Value in Health Sciences
Sağlık Bilimlerinde Değer

2026;16(2):223-229
https://doi.org/10.33631/sabd.1627764

e-ISSN: 2792-0542
https://dergipark.org.tr/en/pub/sabd

Research Article / Araştırma Makalesi

Knowledge Levels of Multiple Sclerosis Patients in Hygiene and Food Preparation: A Case-Control Study

Multipl Skleroz Hastalarının Hijyen ve Yemek Hazırlama Konusundaki Bilgi Düzeyleri: Bir Olgu-Kontrol Çalışması

Esma Oğuz[1*], Mübarra Çil[2], Kadriye Ağan Yıldırım[3], Fatma Esra Güneş[4]

[1] Department of Nutrition and Dietetics, Kırklareli University, Faculty of Health Sciences, Kırklareli, Türkiye. ror.org/00jb0e673

[2] Department of Nutrition and Dietetics, Marmara University, Institute of Health Sciences, İstanbul, Türkiye. ror.org/02kswqa67

[3] Department of Neurology, Marmara University, Faculty of Medicine, İstanbul, Türkiye. ror.org/02kswqa67

[4] Department of Nutrition and Dietetics, İstanbul Medeniyet University, Faculty of Health Sciences, İstanbul, Türkiye. ror.org/05j1qpr59

*Corresponding author / Sorumlu yazar: esmaoguz34@gmail.com

ABSTRACT

Aim: Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system in which environmental factors such as nutrition, lifestyle, infections, and hygiene may contribute to its etiology. This study aimed to compare personal hygiene, food hygiene, and food preparation practices between MS patients and healthy individuals.

Material and Methods: This case–control study was conducted between January and June 2017 at the Multiple Sclerosis Clinic of the Department of Neurology, Marmara University Training and Research Hospital. A total of 100 patients diagnosed with MS according to the McDonald criteria and 60 age- and sex-matched healthy controls were included. Data regarding personal hygiene, food hygiene, and food preparation practices were collected using structured face-to-face questionnaires. Categorical variables were analyzed using chi-square tests, and statistical significance was accepted as $p<0.05$.

Results: No significant differences were observed between MS patients and controls regarding personal hygiene practices, including handwashing frequency, bathing habits, and animal contact. However, significant differences were found in some food hygiene practices. Washing vegetables by soaking them in vinegar was more common among MS patients than controls (42.0% vs. 25.0%; p=0.045). In addition, frying meat in oil was reported more frequently in the MS group (p=0.011).

Conclusion: While personal hygiene practices were similar between MS patients and healthy individuals, differences were identified in food hygiene and cooking methods. These differences may represent modifiable environmental risk factors for MS. Further studies with larger sample sizes and up-to-date data are needed.

Keywords: Multiple sclerosis, hygiene, food hygiene.

ÖZ

Amaç: Multipl skleroz (MS), etiyolojisinde beslenme, yaşam tarzı, enfeksiyonlar ve hijyen gibi çevresel faktörlerin rol oynadığı düşünülen kronik inflamatuvar bir hastalıktır. Bu çalışmada, MS hastaları ile sağlıklı bireylerin kişisel hijyen, besin hijyeni ve besin hazırlama uygulamalarının karşılaştırılması amaçlanmıştır.

Gereç ve Yöntemler: Bu vaka-kontrol çalışması, Ocak–Haziran 2017 tarihleri arasında Marmara Üniversitesi Eğitim ve Araştırma Hastanesi Nöroloji Anabilim Dalı Multipl Skleroz Kliniği'nde yürütülmüştür. McDonald kriterlerine göre tanı almış 100 MS hastası ile yaş ve cinsiyet açısından eşleştirilmiş 60 sağlıklı kontrol çalışmaya dahil edilmiştir. Kişisel hijyen, besin hijyeni ve besin hazırlama uygulamalarına ilişkin veriler yapılandırılmış yüz yüze anketlerle toplanmıştır. Kategorik değişkenler ki-kare testi ile analiz edilmiş, $p<0,05$ anlamlı kabul edilmiştir.

Bulgular: El yıkama sıklığı, banyo alışkanlıkları ve hayvan teması gibi kişisel hijyen uygulamaları açısından gruplar arasında anlamlı fark bulunmamıştır. Buna karşın, bazı besin hijyeni uygulamalarında anlamlı farklılıklar saptanmıştır. Sebzelerin sirke ile bekletilerek yıkanması MS hastalarında kontrol grubuna göre daha sık bildirilmiştir (%42,0'ye karşı %25,0; p=0.045). Ayrıca etin yağda kızartılarak pişirilmesi MS grubunda daha yaygın bulunmuştur (p=0,011).

Sonuç: MS hastaları ile sağlıklı bireylerin kişisel hijyen uygulamaları benzer bulunurken, besin hijyeni ve pişirme yöntemlerinde farklılıklar saptanmıştır; bu farklılıkların MS için değiştirilebilir çevresel risk faktörleri olabileceği düşünülmektedir. Daha geniş örneklemli ve güncel verilerle yapılacak çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Multipl skleroz, hijyen, besin hijyeni.

Received / Geliş: 27.01.2025
Revision / Revizyon: 17.07.2025
Accepted / Kabul: 12.02.2026
Online / Çevrimiçi: 24.05.2026

Cite as/Atıf için: Oğuz E, Çil M, Ağan Yıldırım K, Güneş FE. Knowledge levels of multiple sclerosis patients in hygiene and food preparation: a case-control study. Value Health Sci. 2026;16(2):223–9. doi:10.33631/sabd.1627764.

This is an open access paper distributed under the terms and conditions of the Creative Commons Attribution-NonCommercial 4.0 International License.
Bu makale, Creative Commons Atıf-Gayri Ticari 4.0 Uluslararası Lisansı'nın hüküm ve koşulları uyarınca dağıtılan açık erişimli bir makaledir.

INTRODUCTION

Multiple Sclerosis (MS) is a chronic autoimmune disorder characterized by inflammation, demyelination, and neurodegeneration within the central nervous system (CNS), affecting more than 2.8 million people globally (1,2). The clinical presentation of MS varies depending on the regions of the CNS involved, and may include motor weakness, sensory disturbances, cognitive impairment, fatigue, and mood disorders. Clinically, MS is classified into two major subtypes: (i) Relapsing-Remitting MS (RRMS), which accounts for approximately 85% of cases, and (ii) Primary-Progressive MS (PPMS), comprising about 15% (3). Multiple sclerosis most frequently occurs in early to mid-adulthood and shows a clear female predominance, with women affected about 2.5 times more often than men. Among individuals under 40 years of age, MS is the most prevalent neurological disorder (4). The disease's pathophysiology involves immune-mediated inflammation, oxidative stress, and excitotoxicity (5).

The etiology of MS is multifactorial, involving a combination of genetic predisposition, autoimmunity, and environmental exposures. Contributing factors may include surgical procedures, anesthesia, animal contact, amalgam dental fillings, chemical solvents, industrial pollutants, trauma, viral infections, insufficient sunlight exposure, vitamin D deficiency, childhood obesity, tobacco use, dietary patterns, and vascular comorbidities (6–9).

The “hygiene hypothesis” proposes that increased hygiene standards and reduced exposure to microorganisms in early childhood—common in industrialized countries—may lead to an under-stimulated immune system and increase the risk of autoimmune diseases such as MS (10). Epidemiological data support this theory, showing an inverse relationship between infectious disease exposure and the prevalence of allergies and autoimmune conditions in highly developed regions (11).

Infections and environmental exposures are thought to trigger autoimmune processes in genetically susceptible individuals (11,12). Although the literature on alcohol and caffeine consumption remains inconclusive, numerous studies have identified a significant association between smoking and increased MS risk. Experimental data suggest that components of cigarette smoke exert immunomodulatory and neurotoxic effects, potentially exacerbating demyelination and neuroinflammation (13). Additionally, exposure to environmental tobacco smoke has been positively linked to MS in multiple studies (14,15).

MS is a lifelong, complex, and variable condition that frequently results in substantial disability and reduced quality of life. Physical limitations associated with MS may also impair an individual's ability to maintain adequate personal hygiene. In this context, hygiene behaviors, food safety practices, and cooking methods emerge as potentially relevant factors in the context of MS development and progression. Therefore, the present case-control study was designed to assess the knowledge levels of individuals with MS regarding personal hygiene, food hygiene, and cooking practices.

MATERIAL AND METHODS

Study Type

This case-control study was conducted to examine the relationships among hygiene practices, food preparation, and cooking behaviors in adults with MS compared with healthy individuals.

Study Group and Diagnostic Criteria

The study was carried out between January and June 2017 at the Multiple Sclerosis Outpatient Clinic of the Department of Neurology, Marmara University Training and Research Hospital. The sample included 100 individuals diagnosed with MS and 60 age- and sex-matched healthy controls. All MS diagnoses were confirmed by a neurologist specializing in MS, based on patient history, physical and neurological examinations, and magnetic resonance imaging (MRI), in accordance with the revised McDonald criteria (16).

Inclusion criteria for the MS group were: age between 18 and 55 years, confirmed MS diagnosis, being in a remission phase, and no history of additional chronic or autoimmune diseases. The control group consisted of healthy individuals without neurological, autoimmune, or chronic conditions and who were not taking medications that could influence study parameters.

Exclusion criteria for both groups included: presence of dysphagia; pregnancy or lactation; current infection or fever; use of corticosteroids or receiving corticosteroid injections within the past 30 days; MS relapse during the previous month; use of oral contraceptives; or comorbidities such as diabetes mellitus or chronic kidney disease, which could affect dietary intake. All eligible participants completed the study, and no dropouts occurred during the data collection period.

Sample size was calculated using G*Power software (version 3.1.9; Universität Düsseldorf, Düsseldorf, Germany). With a significance level of $\alpha = 0.05$, a power of 80%, and an estimated effect size of 0.50, the minimum required sample was 30 participants per group. Informed by a prior study with a comparable research design reporting an effect size of 0.54 (17), the sample size was considered adequate for identifying significant between-group differences.

Dependent and Independent Variables

The independent variables in this study include gender, age, marital status, education, occupation, smoking, and alcohol use. The dependent variable is knowledge related to personal hygiene, food hygiene, and food preparation.

Data Collection and Questionnaire Development

A structured questionnaire was developed by the researchers following an extensive review of previous literature (18,19). Some items were adapted from validated tools, while others were modified or newly constructed to align with the study objectives. All questions were closed-ended to facilitate consistency in data collection and analysis. The average survey duration was 15–20 minutes. Data collection was conducted through in-person interviews administered by trained personnel. To ensure content validity, expert feedback was obtained from academics in public health, food hygiene, and neurology.

The final questionnaire comprised four sections:

1. *Sociodemographic Characteristics*
Ten items capturing age, gender, education level, income status, and other relevant variables.
2. *Personal Hygiene Practices*
Five items addressing hygiene-related behaviors such as frequency of handwashing, bathing, house cleaning, and animal exposure.
3. *Food Hygiene Behaviors*
Seven items evaluating water consumption preferences, vegetable washing methods, consumption of raw fruits and vegetables, raw egg intake, handwashing after handling eggs, consumption of raw or undercooked meat, and use of unpasteurized milk.
4. *Food Preparation Knowledge and Practices*
Questions focusing on the type of oil used for frying, frequency of oil replacement (e.g., after every use, 2–3 uses, 4–5 uses), disposal of vegetable cooking water, methods of cooking meat and meat products, and cookware preferences.
The classification of frequency categories (e.g., for handwashing, bathing, and oil change practices) was based on previous studies and public health guidelines (20–23).

Statistical Analysis
All analyses were performed using IBM SPSS Statistics version 22. Descriptive statistics were presented as numbers and percentages [n (%)] for categorical variables, and as arithmetic mean ($\bar{x}$) and standard deviation (SD) for continuous variables. The normality of continuous variables was assessed using analytical methods (Kolmogorov-Smirnov tests). For comparisons of sociodemographic characteristics, the Chi-square test was used for categorical variables, and the independent samples t-test was used for continuous variables. Comparisons of personal hygiene status, food hygiene practices, and knowledge levels related to food preparation between the MS and control groups were conducted using frequency and percentage distributions, along with bivariate Chi-square analyses. Fisher's Exact Test was used to compare methods of cleaning vegetables, and Pearson's Chi-square test was applied to compare methods of cooking meat and meat products. A p-value of < 0.05 was considered statistically significant.

RESULTS

In the MS group, 73 participants (73.00%) were female, while in the control group, 41 participants (68.30%) were female. The mean age in the MS group was 38.00 ± 10.00 years, and in the control group, it was 37.50 ± 9.80 years. In terms of smoking status, 75 participants (75.00%) in the MS group and 51 participants (85.00%) in the control group were non-smokers. Regarding alcohol consumption, 88 participants (88.00%) in the MS group and 50 participants (83.33%) in the control group reported no alcohol use. Overall, the sociodemographic parameters did not show statistically significant differences between the two groups ($p > 0.05$) (Table 1).

Table 1. Comparison of the sociodemographic characteristics of the MS and the control group.

		MS Group (100) n (%)	Control Group (60) n (%)	Test value	*p*-value
Sex	Female	73 (73.00)	41 (68.30)	χ^2=0.203	0.652
	Male	27 (27.00)	19 (31.70)		
Age	($\bar{X}$ ± SD)	38.00 ± 10.00	37.50 ± 9.80	t =0.350	0.720
Education	Graduate of secondary school	9 (9.00)	3 (5.00)	χ^2=1.070	0.780
	Graduate of high school	18 (18.00)	13 (21.60)		
	University	56 (56.00)	34 (56.70)		
	Postgraduate	17 (17.00)	10 (16.70)		
Job	Retired	56 (56.00)	33 (55.00)	χ^2=2.652	0.265
	Officer	32 (32.00)	24 (40.00)		
	Self-employment	12 (12.00)	3 (5.00)		
Smoking	Yes	25 (25.00)	9 (15.00)	χ^2=3.567	0.059
	No	75 (75.00)	51 (85.00)		
Use of Alcohol	Yes	12 (12.00)	10 (16.70)	χ^2=0.041	0.840
	No	88 (88.00)	50 (83.30)		

Values are presented as mean ± SD for continuous variables and n (%) for categorical variables. Independent samples t-test was used for age; chi-square test was used for categorical variables.

When the personal hygiene status of the MS and control groups was compared, 40.00% of the MS group and 33.33% of the control group reported washing their hands 10–20 times per day. Additionally, 59.00% of the MS group and 61.67% of the control group reported bathing 2–4 times per week. It was determined that 77.00% of the MS group and 85.00% of the control group had no exposure to animals. Overall, the groups had similar personal hygiene status (p>0.05) (Table 2).

Table 2. Comparison of personal hygiene status of MS and control group.

		MS Group (100) n (%)	Control Group (60) n (%)	χ^2	*p*-value
Hand washing frequency (per day)	<10	37 (37.00)	18 (30.00)	8.344	0.080
	10-20	40 (40.00)	20 (33.30)		
	20-30	3 (3.00)	9 (15.00)		
	30-40	16 (16.00)	11 (18.30)		
	>40	4 (4.00)	2 (3.40)		
Hand drying	Yes	82 (82.00)	50 (83.30)	0.000	1.000
	No	18 (18.00)	10 (16.70)		
Bathing frequency (once a week)	<1	25 (25.00)	11 (18.40)	1.128	0.569
	2-4	59 (59.00)	37 (61.60)		
	>4	16 (16.00)	12 (20.00)		
House cleaning frequency (once a month)	1-5	47 (47.00)	32 (53.40)	5.966	0.818
	5-10	20 (20.00)	12 (20.00)		
	>10	33 (33.00)	16 (26.60)		
Any pet	Yes	23 (23.0)	9 (15.0)	1.042	0.307
	No	77 (77.0)	51 (85.0)		

x^2: chi-square test.

Regarding food hygiene status, 37.00% of the MS group and 83.33% of the control group reported using fresh water for cleaning vegetables. While 62.00% of the MS group and 65.00% of the control group washed shelled vegetables and fruits with water, soaking vegetables in plain water was more frequent in the control group (75.00%) than in the MS group (58.00%). In contrast, soaking vegetables in vinegar water was more common in the MS group (42.00%) compared to the control group (25.00%). A significant difference was found between the groups in both soaking methods ($p<0.05$) (Table 3).

Table 3. Comparison of food hygiene status MS and control group.

		MS Group (100) n (%)	Control Group (60) n (%)	χ^2	*p*-value
Drinking water preferences	Tap water	7 (7.00)	2 (3.40)	8.907	0.063
	Refined water	20 (20.00)	8 (13.30)		
	Freshwater	37 (37.00)	50 (83.30)		
Methods for cleaning vegetables	Washing by soaking in vinegar water	42 (42.00)[a]	15 (25.00)[b]	4.013	0.045*
	Washing with water	58 (58.00)[a]	45 (75.00)[b]		
Methods of consuming fruits/vegetables	Soaking in vinegar water	2 (2.00)	-	1.853	0.603
	Washing with water	62 (62.00)	39 (65.00)		
	Peel off	36 (36.00)	21 (35.00)		
Consumption of raw eggs and products	Yes	23 (23.00)	8 (13.40)	1.677	0.197
	No	77 (77.00)	52 (86.60)		
Washing hands after contact with an egg	Yes	65 (65.00)	45 (75.00)	1.311	0.252
	No	35 (35.00)	15 (25.00)		
Consumption of undercooked/uncooked meat and meat products	Yes	28 (28.00)	9 (15.00)	2.871	0.090
	No	72 (72.00)	51 (85.00)		
Consumption of unpasteurized milk	Yes	46 (46.00)	20 (33.30)	1.988	0.159
	No	54 (54.00)	40 (66.70)		

x^2 :*chi*-square test; *Different superscript letters in the same row indicate statistically significant differences between groups according to Fisher's Exact Test ($p < 0.050$).

As shown in Table 4, when the knowledge levels of the MS and control groups regarding food preparation were compared, 88.00% of the MS group and 80.00% of the control group preferred sunflower oil. Additionally, 14.00% of the MS group and only 1.67% of the control group reported frying meat in oil. A significant difference was found between the two groups in terms of cooking methods for meat products (p=0.011).

Table 4. Comparison of knowledge levels for food preparation of MS and control groups.

		MS Group (100) n (%)	Control Group (60) n (%)	χ^2	*p*-value
The type of oil used in frying	Sunflower oil	88 (88.00)	48 (80.00)	4.199	0.380
	Corn oil	2 (2.00)	4 (6.60)		
	Olive oil	8 (8.00)	7 (11.70)		
	Nut oils	2 (2.00)	1 (1.70)		
Frequency of oil change the frying	Every time	45 (45.00)	31 (51.60)	4.830	0.185
	2-3 times	41 (41.00)	27 (45.00)		
	4-5 times	14 (14.00)	2 (3.40)		
Pouring the juices after boiling the vegetables	Yes	49 (49.00)	21 (35.00)	2.987	0.084
	No	51 (51.00)	39 (65.00)		
The method of cooking meat and meat products	Boiled	33 (33.00)	15 (25.00)	1.192	0.011*
	Grill	36 (36.00)[a]	35 (58.30)[b]		
	Roasting	17 (17.00)	9 (15.00)		
	Frying in oil	14 (14.00)[a]	1 (1.70)[b]		
Cookware preference	Stainless steel	62 (62.00)	39 (65.00)	13.458	0.620
	Granite	7 (7.00)	1 (1.70)		
	Copper -Aluminum	12 (12.00)	1 (1.70)		
	Teflon	17 (17.00)	15 (25.00)		
	Pine	2 (2.00)	4 (6.60)		

*Different superscript letters in the same row indicate statistically significant differences between groups according to Pearson's Chi-square test ($p < 0.050$).

DISCUSSION

In this case–control study, the MS and control groups exhibited comparable distributions with respect to age, sex, educational attainment, and employment status, supporting the internal validity of the findings and minimizing potential demographic confounding. Consistent with well-established epidemiological patterns, females accounted for 73.00% of the MS group, closely aligning with previous reports, including the study by Gustavsen et al., which documented a female predominance of 73.8% among individuals with MS (24).

Among lifestyle factors, smoking was more prevalent in the MS group supporting previous evidence that tobacco use increases the risk of MS (25–27). Potential biological mechanisms include the neurotoxic and immunomodulatory effects of cigarette smoke constituents, which may promote demyelination and neuroinflammation. Animal exposure, particularly pet ownership, showed no statistically significant difference between groups, though slightly more common among controls (23.00% vs. 15.00%, *p*=0.175). This is consistent with the mixed literature on the subject, which includes reports of null or inverse associations (28,29). While early-life contact with domestic animals may influence immune development through microbial or endotoxin exposure, current evidence remains inconclusive.

The hygiene hypothesis, which posits that reduced microbial exposure in childhood may predispose individuals to autoimmune diseases, remains relevant to MS (30). Although not directly measured, this concept may intersect with observed differences in food hygiene practices.

Notably, the method used for cleaning vegetables differed between groups. Soaking in vinegar was more frequent among MS patients (42.00%) than among controls (25.00%) (*p*=0.018), which contrasts with the expectation that vinegar use might offer a protective effect by reducing microbial or chemical residues (31,32). Considering some vegetables can retain pesticide residues internally, prolonged water washing is recommended as a more effective strategy.

Cooking practices also showed variation between groups. Frying meat in oil—a method associated with the formation of heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) was significantly more common among MS patients (14.00%) than in controls (1.67%) (*p*=0.011). These compounds may play a role in pathways related to neurodegeneration and immune system dysregulation (33-35). Safer alternatives such as baking or stewing could help minimize exposure to such harmful agents.

This study is distinguished by its emphasis on comparing hygiene and food preparation knowledge between individuals diagnosed with multiple sclerosis and healthy participants. The direct assessment of these factors in an MS population represents an approach that has rarely been reported. Although the dataset was obtained in 2017, the publication timeline was extended as a result of sequential journal submissions and lengthy review periods. Nevertheless, the findings provide important perspectives on a research domain that remains relatively underrepresented.

CONCLUSION

This study provides updated insights into the association between food and personal hygiene practices and the risk of MS. The present findings highlight that individuals with MS may demonstrate different hygiene behaviors and food hygiene practices compared to healthy controls. These differences could potentially be related to immune system

modulation and environmental exposures. In the absence of a definitive therapeutic cure for MS, identifying modifiable risk factors remains essential. The hygiene hypothesis, which links reduced microbial exposure to increased immune-related disorders, may offer a valuable framework for interpreting these findings. In clinical settings, assessing patients' hygiene habits and dietary practices may provide insights into MS risk management. Future studies are required to provide clearer insight into the role of environmental contaminants —such as pesticide residues, heterocyclic amines, polycyclic aromatic hydrocarbons, and water pollution—in the etiology of MS.

DECLARATIONS

Acknowledgements: The authors extend their sincere thanks to the editorial board and the anonymous reviewers for their helpful comments and suggestions.

Author Contributions: Conceptualization, E.O. and F.E.G.; Methodology, E.O. and K.A.Y.; Formal Analysis, E.O. and M.Ç.; Investigation, M.Ç.; Data Curation, M.Ç.; Writing—Original Draft Preparation, E.O., M.Ç. and F.E.G.; Writing—Review and Editing, F.E.G. and K.A.Y.; Visualization, E.O.; Supervision, F.E.G. and K.A.Y.; Project Administration, E.O. All authors have read and approved the final version of the manuscript.

Conflict of Interest: The authors declare no conflict of interest.

Supporting Institutions: This research received no external funding.

Ethical Approval: This study was conducted in accordance with the Declaration of Helsinki and approved by the Marmara University Clinical Research Ethics Committee (approval number: 09.2017.076).

Plagiarism Statement: This manuscript was checked for plagiarism using appropriate software, and no instances of plagiarism were detected.

Use of AI Tools: The authors declare that no Artificial Intelligence (AI) tools were used in the preparation of this manuscript.

REFERENCES

1. Riccio P, Rossano R, Liuzzi GM. May diet and dietary supplements improve the wellness of multiple sclerosis patients? A molecular approach. Autoimmune Dis. 2011;2010:249842. doi:10.4061/2010/249842.
2. Jakimovski D, Bittner S, Zivadinov R, Morrow SA, Benedict RH, Zipp F, et al. Multiple sclerosis. Lancet. 2024;403(10422):183–202. doi:10.1016/S0140-6736(23)01473-3.
3. Jamebozorgi K, Rostami D, Pormasoumi H, Taghizadeh E, Barreto GE, Sahebkar A. Epigenetic aspects of multiple sclerosis and future therapeutic options. Int J Neurosci. 2021;131(1):56–64. doi:10.1080/00207454.2020.1732974.
4. Zahoor I, Giri S. Specialized pro-resolving lipid mediators: emerging therapeutic candidates for multiple sclerosis. Clin Rev Allergy Immunol. 2021;60(2):147–63. doi:10.1007/s12016-020-08796-4.
5. Tobore TO. Oxidative/nitroxidative stress and multiple sclerosis. J Mol Neurosci. 2021;71(3):506–14. doi:10.1007/s12031-020-01672-y.
6. van der Mei I, Simpson S, Stankovich J, Taylor B. Individual and joint action of environmental factors and risk of MS. Neurol Clin. 2011;29(2):233–55. doi:10.1016/j.ncl.2010.12.007.
7. Ascherio A, Munger KL. Environmental risk factors for multiple sclerosis. part II: noninfectious factors. Ann Neurol. 2007;61(6):504–13. doi:10.1002/ana.21141.
8. Rodgers J, Friede T, Vonberg FW, Constantinescu CS, Coles A, Chataway J, et al. The impact of smoking cessation on multiple sclerosis disease progression. Brain. 2022;145(4):1368–78. doi:10.1093/brain/awab385.
9. Galoppin M, Kari S, Soldati S, Pal A, Rival M, Engelhardt B, et al. Full spectrum of vitamin D immunomodulation in multiple sclerosis: mechanisms and therapeutic implications. Brain Commun. 2022;4(4):fcac171. doi:10.1093/braincomms/fcac171.
10. Okada H, Kuhn C, Feillet H, Bach JF. The 'hygiene hypothesis' for autoimmune and allergic diseases: an update. Clin Exp Immunol. 2010;160(1):1–9. doi:10.1111/j.1365-2249.2010.04139.x.
11. Venkatesan A. Multiple sclerosis and infections. Neurodegener Dis Manag. 2015;5(Suppl 6):11–4. doi:10.2217/nmt.15.64.
12. Michel L. Environmental factors in the development of multiple sclerosis. Rev Neurol (Paris). 2018;174(6):372–7. doi:10.1016/j.neurol.2018.03.010.
13. Dobson R, Giovannoni G. Multiple sclerosis - a review. Eur J Neurol. 2019;26(1):27–40. doi:10.1111/ene.13819.
14. Bazmi E, Behnoush AH, Talebian MT, Afrooghe A, Sahraian MA. Waterpipe tobacco smoking and multiple sclerosis: a systematic review and meta-analysis. Neuroepidemiology. 2025;59(5):568–78. doi:10.1159/000540087.
15. Schlindwein MAM, de Moura Campos MH, Breis LC, Chara BS, Scherer CS, Caminski VAP, et al. Impacts of environmental tobacco smoke on multiple sclerosis: a systematic review. Arq Neuropsiquiatr. 2024;82(3):1-10. doi:10.1055/s-0044-1779271.
16. Thompson AJ, Banwell BL, Barkhof F, Carroll WM, Coetzee T, Comi G, et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. Lancet Neurol. 2018;17(2):162–73. doi:10.1016/S1474-4422(17)30470-2.
17. Moravejolahkami AR, Paknahad Z, Chitsaz A, Hojjati Kermani MA, Borzoo-Isfahani M. Potential of modified Mediterranean diet to improve quality of life and fatigue severity in multiple sclerosis patients: a single-center randomized controlled trial. Int J Food Prop. 2020;23(1):1993–2004. doi:10.1080/10942912.2020.1840390.
18. Null G, Pennesi L, Feldman M. Nutrition and lifestyle intervention on mood and neurological disorders. J Evid Based Complementary Altern Med. 2017;22(1):68–74. doi:10.1177/2156587216637539.
19. Tamburo E, Varrica D, Dongarrà G, Grimaldi LME. Trace elements in scalp hair samples from patients with relapsing-remitting multiple sclerosis. PLoS One. 2015;10(4):e0122142. doi:10.1371/journal.pone.0122142.
20. Godoy P, Castilla J, Delgado-Rodríguez M, Martin V, Soldevila N, Jordi A, et al. Effectiveness of hand hygiene and provision of information in preventing influenza cases requiring hospitalization. Prev Med. 2012;54(6):434–9. doi:10.1016/j.ypmed.2012.04.009.
21. Xun Y, Shi Q, Yang N, Li Y, Si W, Shi Q, et al. Associations of hand washing frequency with the incidence of illness: a systematic review and meta-analysis. Ann Transl Med. 2021;9(5):395. doi:10.21037/atm-20-6005.
22. Campos MA, Sousa AC, Varela P, Baptista A. Evaluation of hygiene habits: cross-sectional study. Acta Dermatovenerol Alp Pannonica Adriat. 2016;25(3):45–8. doi:10.15570/actaapa.2016.13.
23. Nayak PK, Dash UMA, Rayaguru K, Krishnan KR. Physico-chemical changes during repeated frying of oil: a review. J Food Biochem. 2016;40(3):371–90. doi:10.1111/jfbc.12215.

24. Gustavsen MW, Page CM, Moen SM, Bjølgerud A, Berg-Hansen P, Nygaard GO, et al. Environmental exposures and the risk of multiple sclerosis investigated in a Norwegian case-control study. BMC Neurol. 2014;14:196. doi:10.1186/s12883-014-0196-x.
25. Ascherio A, Munger KL. Environmental risk factors for multiple sclerosis. part I: the role of infection. Ann Neurol. 2007;61(4):288–99. doi:10.1002/ana.21117.
26. Ghadirian P, Dadgostar B, Azani R, Maisonneuve P. A case-control study of the association between socio-demographic, lifestyle and medical history factors and multiple sclerosis. Can J Public Health. 2001;92:281–5. doi:10.1007/BF03404961.
27. Pekmezovic T, Drulovic J, Milenkovic M, Jarebinski M, Stojsavljevic N, Mesaros S, et al. Lifestyle factors and multiple sclerosis: a case-control study in Belgrade. Neuroepidemiology. 2006;27(4):212–6. doi:10.1159/000096853.
28. Mowry EM, Hedström AK, Gianfrancesco MA, Shao X, Schaefer CA, Shen L, et al. Incorporating machine learning approaches to assess putative environmental risk factors for multiple sclerosis. Mult Scler Relat Disord. 2018;24:135–41. doi:10.1016/j.msard.2018.06.009.
29. Esch KJ, Petersen CA. Transmission and epidemiology of zoonotic protozoal diseases of companion animals. Clin Microbiol Rev. 2013;26(1):58–85. doi:10.1128/CMR.00067-12.
30. Wendel-Haga M, Celius E. Is the hygiene hypothesis relevant for the risk of multiple sclerosis. Acta Neurol Scand. 2017;136:26–30. doi:10.1111/ane.12844.
31. Chauhan R, Kumari B, Rana M. Effect of fruit and vegetable processing on reduction of synthetic pyrethroid residues. Rev Environ Contam Toxicol. 2014;229:89–110. doi:10.1007/978-3-319-03777-6_5.
32. Krol WJ, Arsenault TL, Pylypiw Jr HM, Incorvia Mattina MJ. Reduction of pesticide residues by rinsing. J Agric Food Chem. 2000;48(10):4666–70. doi:10.1021/jf0002894.
33. Alaejos MS, Afonso AM. Factors that affect the content of heterocyclic aromatic amines in foods. Compr Rev Food Sci Food Saf. 2011;10(2):52–108. doi:10.1111/j.1541-4337.2010.00141.x.
34. Anderson KE, Sinha R, Kulldorff M, Gross M, Lang NP, Barber C, et al. Meat intake and cooking techniques: associations with pancreatic cancer. Mutat Res. 2002;506-507:225–31. doi:10.1016/S0027-5107(02)00169-0.
35. Lauer K. Environmental risk factors in multiple sclerosis. Expert Rev Neurother. 2010;10(3):421–40. doi:10.1586/ern.10.7.