgroup sizes were modest and unevenly distributed across countries, EDSS bands, and disease-duration categories (e.g., $n = 3$ in the EDSS > 8 group); this raises the possibility of selection bias and limits the precision and generalisability of subgroup comparisons. Third, EDSS scores, MS diagnosis, and disease duration were all self-reported rather than verified against clinical records, and educational attainment was not collected, preventing adjustment for this potential confounder (age and sex, which were collected, are reported in the Study design and participants section, though their distribution differed somewhat between the three national samples). Fourth, dietary intake and Mediterranean diet adherence were assessed using a self-administered, self-reported questionnaire (MEDAS), which is subject to recall and social desirability bias, and which was originally validated

in a Mediterranean population; its performance in Central European and non-Mediterranean populations has not been independently established. Fifth, no biological markers of inflammation or nutritional status were measured, so the proposed mechanistic pathway linking diet, gut microbiota, inflammation, and disability could not be tested directly. Finally, information on participants' dietary habits prior to MS diagnosis, and on whether dietary changes were made on physician recommendation or on patients' own initiative, was not collected, which limits interpretation of the reported changes in eating habits after diagnosis. An alternative analytic approach – for example, directly contrasting MEDAS-defined adherent versus non-adherent patients across EDSS and disease-duration categories – could complement the descriptive analysis presented here and is recommended for future re-analysis of these data.

Given the cross-sectional design, modest and unevenly distributed subgroups, and the other methodological limitations discussed above, these findings should be interpreted as preliminary and hypothesis-generating rather than as evidence of a causal, longitudinal, or dose-dependent influence of disability or disease duration on diet; on this basis, the present study is best regarded as a pilot investigation.

CONCLUSIONS

This cross-sectional survey suggests that Mediterranean diet adherence, assessed using the validated MEDAS tool, is predominantly poor among people with MS across all three countries studied, and that self-reported adherence to the Mediterranean diet substantially overestimates adherence as measured objectively. Lower MEDAS-assessed adherence was observed in association with higher self-reported disability and, less consistently, with longer disease duration.

Nonetheless, the gap between the proportion of patients who changed their diet independently after diagnosis and the much smaller proportion who recalled receiving formal dietary advice from a physician point to an unmet need for structured, professionally guided nutritional support in MS care. Incorporating evidence-based nutritional guidance on the Mediterranean diet, assessed through validated tools such as the MEDAS, into multidisciplinary MS care warrants consideration, with confirmatory research particularly needed for patients with greater disability or longer disease duration.

Future research should build on these findings by using study designs that follow patients over time, confirm disability and diagnosis through clinical assessment and medical records rather than self-report, recruit larger and more balanced samples across EDSS

and disease-duration strata, and include objective measures of dietary quality, nutritional status, and inflammation, such as validated biomarkers and gut microbiome analysis.

Conflict of interest

There were no conflicts of interest.

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