



## DIET AND MULTIPLE SCLEROSIS

Pavan Bhargava, MD

### Introduction

Multiple Sclerosis is a chronic immune-mediated demyelinating disorder that affects the central nervous system (CNS). In MS, inflammatory cells of the immune system (including T cells, B cells and others) are believed to target cells and tissues within the CNS, causing inflammation and damage to myelin, nerve fibers and the cells that make myelin. Several genetic and environmental factors that influence the risk for developing MS have now been identified. Perhaps the most significant dietary factor that has been linked with the occurrence of MS and its disease course is vitamin D.<sup>1,2</sup>

Another recent dietary factor associated with autoimmunity is high salt intake.<sup>3</sup> Ongoing research is also demonstrating a link between the gut microbiota (bacteria in our gut) and MS.<sup>4</sup> Diet plays an important role in shaping our gut microbiota and is also implicated in multiple other chronic diseases (type 2 diabetes, obesity, hypertension). There is increasing interest in the possible role of diet in autoimmunity and in the role of dietary interventions in diseases such as MS.

Possible mechanisms by which diet *may* have an effect on MS -

1. Direct effects on the immune system: Recent immunological research has shown that metabolism plays an important role in the function of several types of immune cells. Additionally several immune cells have receptors (surface structures that allow cells to connect and communicate with other cells) for various types of dietary metabolites (vitamin D, fatty acids). Thus intake of certain types of fats has been linked to greater inflammation while intake of polyunsaturated fatty acids (PUFAs) has the opposite effect.<sup>5,6</sup>
2. Indirect effects through modulation of the gut flora: The gut bacteria metabolize certain components of the diet into short chain fatty acids that, besides helping in colonic health, can also act on immune cells and make T cells more regulatory.<sup>4</sup> Additionally diet can lead to alterations in the gut bacterial composition that can shift the immune system towards a pro- or anti-inflammatory state.<sup>7</sup>
3. Effects on components of the central nervous system: As mentioned above, since altered metabolism may play a role in the adaptation of the nervous system to damage, various experimental foods and diets are being studied for

their effects on the various cellular components of the central nervous system such as the neurons and other glial cells.<sup>8</sup> Diets could have a beneficial role by providing factors that could be protective of these cell populations.

We will provide a synopsis of each diet, review the current evidence that the diet may be beneficial in MS or other conditions, and also comment on what possible nutritional deficiencies may arise from following certain diets (See Table 1, pp. 7-8).

## **Paleolithic diet**

The Paleolithic diet is based on the hypothesis that our bodies are poorly evolved to handle the modern diet that emerged primarily following the agricultural revolution. It advocates a switch to foods that would have been consumed by our ancestors in a hunter-gatherer lifestyle. The paleo diet is also a component of the Wahls protocol that has been popularized by Dr. Terry Wahls.<sup>9</sup>

### *Guidelines for the Paleolithic diet*

The Paleo diet provides guidelines for the kinds of foods that should be eaten and the balance in sources of caloric intake. The first step is to eat natural foods while avoiding highly processed food, especially high glycemic load foods (carbohydrate foods that significantly raise blood sugar). The Paleo diet also emphasizes the intake of game (non-domesticated) meats and plant based foods besides cereals (fruits, roots, legumes and nuts). Animal protein is recommended to be the source of about 30-35% of the daily caloric intake. Consumption of lean game meats also helps in reaching the recommended level of PUFA intake. In the Paleo diet the ratio of saturated fats to PUFA is between 1.4-2:1 – unlike the modern diet in which the ratio is closer to 10:1. The Paleo diet is also high in fiber (45-100 g/day) that is derived from plant sources that are not cereal based. While some sources advocate avoiding potatoes and legumes, others do not. This could be secondary to the fact that potatoes have a high glycemic index.

Modified guidelines for the Paleo diet taken from a study that is quoted below include the following recommendations:

1. Consume 3 servings each/ day of green leafy vegetables, sulfur rich vegetables and intensely colored fruits or vegetables.
2. Consume 2 tablespoons of omega-3 oils; 4 oz. or more each of animal protein and plant protein; only non-lactose containing milks; no more than 2 servings per week of gluten-free grains/ starchy foods.
3. Do not consume any dairy, eggs or gluten containing grains.

### *Evidence in MS or other autoimmune disease*

A small uncontrolled, single-arm study looked at the effect of a multimodal intervention that included a modified Paleo diet on people with secondary progressive MS.<sup>9</sup> In this study there was significant improvement in fatigue scores over a period of 12 months.

This study, however, also involved exercise, stretching, massage, meditation and electrical stimulation, and did not include a control group on a reference (comparison) diet. There is a need for larger controlled trials of the Paleo diet in people with MS.

#### *Evidence in non-autoimmune disorders*

A recent study randomizing people to the Paleo diet or a reference diet showed improvements in several cardiovascular risk factors; however, the Paleo diet group also had a reduction in body weight and a portion of the beneficial effect could have been derived from the weight loss.<sup>10</sup>

#### *Possible deficiencies that may result from the diet*

The Paleo diet can result in deficiencies in folic acid, thiamine and vitamin B6 (due to reduced intake of cereals), calcium and vitamin D (due to lack of dairy intake) and insufficient caloric intake without appropriate nutritional advice.

## **Mediterranean Diet (MD)**

The MD is one of the most extensively studied diets in the setting of cardiovascular health. It has several similarities to the Paleolithic diet but in some ways is more practical to follow. The MD has many components which are thought to be beneficial, however most research suggests the MD as a whole has far greater benefit than its individual components.<sup>11</sup>

#### *Guidelines for MD*

There are various definitions of the MD, however they generally share the following components: high intake of whole grains, vegetables, fruits, legumes, olive oil and fish; a low intake of saturated fats (butter and other animal fats), red meat, poultry, dairy products; and a regular but moderate intake of ethanol mainly consisting of red wine during meals.

The MD is part of the Mediterranean lifestyle. Figure 1 (p. 9) shows the important components of the MD in pictorial fashion.

#### *Evidence for a role in MS or other autoimmune disorders*

There are currently no data for a role of the MD in MS. A meta-analysis of 17 randomized controlled trials demonstrated a benefit of the MD on markers of inflammation.<sup>12</sup>

#### *Evidence for a role in non-autoimmune disorders*

There is evidence for a beneficial effect of the MD in type 2 diabetes, cardiovascular disease prevention and perhaps even in cancer prevention.<sup>12-14</sup>

#### *Nutritional deficiencies that may result from following this diet*

No specific nutritional deficiencies would be expected from following the MD.

## **McDougall Diet**

The McDougall diet is a low-fat, high carbohydrate, moderate sodium, vegan diet. It is based on the premise that the rich Western diet is the cause of several chronic diseases. It aims at eliminating animal based food and vegetable fats and replacing them with low-fat plant based foods.

### *Guidelines for the McDougall diet*

The basic components are plant sources of complex carbohydrates and starch (refined flour or white rice are excluded). The suggested staples of the diet include wheat flour products, corn, rice, oats, barley, quinoa, potatoes, sweet potatoes, beans, peas, and lentils. Fresh fruits and non-starch green or colored vegetables can be added to the diet in any quantity. A low sodium intake is encouraged and small amounts of sugar and spices may be used to flavor foods. No animal-derived foods are allowed; therefore dairy, eggs, meat, poultry and fish are excluded. In addition, oils are not allowed (including vegetable oils).

### *Evidence in MS or autoimmune disease*

No evidence exists in MS or other autoimmune diseases.

### *Evidence in other disorders*

A study from the McDougall center showed that 7 days of the diet led to a reduction in weight, BP and cholesterol levels.<sup>15</sup> This study did not comment on the long-term effects of the diet.

### *Nutritional deficiencies that may result from this diet*

The McDougall diet *could* result in deficiencies in iron, vitamin B12, vitamin D, calcium and  $\omega$ 3-fatty acids.

## **Gluten Free Diet (GFD)**

A GFD is a diet completely devoid of products derived from gluten containing cereals – wheat, barley, rye and triticales (a cross between wheat and rye). Gluten is a protein that is composed of gliadin and glutenin that are found conjoined with starch in wheat, rye and barley. It is a major component of the proteins found in wheat.

Gluten sensitivity is a feature of celiac disease and GFD is a common treatment for this disorder. Besides celiac disease, gluten sensitivity has also been noted in a condition called non-celiac gluten sensitivity (NCGS), which can also lead to gastrointestinal symptoms.

### *Guidelines for a GFD*

It is important to remember that “wheat-free” is not the same as “gluten free”. For a GFD it is necessary to avoid all food containing any derivatives of wheat, barley or

triticales. Additionally it is also important to consider cross-contamination if the food is prepared in an area where these products are utilized. It is also important to find substitutes since this helps in ensuring that the avoidance of gluten containing foods does not result in significant restrictions in caloric intake and ultimately in nutritional deficiencies.

#### *Evidence for a role in MS*

There is no evidence for a role of GFD in patients with MS. Multiple studies suggest that people with MS have the same prevalence of anti-gliadin and anti-TTG antibodies (antibodies elevated in Celiac disease) as healthy controls.<sup>16,17</sup>

GFD is a treatment for celiac disease and dermatitis herpetiformis (a chronic, itchy, bumpy and red rash). It has also been evaluated in other autoimmune conditions such as rheumatoid arthritis with no definite role for GFD noted in these disorders.<sup>18</sup>

#### *Evidence for a role in non-autoimmune disorders*

There is no evidence for a role for GFD in non-autoimmune disorders.

#### *Nutritional Deficiencies that may result from this diet*

No definite nutritional deficiencies expected if gluten-free breads and cereals are substituted.

## **Swank diet**

The Swank diet was described by Dr. Roy Swank and was used by him to treat patients with MS for several years.<sup>19</sup> The diet is essentially a low fat diet that focuses on reducing both saturated and unsaturated fats.

#### *Guidelines for the Swank Diet*

Saturated fat intake should not exceed 15 grams/day, while unsaturated fat /oils intake should be kept below 20-50 grams/day. No processed foods containing saturated fats should be consumed. Similarly dairy products must contain less than 1% fat.

Whole grain cereals and pastas are recommended. Two cups each of fruits and vegetables are recommended.

No red meat intake is allowed for the first year after which 3 oz. of red meat are allowed weekly. White fish and shellfish are permissible in any amount. Skinned trimmed poultry meat is permissible.

A cod liver oil and multivitamin supplement is also recommended. Additional details on the diet are available at the Swank MS Foundation website ([www.swankmsdiet.org](http://www.swankmsdiet.org)).

#### *Evidence in MS*

Dr. Swank in 1970 reported the effects of his diet over a period of 20 years on patients with MS.<sup>19</sup> In this observational report, he suggested that the diet reduced occurrence of relapses, accumulation of disability and mortality. It is important to note that the

study did not have a control arm to compare the subjects on the diet. Also a standardized scoring system such as the EDSS was not available at that time, making comparison with other groups of MS patients challenging.

*Evidence in non-autoimmune disorders*

No evidence for the Swank diet exists in non-autoimmune disorders.

*Nutritional deficiencies that may develop due to this diet*

Though no definite deficiencies would be expected to develop from this diet, a recent study showed that those following this diet were consuming less than the recommended levels of vitamin A, C, E and folate.<sup>20</sup>S

**Conclusions**

While many different dietary strategies are being promoted for people with MS, currently there is insufficient evidence to recommend any of these strategies. Interestingly despite the differences between these diets there are several common themes. Almost all the diets advocate avoiding highly processed food, foods with high glycemic index and food that is high in saturated fat. Most diets also recommend reducing consumption of fatty red meat and increasing consumption of fruits and vegetables.

Other approaches to diet are also being considered and include caloric restriction, which appears to be effective in animal models of MS. Trials of caloric restriction in people with MS are now underway.

More systematic evaluation of dietary strategies in MS is required. However, while we wait for such research to be done, following a diet that incorporates some of the themes that are common to these various diets and also has beneficial effects for overall health may be the most pragmatic option at this time.

**Table 1: “Diets for MS” – at a glance**

Diet	Basic guidelines	Restrictions	Possible deficiencies	Evidence for benefit in MS	Evidence for benefit in other diseases
Paleolithic Diet <sup>9</sup>	Emphasizes consumption of game meats (30-35% of daily caloric intake) and plant foods (besides cereals), multiple daily servings of green, sulfur rich and intensely colored vegetables and fruits, with a high intake of PUFA to target a ratio of saturated to unsaturated fats of 1.4-2:1	Processed food, domesticated meats, dairy	Folic acid, thiamine, vitamin B6, calcium and vitamin D, insufficient caloric intake	Single observation study demonstrating possible improvement in fatigue in progressive MS patients (however diet was bundled with other interventions and there was no comparison group) <sup>9</sup>	Single study showed improvement in cardiovascular risk factors <sup>10</sup>
Mediterranean Diet <sup>21</sup>	High intake of whole grains, vegetables, fruits, legumes, olive oil and fish, a low intake of saturated fats (butter and other animal fats), red meat, poultry, dairy products and a regular but moderate intake of ethanol (mainly red wine)	No specific exclusions	None expected	None	Extensive evidence for a benefit on cardiovascular health, diabetes and possibly on cancer risk <sup>12,13,21,22</sup>
McDougall Diet <sup>15</sup>	High carbohydrate, low fat, low sodium vegan diet with cereals, potatoes, and legumes as staples. Fruits and vegetables are allowed in any amount. Low sodium intake and small amounts of sugar are recommended.	Dairy, eggs, meat, poultry, fish and all oils	Iron, vitamin B12, vitamin D, calcium and $\omega$ 3-fatty acids	None	One study showed improvement in cardiovascular risk factors with one week of the diet (did not look at long term effects) <sup>15</sup>

Gluten Free Diet <sup>18</sup>	Avoidance of all foods containing wheat, barley, triticales or their derivatives	Foods containing wheat, barley or triticales or their derivatives	None expected	None <sup>16,17</sup>	Treatment for Celiac disease and non-celiac gluten sensitivity
Swank Diet <sup>19</sup>	Low fat diet that advocates reduction in the intake of saturated fats. Whole grain cereals are recommended, daily intake of 2 servings of fruits and vegetables, intake of white fish and shellfish and trimmed poultry is allowed. Low fat dairy is allowed and small quantities of red meat are permissible after the 1 <sup>st</sup> year of the diet	Processed food with saturated fats, high fat dairy products, red meat for 1st year	None expected (possibly vitamin A, C, E and folate)	Observational data from a single cohort of patients treated with this diet suggested an improvement in relapses and functional status. (there was no control comparison group) <sup>19</sup>	None

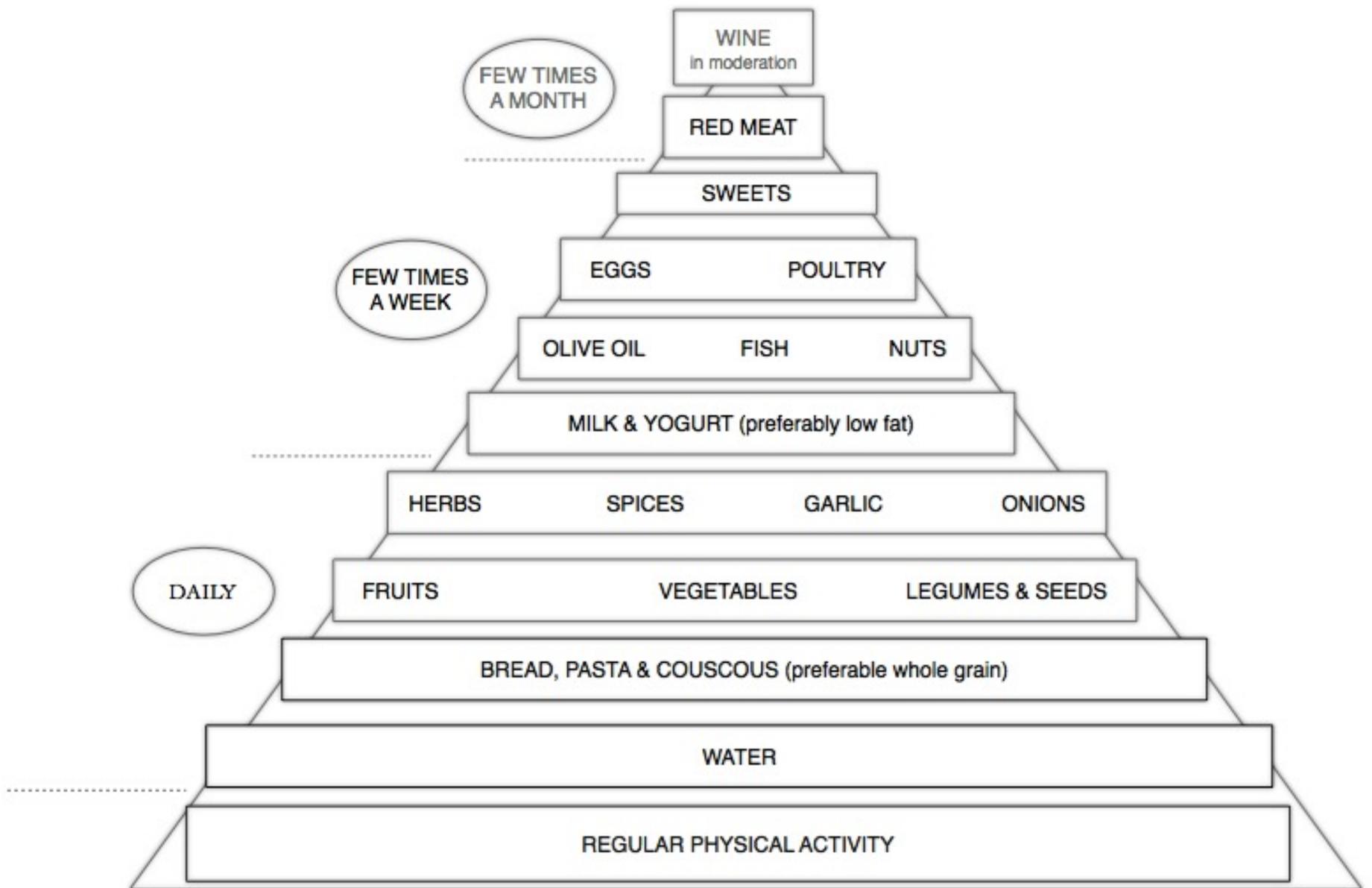


Figure 1: Pyramidal representation of the components of the Mediterranean diet and lifestyle (adapted from Ostan et al.<sup>21</sup>)

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