



# Preventing Glioma with a Plant-Based Diet



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## Abstract

Malignant glioma (glioblastoma) is an aggressive form of brain cancer with a poor prognosis. No early detection of glioma is available and it's difficult to treat, so prevention is crucial. Dietary patterns such as the Mediterranean, the MIND and the DASH dietary patterns, which all include a high intake of plants foods, have been shown to reduce the risk of glioma. A plant-based diet composed of only plant foods reduces the risk of glioma by 71%. Studies show that the phytochemicals in plant foods are key to risk reduction. Chemoprevention with phytochemicals from plant foods can interrupt the carcinogenic process, which includes initiation, promotion and progression of otherwise normal cells leading to malignancy. During glioma progression, reactive oxygen species are activated resulting in oxidative stress. A plant-based diet reduces oxidative stress through its rich supply of antioxidants. Research has shown that a plant-based diet is a safe and effective way to significantly reduce the risk of glioma. While reducing the risk of glioma, a plant-based diet can also reduce the risk of several chronic diseases.

**Keywords:** Brain cancer; Glioblastoma; Mediterranean diet; MIND diet; Oxidative stress; Phytochemicals; Vegetarian; Vegan

**Abbreviations:** DASH: Dietary Approaches to Stop Hypertension; HPD: Health-Promoting Plant-Based Diet; MIND: Mediterranean-DASH Diet Intervention for Neurodegenerative Delay; PD: Plant-Based Diet

## Introduction

Malignant glioma is a highly aggressive brain cancer, with an unusually dismal prognosis (death typically results in the first 15-16 months after diagnosis) [1], and a 5-year survival rate of only 5%. In North America, the incidence is 5.0 per 100,000 population, representing 15 to 20% of all primary intracranial neoplasms in adults [2].

These tumors arise from astrocytes and oligodendrocytes. The majority of glioblastoma are found in the supratentorial brain (frontal, temporal, parietal, and occipital lobes), with rare occurrence in the cerebellum, the brain stem, and the spinal cord [3]. The most frequent location for glioma is in the cerebral hemispheres; with 95% of these tumors arise in supratentorial region, while only few percent of tumors occur in cerebellum, brainstem and spinal cord [4].

No early detection of glioma is available. Standard magnetic resonance imaging provides the most sensitive tool for initial detection. However, once a definable lesion is identified with imaging, the tumor is already at an advanced state [5]. Considering the highly aggressive nature of glioma, widely disseminated in the brain, a complete surgical resection is hard to achieve [6]. Due to the rapid onset, extremely poor

prognosis, and high mortality rate, glioma causes a severe disease burden for patients [7]. While some innovative strategies to treat glioma are being developed [8], none are yet fully clinically proven.

Exposure to high-dose ionizing radiation has been identified as an established environmental risk factor for glioma [9,10]. Prioritizing the identification of other, more modifiable, risk factors for glioma is of vital importance for prevention.

### Dietary factors that may reduce the risk

While studies of individual foods and the risk of glioma have shown mixed results [11], a meta study found that those with the highest total vegetable intake reduced their risk of glioma by 16%. Another meta study produced similar results [12]. One meta study showed a 23% reduced risk in those with the highest intake of vegetables. [13].

Several studies of overall dietary patterns have shown more consistent results. In one study, those with the greatest adherence to the Mediterranean dietary pattern had a 74% reduced risk of glioma [14]. The Mediterranean diet is characterized by a high intake of plant foods, a high intake of olive oil, a moderate intake of dairy products, zero to four eggs a week, with fish and poultry

consumed in low to moderate amounts and red meat consumed in low amounts [15].

In separate studies, the reduction in risk of glioma by following either the MIND diet or the DASH diet have also been examined. The MIND diet is a plant-strong diet that emphasizes fruits, mainly berries, green leafy vegetables, nuts, olive oil, whole grains, beans, fish and poultry [16]. One study showed a 73% reduction in the risk for those with the greatest adherence to the MIND diet [16]. The Dietary Approaches to Stop Hypertension (DASH) diet consists of a set of recommendations including increased consumption of whole grains, fruits and vegetables, low-fat dairy products, and nuts and reduced consumption of sweets, sodium, and red and processed meats [17]. Another study found that those with the greatest adherence to the DASH diet had a 72% reduction in the risk of glioma [17].

Looking specifically at a plant-based diet composed only of fruits, vegetables, whole grains, legumes, nuts and seeds, in a study of the reduction in risk of glioma, subjects in the highest tertile of adhering to a plant-based diet (PD) and a health-promoting plant-based diet (hPD) were 69% and 71% less likely to have glioma compared with those in the lowest tertile. The hPD emphasized plant foods that were known to be particularly health promoting [18]. In this same study, adherence to an unhealthy plant-based diet increased the risk of glioma significantly. An unhealthy plant-based diet often includes significant levels “junk foods” that are technically plant foods but are highly processed and lower in fiber and phytochemicals [18].

### Phytochemicals

Phytochemicals constitute a heterogeneous set of bioactive compounds classified by chemical structure and include polyphenols, alkaloids, carotenoids, and nitrogen compounds [19]. These compounds are naturally found in fruits, vegetables, legumes, grains and other plant products and are often responsible for distinct plant characteristics such as color pigmentation and smell [19]. More than 5000 individual phytochemicals have been identified in plant foods [20]. Cancer chemoprevention with phytochemicals tends to interrupt the carcinogenic process, which includes initiation, promotion and progression of otherwise normal cells leading to malignancy [21].

Studies to date have demonstrated that phytochemicals in common fruits and vegetables can have complementary and overlapping mechanisms of action including antioxidant activity and scavenging free radicals; regulation of gene expression in cell proliferation, cell differentiation, oncogenes, and tumor suppressor genes; induction of cell-cycle arrest and apoptosis; modulation of enzyme activities in detoxification, oxidation, and reduction; stimulation of the immune system; regulation of hormone metabolism; and antibacterial and antiviral effects [20-24].

During glioma progression, reactive oxygen species (ROS) are activated and resulting in oxidative stress [25]. A plant-based diet reduces oxidative stress through its rich supply of antioxidants. In particular, phytochemicals are reported to have antioxidant properties [26,27]. The benefits of phytochemicals are additive and synergistic [28,29]. The additive and synergistic effects of phytochemicals in fruit and vegetables are responsible for their potent antioxidant and anticancer activities. The benefit of a diet rich in fruit and vegetables is attributed to the complex mixture of phytochemicals present in whole foods [28,29].

High consumption of phytochemical-rich foods has been found to help to prevent glioma. In one study that looked at phytochemical intake, those with the highest intake had a 57% reduced risk of glioma [30].

### Clinical Considerations

Regular consumption of fruit and vegetables is associated with reduced risks of several cancers, not to mention cardiovascular disease and other aging-related diseases. Convincing evidence shows that increased fruit, vegetables, legumes and grains consumption is a relatively easy and practical strategy to significantly reduce the incidence of certain cancers and many chronic diseases [31-38].

A plant-based diet has the significant advantage of having no contraindications or adverse reactions and is an affordable prophylaxis for all patients over the long-term. When treating a patient with a plant-based diet it is important to titrate relevant medications, for pathologies such as hypertension and type II diabetes in particular, as the effects of the diet become evident.

Patient compliance on plant-based diets has been good in almost all studies. The degree of compliance has often been very high. For instance, one study obtained a 99% compliance [39]. In a 22-week study 94% of subjects on a vegan diet were compliant [40]. In a somewhat longer study, 84% of the participants in each group completed all 24 weeks [41]. In studies of patients placed on plant-based diets for coronary artery disease, high compliance has been noted even over several years. For instance, one study of patients placed on a plant-based diet showed 89% compliance for 3.7 years [42].

### Discussion

There is sufficient evidence to include diet as a risk factor for glioma. Since glioma is very difficult to treat and early detection is unlikely, prevention becomes even more important. The plant-based diet has the advantage of having no adverse reactions or contraindications. While a plant-based diet is usually prescribed for the prevention of more common pathologies, including more common forms of cancer such as colon cancer, it seems that it has prophylactic value for some of the less common pathologies as well.

A plant-based diet, and specifically manufactured plant-based foods, are now considered mainstream and several studies have shown good patient compliance. Increasing numbers of physicians are prescribing a plant-based diet for their patients in order to prevent and treat disease. The prevention of glioma adds yet another pathology to the long list of pathologies that can be prevented with a plant-based diet.

## Conflict of Interest statement

The authors state that they have no conflicts of interest.

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