

Nutrition in Multiple Sclerosis

A review of scientific literature and advice from MS organisations



The information in this white paper is the views from DAHRT Biocare.

DAHRT Biocare markets Ceventrix,, for the dietary management of Multiple Sclerosis

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Multiple sclerosis (MS) is the most common neurodegenerative disease and is considered to be a result of a combination of genetic and environmental triggers. Recent evidence has confirmed an important role of contracting mononucleosis in the development of MS. Additional triggers are also likely to play a role in the complex interplay of environment and genetics.

One such trigger is gut health. Through the concept of the brain-gut axis, a healthy gut can influence the functioning of the brain through a number of mechanisms including communication through the nervous system, release of hormone and endocrine factors by the gut, and regulation of inflammation. Gut health is partially dependent on a healthy bacterial environment which digests food products like fibre and provides energy and signaling molecules to the body. Numerous studies show that MS is associated with an imbalance of the microbiota.

A healthy diet can therefore provide numerous health benefits by providing necessary vitamins and minerals, the correct balance of omega-3 and omega-6 fatty acids, low fat, low salt, rich in fibre for gut motility and gut microbiota and sufficient, but not excessive, energy.

The pill burden for pwMS patients is high, with 30% having polypharmacy (more than 5 medications) which are often composed of disease modifying medicines and medicines for symptom relief [1]. Because of the high level of drug intervention and natural means of disease control, there is an increasing interest and demand for nutritional advice for those with MS [2]. Unfortunately, the common theme throughout the nutritional field is the lack of high-quality research. Although evidence may exist in the form of detailed biological mechanisms of action there is often few or no clinical studies available to support recommendation of nutrients or diets for pwMS.

Eat your way to health

The popular press contains many diets for MS largely based on existing diets re-worked as beneficial for MS patients. A healthy diet alone or use of specific supplements cannot cure MS but it may alleviate some symptoms and it may help in creating a general feeling of health and well-being. It is no surprise that MS associations and health practitioners recommend a balanced diet with exercise as part of a healthy lifestyle. Low or medium impact exercise contributes to reducing stress, reducing chronic inflammation, improvement in cardiovascular health [3], reduction of blood pressure, increased appetite and more regular and deeper sleep [4, 5] [6].

There is interest amongst the MS community to understand the role of diet and optimise their nutritional intake. This is reflected in a high use of supplements ranging from 34 - 85% of pwMS taking supplements or natural medicines [1, 7].

Dietary habits of people with MS

A systematic literature review revealed that pwMS eat less carbohydrate and protein than the daily recommended intake, which is reflected in markedly lower BMI in pwMS compared to the recommended range. The daily intake of total and saturated fats is higher than recommended whilst intake of polyunsaturated fats and dietary fibre were less than recommended [8]. Therefore, many pwMS are undernourished or have

malnutrition and there is an opportunity for improving their quality of life and potentially MS disease by adjusting their diet.

Here we review diets and nutrients commonly suggested for those with MS

Low carb diets (Atkins, Keto, Paleo diets)

Low-carbohydrate diets were originally proposed as weight loss programs. The principle behind the diets being that the body's energy source is changed from carbohydrates and sugars to fat which is a switch normally seen when the body is in starvation.

Reduced carbohydrate intake leads to reduced sugar in the blood and less insulin spikes. The body is “tricked” into starvation modus and begins to utilise fat as an energy source. There is also an additional benefit that eating a high fat diet gives a feeling of satiety (feeling full) so there is less of a tendency to overeat.

These diets claim to reduce inflammation and provide an alternative energy source in cells. However, no clinically relevant benefits have been shown from the use of these diets in MS patients. Interestingly, low carb diets have been shown to negatively affect the microbiota, leading to a reduction in the proportion of short chain fatty acid producing bacteria which may have negative impact on MS [9]

The SWANK diet

The SWANK diet originates from an observation that Norwegians living in coastal towns had low prevalence of MS which was associated with low intake of animal meats and high fish consumption [10]. The SWANK diet recommends low intake of saturated fats (max 15g per day) and encourages use of olive oil, soybean oil and other unsaturated fats. Unrestricted use of fruits and vegetables is part of the diet and red meat and pork is banned for the first year. Non-fat or low-fat dairy products are encouraged. Vitamins C and E, fish oil and multivitamins are encouraged.

Swank himself published studies showing a positive effect of the diet in MS on clinical outcomes and morbidity (symptoms of MS) [11], but outside of these, no well-controlled clinical studies have been performed to measure the effect of the diet. Whilst the diet is touted as being healthy, there are also concerns that strict-adherence diets can exclude specific nutrients leading to nutritional deficiency.

In the absence of independent studies supporting the use of SWANK and other restrictive diets, together with potential harmful effects, we have been unable to find any MS-organisations that support the use of the above diets.



Mediterranean diet

The Mediterranean diet is characterized by use of unsaturated fatty acids (olive oil), unprocessed high-fibre, fruits and fresh vegetables and low amounts of butter, animal fats, dairy products and moderate wine intake. The diet is also associated with a social pattern of slow eating, of gathering the family, conviviality, sensory stimulation, socialization, biodiversity, and seasonality, aspects which are considered to be important in lowering stress and oxidative stress [12].

From as early as the 1950s this diet has been described as a healthy diet resulting in beneficial cholesterol profile, reduced coronary heart disease and stroke [13]. A large study performed in 2012 of 966 healthy individuals followed over 7 years showed that the Mediterranean diet is associated with healthier brain vasculature as shown by MRI [14] and studies support the benefit of this diet in general brain health, for example against age related dementia [15] and Alzheimer's Disease [16].

Unfortunately, there have been few studies of the effects of the Mediterranean diet on MS but those that have been performed show positive results. Quality of life measurements (depression, cognitive impairment etc) were improved with a Mediterranean diet [17] and a case-controlled study of 212 participants showed a reduced MS risk when eating a Mediterranean diet [18].

A pilot, randomized controlled trial performed in 2018 showed that intense follow-up and adherence to a Mediterranean diet may improve fatigue and quality of life in those with MS [19].

Fruit and vegetables are rich in flavonoids, and phytopigments that can impact the immune system and provide neuroprotection. Unprocessed foods also contain fibre (non-digestible carbohydrates) which are important for

gut health and gut-microbial variation and abundance. There are therefore good reasons to believe that the Mediterranean diet is healthy and beneficial for general health and possibly for the health and well-being of those with MS.

MIND diet

The Mediterranean-DASH Intervention for Neurodegenerative Delay diet is based on the Mediterranean diet with adaptation to include or exclude nutrients thought to play a role in neuroprotection /neurodegeneration. The MIND diet includes berries and green leaf vegetables and recommends less grains. Both diets emphasise fruits, vegetables, fish, saturated fatty acids as found in olive oil and lower amounts of red meat and dairy products with the quantities varying between the diets (for a comparison see [20]).

Studies support the protective effect of this diet in age related cognitive decline [21] and Alzheimer's Disease [20, 22]. Recently, a study in early MS was performed with 180 subjects. The study measured brain volume [23]

Overcoming MS (OMS)

OMS is an holistic program with dietary advice on what and what not to eat, largely based on the Mediterranean diet. In addition, the program encourages exercise, Vitamin D supplementation, reasonable exposure to sunlight, meditation and use of medications. Dairy products are discouraged although these are sources of vitamins and calcium, and people on this diet should be aware of a potential need to compensate. The OMS program brings together lifestyle choices both physical and mental based on scientific research. Independent scientific validation of the entire package has yet to be performed but many of the components are similar to those recommended by MS organisations. For more information see <https://overcomingms.org/>

Gluten Free Diet

The gluten free diet restricts the intake of gluten and is important for those with gluten allergy. There is no evidence that a gluten free diet is of benefit against MS.

Omega-3 fatty acids

Omega-3 fatty acids are important in inflammation, joint health, heart health, eye and brain development, and act against premature births. The omega-3 fatty acids EPA and DHA are mild anti-inflammatory agents, they down regulate T-cell activity [24] and are important for brain function and recovery from damage. Several studies show that use of fish oils or high concentrate omega-3 improves relapse rate and EDSS scores and reduces inflammatory biomarkers [25, 26]. However, not all studies support a beneficial role of omega-3 although none are detrimental. A well-controlled meta-analysis looked at 4 clinical studies showing that despite reduced inflammation, omega-3 had no effect on EDSS score [27]. At present, the data supporting use of omega-3 to reduce symptoms of MS is inconclusive [28], although there is supportive animal data and good mechanistic data [29-31] further studies are required to determine the function of omega-3 in MS.

Studies of omega-3 oils in MS may well suffer from design challenges. The studies presented here did not provide supplementation longer than 12 months which may be too short to affect clinical MS. Omega-3 lipids

have a wide variety of health benefits outside of MS which may justify including fish or omega-3 supplements in a normal diet.

Vitamin C

Vitamin C is a water-soluble Vitamin with limited ability for storage in the body. Vitamin C is important in a number of biological systems including immunity. When eating between 30-180mg, Vitamin C is efficiently absorbed and utilised by the body but intake over this level leads to reduced absorption or increased concentrations in urine. Taking high levels of Vitamin C will lead to increased blood levels for a limited period of time.

Table 1: Recommended intake of Vitamin C

	Adult men (mg)	Adult women (mg)
RDA (US) ¹	90	75
PRI (EU)	110	95
US Upper tolerable limit	2000	
US average intake	105	83
https://ods.od.nih.gov/factsheets/VitaminA-HealthProfessional/		

RDA: Recommended Daily Allowance; PRI: Population Reference Intake

Vitamin C is an anti-oxidant, regulates immune function and may play a role in myelin sheath formation indicating a potential role in multiple sclerosis. However, there is an indication that Vitamin C in high doses may worsen MS due to free radical production [32]) and a study of an EAE animal model with Vitamin C has shown worsening of MS. A review of MS studies in 2018 suggests there have been no studies of Vitamin C in human MS.

Generally speaking, we receive enough Vitamin C in our diet and supplements are not necessary.

¹ The RDA defines an adequate daily intake for meeting nutrient requirements of nearly all healthy individuals, as defined by the Food and Nutrition Board (FNB) at the Institute of Medicine of the National Academies (formerly National Academy of Sciences) in the US. In the EU, the European Food Safety Authority (EFSA) has a similar recommendation called the population reference intake (PRI) (for more details see https://www.efsa.europa.eu/sites/default/files/assets/DRV_Summary_tables_jan_17.pdf).

Minerals

Magnesium is commonly taken by those with MS for nocturnal leg cramps or general muscle cramps. Calcium is often taken together with magnesium as they increase the uptake of each other. A Cochrane review of the use of magnesium in idiopathic cramp showed no benefit of taking magnesium compared to placebo [33].

A recent study looked at metals in the blood of 30 MS patients. Reduced concentrations of beryllium, copper, chromium, cobalt, nickel, magnesium and iron were noted and interestingly the mean concentration of lead in blood was significantly elevated in the MS group. No difference was observed in the concentrations of Molybdenum, Calcium and Zinc in blood of MS patients and normal controls [34].

Anti-oxidants

Oxidative damage has been shown to occur during MS attacks. Reactive oxidative species are important components of a normal inflammatory process to kill invading pathogens, but during chronic inflammation oxidative species can lead to mitochondrial stress, protein and lipid oxidation and damage to RNA and DNA. Each cell normally contains a high amount of anti-oxidants such as glutathione but these systems can be over-run and oxidative stress and damage is considered an important step in the development of MS. Therefore, there is a belief that anti-oxidants could help in protecting nerves from oxidant damage. Nutrients with anti-oxidant activity include Curcumin, Vitamin E, Melatonin, Resveratrol, and flavonoids (colourful polyphenols found in fruits and vegetables) (Miller 2019).



Curcumin

Curcumin is the active ingredient in turmeric often used in Indian food. This vibrant yellow spice has well-known anti-oxidant activity and has been studied in a number of disease states. There is significant mechanistic support for the activity of curcumin as an immune modulator [35, 36] anti-oxidant and as an anti-inflammatory agent [37, 38] with efficacy in animal models of MS [38-40]. The therapeutic potential of curcumin has been discussed for neurodegenerative diseases, including Alzheimer's disease (AD), Parkinson's disease (PD), and MS. We have not found any reported clinical trials using curcumin in MS patients although Merck has a clinical study

registered with clinicaltrials.gov reported as completed in 2016 (NCT01514370). Several positive studies have been performed with osteoarthritis patients and diabetics showing improvement in inflammation and in clinical measurements of osteoarthritis [41-44]. Curcumin supplementation appears to be a promising anti-inflammatory, neuroprotective nutrient and may well be an important nutrient in the future but at present no clinical data exists to either support or discredit its use and therefore there is no recommendation for use against MS.

Vitamin A

Vitamin A is an essential vitamin which is converted to retinol and then to its active state called retinoic acid. Vitamin A is sold as a supplement whilst retinol is sold as part of skin lotions for anti-aging. Natural sources of Vitamin A include meat and dairy products. Vitamin A and its derivatives have important roles in immunity, visual function, reproduction and cell communication.

A randomized study with all trans-retinoic acid (a type of Vit A) showed no improvement in clinical measurements of MS, nor alterations in important immune cells (T or B cell populations) [45]

Although the average intake of Vitamin A (in the US) is below the recommended dietary allowance (RDA)s, the values are still considered to be sufficient to meet nutrient needs.

Vitamin A deficiency has not been associated with MS development and supplementation has not led to a reduction in EDSS score [46]. Vitamin A is fat soluble and eating excess leads to storage in the liver. Vitamin A is a safe product and toxicity requires high intake, the product is therefore safe but there is currently no evidence to support its use in MS.

Resveratrol

Resveratrol is a polyphenol found in a variety of foods and beverages, including red grapes, peanuts, and red wine. Resveratrol has been reported to have multiple functions with anti-inflammatory, antioxidant, anti-aging, and antiviral properties that could be beneficial in diabetes and cardiovascular diseases, as well as being neuroprotective. A proposed mechanism of action in MS is through its effects on mitochondrial function. Despite several papers showing mechanistic and good treatment effects in animal models, no human clinical studies appear to have been performed [2].

In 2013, a study using two animal models of MS reported worsening of neuronal damage in mice treated with resveratrol, no anti-inflammatory activity was seen and a number of histological endpoints including demyelination were worse in both models following use of resveratrol [47]. We these results in mind, we do not recommend the use of resveratrol by pwMS.

Vitamin B6

Vitamin B6 is also known as folate or folic acid. Recently, a study of B12 and folate supplementation was shown to reduce serum homocysteine (homocysteine can have detrimental neurological effects). The double blinded, placebo-controlled study showed that quality of life (both physical and psychological) was improved in those

that took supplementation of both Vitamins [48]. Apart from this study no further clinical studies have been performed with Vitamin B6 in MS patients.

Vitamin B12

Vitamin B12 is essential for nerve growth and myelination and a deficiency leads to symptoms similar to those seen with MS [49]. Vitamin B12 deficiency in MS has been reported by some studies but refuted by others [50] and a recent meta-analysis found no difference in serum Vit B12 levels between MS and healthy individuals [51]. A small intervention study has shown that Vitamin B 12 leads to reduced scores on a neurological scale, but in this study Vit B12 was injected intramuscularly. At present, although Vit B12 has been shown to be essential for the myelin sheath more studies are needed to determine whether supplementation is of any benefit for MS patients [52].

Table 2: Recommended intake of Vitamin B12

	Adult men (ug)	Adult women (ug)
RDA (US)	2.4	2.4
PRI (EU)	None defined	
US Upper tolerable limit	None defined	
US average intake	3.4ug	
https://ods.od.nih.gov/factsheets/VitaminB12-HealthProfessional/		

In the US an estimated 2-15% of the population are deficient in Vitamin B12. Vitamin B12 is found in high amounts in beef and some fish and in poultry, eggs and dairy products and lack of intake of these foods – for example for some strict vegetarians – can result in low levels of Vitamin B 12. Vitamin B12 has an important role in healthy nerves but it is not clear whether supplementation is helpful in MS.

Vitamin D

Low levels of Vitamin D are recognised as a risk factor for development of MS and supplementation is recommended by many healthcare professionals. Vitamin D has an important function in calcium absorption and growth and repair of bones as well as activity on a number of immune cells. Vitamin D has been shown to block MS development in the EAE animal model and deficiency is strongly associated with risk of MS [53].

Vitamin D is present in fish and dairy products and is produced in skin following sunlight exposure. Vitamin D requires processing (hydroxylation) to calcidiol and further to the active form, calcitriol (1,25-dihydroxycholecalciferol (1,25-(OH)2D3). The active form of Vitamin D binds the Vitamin D receptor (VDR) which is found in a wide variety of tissue and cell types. In the immune system Vitamin D affects a number of immune cells, it has anti-inflammatory activity and up-regulates anti-inflammatory Treg cells [54].

The consistent finding of Vitamin D deficiency as a risk factor [55] together with its activity as an immune modifying agent and initial findings that supplementation was protective [56] has led to widespread acceptance of the need for Vitamin D supplementation by those with MS. Interestingly, further studies now give mixed clinical evidence raising some doubt as to the role of Vit D in MS. A Cochrane review of 12 clinical interventional trials in 2018 showed no effect on clinically relevant outcomes in MS from the use of supplemental Vitamin D [57]. An extension of the Cochrane review was performed in 2020 reviewing 24 studies with doses from 25-60,000 IU/day without finding any significant effect of Vitamin D supplementation [58]. However, meta-analyses have the weakness of summarizing results from studies with different dosages, endpoints, intervention duration and study populations. Negative outcomes can therefore arise from the influence of different study designs.

A large study of two cohorts of women: the Nurses’ Health Study (NHS; 92,253 women followed from 1980 to 2000) and Nurses’ Health Study II (NHS II; 95,310 women followed from 1991 to 2001) in which 173 cases of MS were confirmed concluded that dietary Vitamin D, particularly in the form of supplementation, was protective against the development of MS [56].

Table 3: Recommended intake of Vitamin D

	Adult men (ug) (International Units)	Adult women (ug) (International Units)
RDA (US)	15 (600)	15 (600)
PRI (EU)	15 (600)	15 (600)
US Upper tolerable limit	100 (4000)	
US average intake	5.1	4.2
https://ods.od.nih.gov/factsheets/VitaminA-HealthProfessional/		

The highest natural source of Vitamin D is in fish oils and fatty fish such as salmon. Concentrated omega-3 capsules are commonly made from fish oils, but the purification process removes Vitamin D. If you are taking fish oil as a source of vitamin D, check the label to ensure the oil contains Vitamin D.

Vitamin D is produced by sun exposure to the skin and whilst there are many variables affecting rate, a general rule can be stated that 5-30 mins per day or at least twice weekly exposure of face, arms and legs without sunscreen will provide adequate levels of Vitamin D (ref: <https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/>).

Vitamin D has activities throughout the body, it has specific activity on T-cells important in the pathophysiology of MS. The strong association of Vit D deficiency with risk of MS and its known biological activity on immune cells supports the use Vitamin D by pwMS.

Vitamin K2

Vitamin K is important in blood clotting (Vit K1) and heart health (K2) and its role in mitochondrial protection may be of importance for MS [59].

Vitamin K2 is found at high concentrations in myelinated nerves and has been shown to have anti-oxidant and anti-inflammatory activities in the nervous system [60].

Substantially lower levels of Vit K2 were seen in the serum of MS patients vs controls [59] which was further reduced with age and number of attacks. Some promising mechanistic data has been gathered pointing towards the ability of Vitamin K2 to reduce oxidative stress and protect neurons and their supportive cells called oligodendrocytes from oxidative mediated inflammatory damage. Neuroprotective effects however have not been shown in vivo and no clinical data in MS patients is currently available.

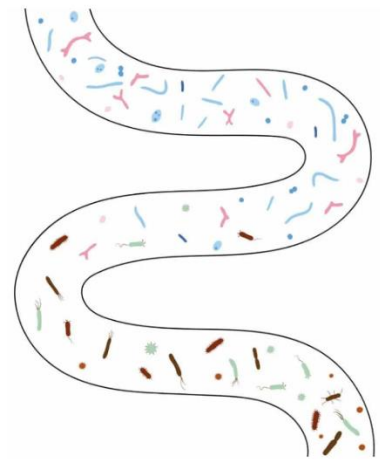
A study of MS in an animal model has shown that Vitamin K2 may provide some protection against the development of MS but had no effect once MS was established [61]. At present, the lack of human clinical data prevents any recommendation of Vitamin K2 for the management of MS although this is an interesting area of development.

Vitamin K2 is obtained mostly through bacterial metabolism and significant amounts are found in the colon. Caution should be shown if used together with anti-coagulants.

Gut brain axis

In recent years there has been increasing interest in the communication between the gut and the brain, the so-called gut-brain axis. Associations between auto-immune diseases such as MS and Parkinson's disease and gut health have been described [62, 63].

The gut bacteria are collectively known as the gut microbiome and can weigh up to 2 kg. A healthy microbiome is essential for maintaining a healthy gut and dysbiosis can lead to constipation and diarrhea. In recent years, the microbiome has been linked to a range of diseases, but despite years of research, developing specific strains of bacteria as a supplement (commonly known as probiotics) has proven difficult. Many companies offer probiotic solutions for gut health, but there is still much to learn about the use of probiotics and whether they have a permanent role in disease management. Eating a fibre rich diet (prebiotics) can help maintain a natural microbial balance.



Probiotics

A series of studies have shown the association of MS with abnormal bacterial (a state called dysbiosis) [64-66]. One way of overcoming this is to give patients a boost of the necessary "good" bacteria. Faecal transfer from healthy patients to MS patients may be effective [64, 67, 68] but may not be a scalable or preferred method. Giving a pill containing living bacteria is another option. Currently, there are no products on the market aimed specifically at MS or auto-immune diseases of the nervous system. There is a considerable effort to identify the "good" and "bad" bacteria involved in specific diseases with the intention of providing a treatment. The auto-immune diseases are hot spots of research within probiotics and we can expect movement in this area in the next 5-10 years.

Short chain fatty acids (acetate, propionate, butyrate)

Several studies show that bacteria and their metabolic products, short-chain fatty acids, are reduced in MS [65, 66, 69, 70]. One of these short chain fatty acids called propionate has shown promising results. The mechanism of action has been described as a direct effect of propionate on gut associated immune cells (Treg cells and T17 cells) [71-73]. Supplementation with propionate reduces disease scores in the EAE animal model of MS [73-75]. Propionate is deficient in MS patients. A study of MS patients taking a propionate supplement showed a decrease in inflammatory T-cells and a reduction in the annual relapse rate and a significant reduction in disease progression over a 3-year period [66].

Fibre

Fibre is an important component of our diet that provides energy to the gut bacteria. Fibre, also called roughage, can be found in uncooked vegetables and fruit as well as low-processed corn products. Many pwMS suffer from stomach complaints such as constipation and diarrhea. Eating enough fibre can help with gut health; but avoid making sudden large changes as this can make conditions worse.

What are the organisations saying?

The multiple sclerosis organisations are interested in providing advice on nutrition and many produce their own leaflets on this topic. The top-line message from them is the promotion of a balanced diet and that, with the exception of Vitamin D, supplements are not required unless you have a specific deficiency.

The recommendations from the associations are summarised below using the following categories: Positive, neutral, caution or avoid. These categories have been assigned by the authors of this paper.

Recommendations from National Multiple Sclerosis Society (NMSS), Multiple Sclerosis Foundation (MSF), Multiple Sclerosis Trust (MST), and Multiple Sclerosis Society (MSS) are provided in Table 4.

Table 4: Supplement and dietary recommendations from MS organisations

			
	NMSS	MST	MSS
Vitamin A	Caution	Not mentioned	Not mentioned
Vitamin B6	Avoid (possible side effects at higher doses)	Not mentioned	Not mentioned
Vitamin B12	Positive; but only for those with deficiency	Not mentioned	Positive, but only for those with deficiency
Vitamin C	Caution with higher doses	Not mentioned	Not mentioned
Vitamin D	Good mechanistic data. Little clinical evidence. Positive attitude.	Recommended	Positive.
Vitamin E	Caution with higher doses	Not mentioned	Not mentioned
Vitamin K2	Not mentioned	Recommended if you are deficient Positive attitude. No clinical evidence.	Not mentioned
Short chain fatty acids	Not mentioned	Not mentioned	Not mentioned
Probiotics	Not mentioned	Not mentioned	Not mentioned
Omega-3	Good mechanistic data. Contradictory clinical evidence. Positive	Not mentioned	Neutral
Anti-oxidants	Caution	Not mentioned	Neutral - no need to take antioxidants if you have a balanced diet
Special diets	No evidence of effect for Swank, Paleo, McDougall, Mediterranean or Gluten Free Diets	Not mentioned	Caution or neutral to special diets.
Minerals	Selenium- no opinion Calcium recommended for osteoporosis Zinc -avoid excess		Positive to calcium - particularly against osteoporosis.

*NMSS advice is restricted to Vitamin D and biotin (a form of Vit B). For additional nutritional advice, the site refers to the review by Bhargava et al.²

Conclusion

General well-being is important in tackling our everyday life whether you have MS or not. Our mental health, our physical well-being and our feeling of control and balance is promoted by regular exercise and eating a balanced diet, rich in vegetables, fruit, fibre and unsaturated fats. Mealtimes also have a cultural element that may be of importance. Eating with friends or family, investing time in food preparation, enjoying the meal and relaxing may contribute to reducing stress, anxiety and ultimately improve quality of life.

As yet, the benefit of specific diets in MS has not been sufficiently documented in independent studies to allow for specific recommendations. Those wishing to use a very restrictive diet should be aware of the potential risk of nutritional deficiency created by such diets.

Recommendations

A potential benefit may be gained from the Mediterranean diet, MIND diet and Overcoming MS strategy. These diets are roughly similar with a central theme of low levels of saturated fats, high levels of unsaturated fats, use of fresh, low-processed foods with plenty of vegetables and fruits. Additionally, salt, sugar, and smoking should be avoided and alcohol use should be low [76]. Some may find OMS helpful as it provides an holistic approach where nutrition, exercise and mental health are considered as part of a total lifestyle approach.

Vitamin D: There is a well-established risk of MS associated with Vitamin D deficiency. There are also numerous studies describing the positive effects of Vitamin D on the immune system, supportive for its use in MS. Intervention studies have shown mixed results, however the overall strong evidence for Vitamin D association with MS has led to a recommendation for those with MS to take Vitamin D supplementation.

The gut-brain axis: Whilst the concept of gut-brain interaction is not new, the ability to manipulate this is novel. The use of probiotics may well cover this need in the future but at present there are no identified probiotic products for MS. Use of the post-biotic propionate may reduce progression of MS [77].

Omega-3: Omega-3 fatty acids reduce inflammation via several mechanisms and the beneficial effects have been variable in clinical studies.

The promise of nutrients, diets and supplements to improve MS in a natural and safe manner is enticing. Whether you have MS or not, it is sensible to have a balanced diet with fresh fruits and vegetables, with restricted saturated fats and high in unsaturated fats. Supplementation is necessary in cases of deficiency and there may be a particular need for Vitamin D for those with MS. Nutritional candidates that are promising against MS include Vitamin B12 and propionate and supplements that could be of value in the future include probiotics and Vitamin K2.

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² Bhargava. <https://www.nationalmssociety.org/NationalMSSociety/media/MSNationalFiles/Documents/Diet-and-Multiple-Sclerosis-Bhargava-06-26-15.pdf>

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