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NON-PHARMACOLOGICAL MANAGEMENT OF MULTIPLE SCLEROSIS: A FOCUS ON DIET AND SUPPLEMENTATION

Anna Górowska

ORCID: https://orcid.org/0009-0004-0211-7998

agorowska07@gmail.com

5th Military Clinical Hospital with Outpatient Clinic SPZOZ in Cracow, Poland

Julia Lenart

ORCID: https://orcid.org/0009-0006-7934-2063

julialenart3@gmail.com

5th Military Clinical Hospital with Outpatient Clinic SPZOZ in Cracow, Poland

Natalia Janik

ORCID: https://orcid.org/0009-0000-3005-8076

natalia.9.janik@gmail.com

5th Military Clinical Hospital with Outpatient Clinic SPZOZ in Cracow

Zuzanna Wadowska

ORCID: https://orcid.org/0009-0000-3910-7065

zuzannawado@gmail.com

Stefan Zeromski Specialist Hospital

ul. Osiedle Na Skarpie 66, 31-913, Krakow, Poland

Julia Janowiak
ORCID: https://orcid.org/0009-0007-4042-9302
julka.janowiak197@gmail.com
Stefan Zeromski Specialist Hospital
ul. Osiedle Na Skarpie 66, 31-913, Krakow, Poland

Martyna Sobiś
ORCID: https://orcid.org/0009-0009-6854-1413
martynasobis@gmail.com
Centrum Medyczne HCP Szpital im. Św. Jana Pawła II, Poznań, Poland

Anna Bogacka
ORCID: https://orcid.org/0009-0003-2643-4894
abogacka99@gmail.com
Jagiellonian University in Cracow, Collegium Medicum

Nina Kiersznowska
ORCID: https://orcid.org/0009-0003-9101-5215
nina.k.200@gmail.com
Jagiellonian University in Cracow, Collegium Medicum

Małgorzata Buchman
ORCID: https://orcid.org/0009-0003-1445-9189
margrethe.i@icloud.com
Jagiellonian University in Cracow, Collegium Medicum

Barbara Miłek
ORCID: https://orcid.org/0009-0007-0620-6703
milek.barbara12@gmail.com
Uniwersytecki Szpital Kliniczny w Poznaniu

Corresponding Author
Anna Górowska
E-mail agorowska07@gmail.com

ABSTRACT

Background: Multiple sclerosis (MS) is a chronic autoimmune and demyelinating disease of the central nervous system, characterized by inflammation, neurodegeneration, and diverse neurological symptoms. Emerging evidence suggests that dietary interventions and supplementation may influence disease activity, symptom severity, and overall quality of life in MS patients.

Objective: This review aims to present current knowledge on the effects of specific dietary patterns, caloric restriction, and nutritional supplementation on the clinical management and progression of MS.

Methods: Peer-reviewed studies published between 2015 and 2025 were identified through PubMed and Google Scholar using keywords including "multiple sclerosis," "diet," "ketogenic diet," "Swank diet," "Wahls diet," "fasting," "vitamin D," and "epigallocatechin gallate." Studies were selected based on scientific credibility, relevance, and methodological integrity.

Results: Evidence suggests that the Swank and Wahls diets, despite differing approaches, both improve fatigue, mood, and quality of life by emphasizing high fruit and vegetable intake and limiting saturated fats and processed foods. Ketogenic diet enhance mitochondrial function, reduce pro-inflammatory enzyme expression, and may support remyelination. Vitamin D supplementation demonstrates immunomodulatory and neuroprotective effects, while epigallocatechin gallate may further reduce inflammation, anxiety, and cardiovascular risk. However, limitations of these studies include small sample sizes, short study durations, and varies interventions, complicating the isolation of individual effects.

Conclusions: Dietary interventions and supplementation represent promising adjunctive strategies for MS management. While current evidence supports potential benefits in symptom reduction, neuroprotection, and quality of life, large-scale, long-term randomized controlled trials are needed to establish efficacy, safety, and underlying mechanisms.

Keywords: Multiple sclerosis, supplementation, Swank and Wahls diet, ketogenic diet, vitamin D, neuroprotection, nonpharmacological management, fatigue, neurodegeneration

1.INTRODUCTION

Multiple sclerosis (MS) is a chronic inflammatory and demyelinating disease of the central nervous system (CNS) mainly affecting young adults. The first symptoms of MS usually occur between 20 and 40 years of age, affecting women about twice as often as men. [1] Despite intense research, the pathomechanism of multiple sclerosis remains incompletely recognized. MS is characterized by the infiltration of peripheral autoreactive immune cells comprising T cells, B cells, and myeloid cells into the CNS leading to destruction of myelin and oligodendrocytes resulting in gliosis and axonal damage. [1, 2] This autoimmune reaction is caused by an imbalance of pro-inflammatory and suppressive mechanisms that arise from a combination of genetic and environmental factors. [2]

Consequently, chronic inflammation and demyelination will affect the neuron function, leading to clinical symptoms. Multiple sclerosis presents with a wide range of symptoms depending on the location of lesions in the CNS. Symptoms may include sensory disturbances like numbness, prickling sensations or pain, along with motor and coordination impairment, spasticity, and sometimes muscle weakness. The first manifestation is very often optic neuritis, causing vision problems such as blurred vision, diplopia or reduced ability to distinguish between red and green hues. Other symptoms can include fatigue, bladder and bowel issues, dizziness, slurred speech, cognitive deficits, affecting memory, concentration, and information processing, or mood changes, such as depression. [3, 4]

MS can be classified into several types based on its progression: relapsing-remitting (RRMS), secondary progressive (SPMS), primary progressive (PPMS), and progressive relapsing (PRMS). About 85% of MS patients develop an RRMS form of the disease characterized by attacks of worsening neurological function and symptom exacerbation followed by complete or partial remission. [1] Progressively, as the destruction of myelin evolves, the recovery from symptoms becomes incomplete, and most of the patients with a long history of the disease develop an SPMS form in the later stages of RRMS. Some patients might follow a progressive clinical course with symptoms steadily worsening from the onset of the disease, which is termed primary progressive MS (PPMS). The PRMS form of the disease is a rare type where progressive worsening occurs with acute relapses but without distinct remission periods. [1,2]

Multiple sclerosis is caused by a combination of genetic and environmental factors. Epidemiological studies have shown that the risk of multiple sclerosis is higher among relatives of MS patients, suggesting the role of genetic predisposition in MS etiology [5, 6] However, the genetic component alone cannot completely explain pathogenesis of the multiple sclerosis. Several environmental factors trigger the development of autoreactive T lymphocytes in

patients with the expression of specific alleles in immune response regulatory genes . T lymphocytes targeting myelin cross the blood-brain barrier (BBB) and cause the inflammation. [1, 4] Environmental factors such as low serum vitamin D level, teenage obesity, working on night shifts and lack of sunlight exposure, as well as smoking and some viral infections, especially Epstein-Barr virus (EBV), have all been shown to trigger the development of the disease. [1, 4] The fact that epidemiological data shows that multiple sclerosis is more frequent in Western countries than in less-developed nations suggests that nutrition might be among these factors. The Western diet is high in energy, especially from saturated fats and sugars. Notably, a meal high in fat and refined carbohydrates has been shown to cause a more substantial postprandial insulin secretion and enhanced inflammation compared to a meal high in fiber and fruits. [4, 13]

2. RESEARCH MATERIALS AND METHODS

This literature review draws on sources accessed through the PubMed and Google Scholar databases, with a primary emphasis on peer-reviewed studies published between 2015 and 2025. The objective was to compile a wide range of scholarly works investigating how dietary patterns, targeted supplementation, physical activity, and broader lifestyle interventions influence the clinical management and progression of multiple sclerosis. Particular attention was directed toward the ketogenic, Swank, and Wahls dietary protocols and vitamin D supplementation. Search strategies include combinations of keywords such as “multiple sclerosis,” “nutritional supplementation,” “vitamin D,” “ketogenic diet,” “Swank diet”, “Wahls diets,” “fasting diet,” “Epigallocatechin gallate” and “rehabilitation interventions”. The studies were selected based on their scientific credibility, relevance to the topic, and methodological integrity. This approach ensured the inclusion of high-quality and relevant research to support a comprehensive assessment of dietary modification strategies in MS management.

3. RESEARCH RESULTS

Multiple Sclerosis and Specific Diets

Due to the systemic inflammatory nature of multiple sclerosis, there has been increasing attention on the role of diet as an adjunctive strategy for symptom management and potential disease modification. Various nutritional models, including the Swank and Wahls diets, the ketogenic diet, fasting, caloric restriction and plant-based dietary patterns, have been examined for their ability to influence MS-related biological pathways. These nutritional strategies are

thought to exert effects through alterations in immune function, reductions in pro-inflammatory signaling, and modulation of metabolic and mitochondrial processes, thereby offering potential benefits for both disease activity and overall patient well-being.

The Swank and Wahls Diets and Multiple Sclerosis

The low saturated fat (Swank) and modified Paleolithic elimination (Wahls) diets are two different eating patterns specifically designed to treat multiple sclerosis and are very popular within the MS community. The Swank diet was developed in 1948 by Dr. Roy Swank. [7] Based on epidemiological studies that show that increased consumption of fat, especially from meat and dairy was associated with higher incidences of MS, Swank began recommending his patients consume a low saturated fat diet and followed them for up to 50 years. [8] He published a series of reports following a cohort of 150 patients who were diagnosed with relapsing-remitting multiple sclerosis (RRMS) and observed that the group of patients on low saturated fat diet was less likely to have exacerbations and had reduced risk of mortality. [7, 8] His studies have been criticized for not being blinded randomized controlled trials, absence of brain MRI control, and the lack of standardized assessment measures of diet and outcomes. Despite criticism the Swank diet is still in use. [7] The Swank diet limits saturated fat to ≤15g per day, provides 20–50g of unsaturated fat daily, and contains four servings of grains, fruits and vegetables per day. [9] Swank believed that multiple sclerosis has a vascular component and that atherosclerosis and chronic ischemia of central nervous system are associated with worsening disability. [7] Latest research found positive associations between increased disability and triglyceride and cholesterol levels. The multicenter study done on pediatric population of 219 patients in the USA suggests that in children with MS, high energy intake from fat, especially saturated fat, may increase the frequency of relapse (adjusted HR 1.56, 95% CI 1.05 to 2.31, p=0.027), while one cup equivalent of vegetable intake may be independently protective (adjusted HR: 0.50, 95% CI 0.27 to 0.91, p=0.024). [10]

The Wahls diet is a modified Paleolithic diet that involves excluding grains, dairy products, eggs, legumes, and processed foods. The exclusion of certain products in Wahls diet is believed to eliminate dietary antigens, like gluten, lectins, and casein, and prevent disease progression. [8, 9] The Wahls diet consists mainly of fish, lean meat, roots, fungi, and nuts. It recommends 6–9 portions of fruits and vegetables per day. [7] In sum, the Paleo diet is relatively high in vitamins B and K, polyunsaturated fatty acids, coenzyme Q10, α-lipoic acid, polyphenols, carotenoids, zinc, and selenium, all of which support myelin growth and repair. [12] This eating pattern has been associated with improved biomarkers linked to a reduced risk for heart disease,

such as reduced blood pressure, weight, waist to hip ratio, increased insulin sensitivity, and reduced LDL serum levels. [7, 9] Preliminary studies suggest that the modified Paleolithic diet has the potential to improve fatigue and quality of life (QoL) among individuals with primary progressive or relapsing-remitting MS compared to usual diet or ketogenic diet. [11, 12] The modified Paleolithic diet is also associated with increased serum vitamin K levels, reduction in inflammation, and improvements in exercise capacity and motor function. Recent studies suggest using a Paleo diet may improve overall well-being in individuals diagnosed with relapsing-remitting multiple sclerosis. [12] Most of the studies include multimodal lifestyle interventions (such as modified Paleo diet, supplementation, exercise and rehabilitation, neuromuscular electrical stimulation, and stress reduction). Therefore, larger randomized controlled trials are needed to determine the efficacy, tolerability, and safety of the modified Paleolithic diet and to address whether this diet alone is effective in reducing fatigue and improving quality of life, both mental and physical. [8, 11, 12]

The WAVES randomized parallel-arm clinical trial involved 77 participants with RRMS randomly divided into two groups, each assigned to the Swank and Wahls diets. The objective of this study was to compare the effect of the Swank and Wahls diets, especially on perceived fatigue and quality of life in individuals with multiple sclerosis. In a head-to-head comparison, both the low-saturated fat and modified Paleolithic elimination diets were associated with improvements in quality of life and reductions in fatigue among individuals with relapsing-remitting multiple sclerosis, but there were no significant differences between the two diet groups. [8] The secondary analysis of the WAVES trial found that both the Swank and Wahls dietary interventions, which included supplementation of folate and vitamin B12, resulted in significant improvements in Mental Health Inventory (MHI), and Hospital Anxiety and Depression Scale (HADS) scores. In conclusion, these results suggest that both dietary interventions with supplementation of vitamin B12 and folate result in significant improvements in depression and anxiety symptoms. [13]

Environmental factors such as diet and supplementation may impact the development and severity of MS symptoms. The Swank and Wahls diets have been proven to have favorable impact on MS symptoms. Both the Swank diet and the Wahls diet are very popular among patients with multiple sclerosis, and it is important to consider how these two diets are similar rather than how they differ. Both recommend a high intake of fruits and vegetables and limited intake of saturated fats and ultra processed foods. [7, 8] However, larger randomized controlled trials with longer durations and larger sample sizes are needed to explore the intersection

between dietary interventions and the MS disease course and to investigate the pathomechanism of this impact. [7, 9]

Ketogenic and Fasting Diet and Multiple Sclerosis

The ketogenic diet was initially used as an alternative treatment for pharmacoresistant epilepsy in pediatric population in 1920s and has effectively treated childhood epilepsy for many years. Nowadays, this diet is commonly used among patients with many other neurodegenerative diseases such as Alzheimer's disease or Parkinson's disease. [14]

The ketogenic diet is high fat and very low in carbohydrates, which mimics fasting and shifts metabolism to nutritional ketosis, where ketone bodies become the primary energy source and an alternative fuel for the brain, which might even be more efficient than glucose. [15] Individuals on the ketogenic diet have decreased glucose and insulin serum levels. Studies have proven that ketogenic diet improves mitochondrial function and inhibits excitotoxicity [14, 15] It has also been suggested that the resulting ketone bodies facilitate the regeneration of demyelinated axons. [17]

Alterations in the gut microbiota have been linked to numerous health conditions, including autoimmune diseases like multiple sclerosis. Because the gut microbiome interacts closely with the immune system, disturbances in its composition can drive persistent inflammation and contribute to neuroinflammatory processes. The Western diet, typically high in ultra-processed foods, unhealthy fats, and low in fiber, tends to promote microbial imbalance (dysbiosis), chronic low-grade inflammation, and changes that may affect the brain. In fact, many people with MS show signs of gut dysbiosis. Dietary approaches such as the fasting diet and the ketogenic diet may help counter these effects by boosting microbial diversity and supporting a healthier, more balanced gut ecosystem. [14]

A molecular study done on 24 patients with relapsing remitting multiple sclerosis explored the impact of ketogenic diet and caloric restriction on gene expression of biosynthetic enzymes: ALOX5, COX1, and COX2. These enzymes have been connected with demyelination in MS because they are involved in synthesis of pro-inflammatory eicosanoids – molecules thought to contribute to the development of multiple sclerosis, by increasing vascular permeability and facilitating the movement of leukocytes through the blood brain barrier. The group of patients on ketogenic diet and caloric restriction had significantly reduced expression of COX-1 ($p<0.001$), COX- 2 ($p<0.05$), and ALOX-5 ($p<0.05$) in real-time PCR. This interference in eicosanoid biosynthesis might be beneficial for patients with RRMS. [16]

Plant-Based and Caloric Restriction Diets and Multiple Sclerosis

The randomized control trial conducted on 39 patients with multiple sclerosis that a low fat, plant-based diet might be beneficial, as it decreased symptom burden and fatigue, as well as improved weight management outcomes. Patients in experimental group on low-fat diet reduced their daily intake of total fat calories to less than 20%, with saturated fat at less than 7%, and rest of caloric breakdown consisting of 20% protein and 60% carbohydrates. Their diet was mostly plant-based, but they were allowed to add lean animal protein sources, except red meat and dairy products. After a 16 week period, fatigue measured by MFIS decreased by 4.0 (95% CI −12.0, 4.0) compared to the control. This study demonstrates significant improvement in fatigue and also good diet tolerance. [18]

Another study on the effect of a calorie-restricted diet on the course of multiple sclerosis focused on neuroimaging markers of MS. Participants in the experimental group were supposed to reduce their daily calorie intake to around 25% of usual intake on two non-consecutive days per week. On these fasting days, patients were allowed to eat one or two salads with a light dressing and were asked not to exceed 500 calories. After a 12 week study period, participants on caloric restriction diets presented with significant improvement in MRI. Brain volume increased in the left superior and inferior parietal gyri (p: 0.050 and 0.049, respectively), and cortical thickness improved in the bilateral medial orbitofrontal gyri (p: 0.04 and 0.05 in right and left, respectively), the left superior temporal gyrus (p: 0.03), and the frontal pole (p: 0.008) in the caloric restriction diet group compared to the control group on a standard Western diet, high in fat, sugar, and ultra-processed foods. [19]

Supplementation and Multiple Sclerosis

Many epidemiological studies have shown that hypovitaminosis D is linked to an increased risk of multiple sclerosis, as well as higher disease activity and progression. [20] Based on these results, vitamin D supplementation has gained attention in scientific community, resulting in a large number of clinical trials on cholecalciferol supplementation among multiple sclerosis patients. [21] It is well established that vitamin D have immunomodulatory effects in many autoimmune diseases, particularly through the attenuation of pro-inflammatory pathways and the regulation of adaptive immune responses. Recent studies suggest that vitamin D could play a protective role in the nervous system of people with MS. [22] The active metabolite of vitamin D, $1,25(OH)_2D_3$, exerts multiple neuroprotective effects that may support remyelination and reduce neurodegeneration in demyelinating disorders such as multiple sclerosis. This metabolite promotes the proliferation of neural stem cells and facilitates their differentiation

into oligodendrocytes, thereby supporting the repair of myelin. Additionally, $1,25(OH)_2D_3$ increases the expression of neurotrophins, which promote neurogenesis and protect neurons from apoptosis and degeneration. It also modulates central nervous system immune responses, shifting microglial activation toward the anti-inflammatory M2 phenotype while suppressing M1 microglia and reactive astrocytes, resulting in decreased production of pro-inflammatory cytokines and reactive oxygen species (ROS). Furthermore, $1,25(OH)_2D_3$ contributes to the stabilization of the blood–brain barrier, limiting the entry of autoreactive T cells into the central nervous system. Collectively, these mechanisms support remyelination, reduce neuroinflammation, and enhance overall neuronal protection. [22, 23]

While the role of vitamin D is relatively well established, evidence regarding other supplements remains limited, though several substances are under investigation for potential benefits. Epigallocatechin gallate (EGCG), the main polyphenol found in green tea, is known for its high antioxidant and anti-inflammatory activity. It has been proven that EGCG helps suppress the proliferation of autoreactive T cells, lowers the release of proinflammatory cytokines, reduces Th1 and Th17 populations, and an increases the number of regulatory T cells. Additionally, EGCG is able to cross the blood–brain barrier, where it decreases apoptosis of neurons. The pilot study done on 51 patients with multiple sclerosis, randomly divided into an intervention group that received 800 mg of EGCG and 60 mL of coconut oil, and a control group that received a placebo, explored the impact of coconut oil and epigallocatechin gallate on the levels of anxiety among MS patients. The combination of epigallocatechin gallate and coconut oil caused a significant improvement in state anxiety. [24] Another study on the supplementation of epigallocatechin gallate explored its impact on cardiovascular risk. The problem of high incidence of cardiovascular complications among patients with multiple sclerosis is relevant as they have increased fat mass, especially accumulated in the abdomen, and experience muscle loss. It has been proven that epigallocatechin gallate supplementation in multiple sclerosis patients increased blood ketone levels and reduced cardiovascular risk. This effect was associated with improvements in anthropometric parameters, including decreased waist-to-hip ratio and increased muscle mass, as well as serum biomarkers, including elevated PON1 and albumin. [25] Both studies are promising; however, these results need to be confirmed in a larger sample randomized controlled trials with a longer duration. [24, 25]

4. CONCLUSIONS

Dietary interventions and supplementation represent promising additional strategies in the management of multiple sclerosis, with growing evidence supporting their potential to

modulate disease activity, improve symptoms, and enhance quality of life. Both the Swank and Wahls diets emphasize high fruit and vegetable intake and reduced saturated fat consumption. Clinical studies, including the WAVES trial, suggest that these diets can reduce fatigue, improve mood, and enhance overall well-being in patients with relapsing-remitting multiple sclerosis.

Ketogenic and intermittent fasting diets appear to offer additional benefits by improving mitochondrial function, reducing pro-inflammatory enzyme expression, and potentially supporting remyelination. Similarly, plant-based and caloric restriction diets show promise in reducing fatigue, improving neuroimaging markers, and supporting weight management in MS patients.

Supplementation, particularly with vitamin D, demonstrates strong immunomodulatory and neuroprotective effects, potentially aiding remyelination and reducing neuroinflammation. Epigallocatechin gallate (EGCG) may further contribute to symptom reduction, cardiovascular health, and anxiety management, though larger, long-term randomized trials are needed to confirm these effects.

Overall, while current evidence suggests that dietary and lifestyle interventions can positively influence MS progression and symptom burden, limitations exist, including small sample sizes, short study durations, and the frequent use of multimodal interventions that make it difficult to isolate the effects of individual diets or supplements. Future research should focus on long-term randomized controlled trials to determine the efficacy and safety of specific dietary strategies and supplementation in MS populations.

Disclosure

Supplementary Materials

Not applicable.

Author Contributions

Conceptualization: Anna Górowska, Zuzanna Wadowska, Julia Janowiak, Martyna Sobiś, Natalia Janik

Methodology: Anna Górowska, Julia Lenart, Anna Bogacka, Nina Kiersznowska, Barbara Miłek, Małgorzata Buchman

Software: Julia Lenart

Check: Martyna Sobiś, Anna Bogacka

Formal analysis: Anna Górowska, Barbara Miłek, Nina Kiersznowska

Investigation: Anna Górowska, Julia Lenart, Natalia Janik, Zuzanna Wadowska, Julia Janowiak, Martyna Sobiś, Anna Bogacka, Małgorzata Buchman, Barbara Miłek

Resources: Barbara Miłek

Data Curation: : Anna Górowska, Anna Bogacka, Julia Janowiak

Writing-rough preparation: Anna Górowska, Julia Lenart, Natalia Janik, Zuzanna Wadowska, Martyna Sobiś, Anna Bogacka, Nina Kiersznowska, Małgorzata Buchman, Barbara Miłek, Julia Janowiak

Writing-review and editing: Anna Górowska, Julia Lenart, Zuzanna Wadowska

Visualization: Natalia Janik

Supervision: Anna Górowska, Julia Lenart

Project administration: Anna Górowska

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