

# Asthma-Prevention and Treatment with a Plant-Based Diet



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## Abstract

Asthma is the most common chronic disease of childhood. A plant-based diet can reduce the risk of asthma and can also be a step in the stepwise treatment of asthma. There is evidence of the influence of food on asthma treatment outcomes, regardless of allergic status. Levels of inflammation, oxidative stress, and exposure to advanced glycation end products all contribute to the development of an asthmatic response and can be reduced with a plant-based diet. Plant-based diet intervention studies on asthmatic patients have been shown to be effective at reducing symptoms and clinical measures. A plant-based diet should be prescribed for all asthmatic patients. Medications used to treat the asthma patient may need to be titrated down as the treatment effects of a plant-based diet become evident.

**Keywords:** Inflammation; Oxidative stress; Advanced glycation end products; Mediterranean diet; Vegetarian; Vegan

**Abbreviations:** AGE: Advanced Glycation End Products; BMI: Body Mass Index; FEV1: Forced Expiratory Volume in One Second; hs-CRP: High Sensitivity C-Reactive Protein; ROS: Reactive Oxygen Species; T2DM: Type 2 Diabetes Mellitus

## Introduction

Asthma is the most common chronic disease of childhood. The prevalence has been increasing at an alarming rate and has more than doubled in the last decade. Over 9 million children in the United States have been diagnosed with asthma, of whom 75% have active disease [1]. Asthma is based on an aberrant immune response to non pathogenic stimuli in the airways, leading to a chronic inflammatory response relevant to the pathogenesis of the disease. The inflammation affects all compartments of the airways including the upper respiratory tract and the nose, with many cells and cellular elements playing a role, although the major physiological effect comprises the medium-sized bronchi and the small airways.

The chronic inflammation is associated with airway hyperresponsiveness that leads to recurrent episodes of wheezing, breathlessness, chest tightness and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread, but variable, airflow obstruction within the lung that is often reversible either spontaneously or with treatment [2,3]. Several risk factors are associated with asthma morbidity and mortality, such as treatment non-adherence, exposure to environmental triggers, low income households, exposure to chronic stress, child psychological problems, parental stress, family functioning, obesity, physical inactivity, and unhealthy diets. These

risk factors often have complex interactions and interrelationships [4]. Rapid increases in worldwide asthma prevalence in only the past couple decades, especially in westernized countries, signal an important role of the environment factors including diet [5]. A plant-based diet can reduce the risk of asthma and can also be a step in the stepwise treatment of asthma.

## Epidemiology

The Western diet, prevalent in developed countries, is dominated by convenience and highly processed foods, resulting in high intakes of refined grains, processed and red meats, desserts and sweets, fried foods, and high fat dairy products, with low intake of fruits and vegetables [6]. In one study, higher cured meat intake increased the risk of worsening asthma symptoms over time by 76%, through a direct effect and to a lesser extent an effect mediated by BMI [7]. An epidemiological study comparing vegetarian women to nonvegetarian women found that nonvegetarian women had a 24% increased risk of asthma [8]. While a Mediterranean diet is not fully vegetarian, it includes much less meat and dairy, and more fresh fruits and vegetables, than the Western diet.

Several studies have found that the Mediterranean diet had a protective effect against asthma [9-12] and a cross sectional study

showed that high adherence to the Mediterranean diet increases the likelihood of asthma being under control in adults [13].

Type 2 diabetes often presents as a comorbidity of asthma. Longitudinal observational studies have found a risk of between 21% and 37% of the incidence of Type 2 Diabetes Mellitus (T2DM) in adults with self-reported asthma [14-16]. Thomsen et al. observed an almost doubled asthma risk in patients with T2DM compared to individuals without T2DM in a large study among Danish twins [17]. Using administrative data from veterans' hospitals, Hashemzadeh and Movahed [18] found that asthma was present in 4.5% of patients with T2DM vs. 2.9% in the control group, regardless of other comorbid conditions. Those following a plant-based diet have a 78% reduction risk of Type II diabetes mellitus (T2DM) [19].

Obesity alone also has a significant impact on asthma risk, phenotype, and prognosis. Epidemiological studies have clearly demonstrated that asthma is more likely to occur in obese patients, and health status is impaired in obese individuals with asthma, with such asthmatics experiencing more symptoms, worse quality of life, increased healthcare use, and increased asthma severity [20,21]. A healthy body mass index (BMI) range is 18-25kg/m<sup>2</sup>. The average BMI on a typical American Diet is 28.8 kg/m<sup>2</sup>, whereas the average BMI on a vegan diet is 23.6kg/m<sup>2</sup> [22]. Vegans have a 65% decreased risk of being overweight or obese [23].

Vegetarian children also have a lower BMI than their meat-eating counterparts, with the average BMI of a vegetarian child being 17.3kg/m<sup>2</sup> at age 6-11, compared to 18.5kg/m<sup>2</sup> for a non-vegetarian child, and 20.0kg/m<sup>2</sup> at age 12-18, compared to 22.3kg/m<sup>2</sup> for a non-vegetarian child [24]. With the reduced risk of obesity, one would expect the risk of asthma to be reduced for those on a vegetarian diet as well. Indeed, the prevalence of current wheezing was significantly lower in children on a vegetarian diet. The effect was especially strong in girls [25]. One study found that frequent consumption of vegetables and grains, and low consumption of dairy products, is associated with lower plasma levels of IL-17F cytokine and decreased risk of childhood asthma [26].

### Pathophysiology

Although asthma has long been considered a single disease, recent studies have increasingly focused on its heterogeneity [27]. The pathophysiology of asthma is complex, involving various host-environment interactions occurring at various scales, from genes to organs [28]. The characterization of this heterogeneity has led to the concept that asthma consists of various "phenotypes" or consistent groupings of characteristics [27]. These include syndromes characterized by allergen-exacerbated, nonallergic, and aspirin-exacerbated factors, along with syndromes best distinguished by their pathologic findings (eosinophilic, neutrophilic, pauci-granulocytic), response to therapy

(corticosteroid resistant), and natural history (remodeling prone) [29].

A study by Julia et al. has found that the role of diet may be a key factor influencing the development of allergic diseases [30]. There is evidence of the influence of food on asthma treatment outcomes, regardless of allergic status [31]. Dietary factors show the potential of being directly involved in the pathogenesis of asthma [32,33]. Han et al. [26] observed a positive association between consumption of dairy products and pro inflammatory interleukin (IL)-17F concentrations. The mechanisms by which dairy products may influence the development or course of asthma are not clear but may include responses to milk proteins or milk lipids [34].

### Inflammation

Population-based studies showed a correlation between increased levels of serum high sensitivity-CRP (hs-CRP) with a high frequency of airway hyper-responsiveness and low forced expiratory volume in one second (FEV1) among asthmatics without heart disease [35]. One study found that serum concentrations of hs-CRP were significantly increased in asthmatic patients, and in steroid-naïve patients it partly correlated with FEV1 and numbers of sputum eosinophils. This suggests that serum hs-CRP can indirectly indicate the degree of airway inflammation [36].

Another study showed a negative correlation between FEV1 and haptoglobin level in men [38]. This relationship indicates that with increasing severity of disease and further reduction of FEV1, the inflammatory process and its serum markers will increase. A plant-based diet has been shown to reduce markers of inflammation such as hs-CRP. Lower levels of hs-CRP were found in those following a vegetarian diet for more than 2 years [38,39]. An interventional study found that after 8 weeks on a vegan diet, hs-CRP was reduced 32%, even more than the American Heart Association diet [40].

### Oxidative Stress

Studies have indicated that oxidative stress also plays an important role in the development of asthma [41]. Reactive oxygen species (ROS) present in asthmatic airways are derived from many sources, including exposure to environmental oxidants, infiltration of inflammatory cells in the airway, metabolic disorders, and decreased levels of cellular antioxidants. Airway oxidative stress also has been associated with declining disease status, poor lung function, and epigenetic changes [42]. A plant-based diet protects against chronic oxidative-stress-related diseases. Dietary plants contain variable chemical families and amounts of antioxidants. Plant antioxidants may contribute to the beneficial health effects of dietary plant foods [43]. On average plant foods provide 11.57mmol/100gm antioxidant content, while animal foods provide only on average 0.18mmol/100gm [43].

## Advanced Glycation End Products

Dietary advanced glycation end products (AGEs) are highly oxidant, proinflammatory compounds, with highest levels present in cooked meats [44]. AGEs are ligands for the AGE receptor (RAGE), a pattern recognition and danger signal receptor, with highest expression in the lungs, and an important driving force behind downstream Th-2 inflammation [45]. AGEs directly stimulate the inflammatory response of humans' innate immune cells [46].

In one study, higher AGE intake was significantly associated with increased risk of wheezing, wheeze-disrupted sleep and exercise and wheezing requiring prescription medication [47]. AGEs have higher concentration in meat and dairy than in most plant foods, ranging from butter (26,480 units/100gram), chicken broiled, (8,299 units/100gram) and McDonald's Hamburger (5,418 units/100gram) to a veggie burger (Boca Burger, microwaved) having only 67 units/100gram [44,48,49]. Higher intake of meats was associated with wheeze-disrupted sleep (2.32; 95% CI 1.11 to 4.82) and wheezing requiring prescription medication (2.23; 95% CI 1.10 to 4.54 [47].

## Intervention

Several studies have assessed the treatment of asthmatic patients with a plant-based diet. One study with 46 participants, comparing the effects of weight loss achieved by dietary restriction, exercise or a combination on airway inflammation and clinical outcomes in overweight and obese adults with asthma over a 10-week period, found that a reduction of dietary saturated fat intake was associated with a reduction in neutrophilic airway inflammation in asthmatics, compared to those who only exercised [50].

In another study, after 14 weeks, subjects consuming a low-antioxidant diet had a lower percentage predicted forced expiratory volume in 1 second and percentage predicted forced vital capacity than did those consuming the high-antioxidant diet. Subjects in the low-antioxidant diet group had increased plasma C-reactive protein (CRP) at week 14. At the end of the trial, time to exacerbation was greater in the high-antioxidant than in the low-antioxidant diet group, and the low-antioxidant diet group was 2.26 times as likely to have exacerbated symptoms [51].

In a study of 35 asthmatic patients, 20 of whom had been admitted to hospital for acute asthmatic attacks during the past 2 years, and who had suffered from bronchial asthma for an average of 12 years, all receiving long-term medication, were treated with a vegan diet for 1 year. In almost all cases, medication was withdrawn or drastically reduced. There was a significant decrease in asthma symptoms. 71% of patients reported improvement at 4 months and 92% at 1 year. There was a significant improvement in a number of clinical variables including vital capacity, forced expiratory volume at one second, and physical working capacity, as well as a significant change in various biochemical indices as

haptoglobin, IgM, IgE, sed rate (ESR), cholesterol, and triglycerides in blood [52]. These studies show that a plant-based diet may be an efficacious treatment or adjunct treatment for asthma.

## Clinical Considerations

Asthma is a chronic disease requiring ongoing and comprehensive treatment aimed at reducing the symptom burden (i.e. good symptom control while maintaining normal activity levels), and minimizing the risk of adverse events such as exacerbation of symptoms, fixed airflow limitation and treatment side effects [2, 53]. Asthma treatment is based on a stepwise approach. The management of the patient is control-based; that is, it involves an iterative cycle of assessment (symptoms, risk factors, etc.), adjustment of treatment (i.e. pharmacological, non-pharmacological and treatment of modifiable risk factors) and review of the response (symptoms, side effects, exacerbations, etc.) [53].

Pharmacologic treatment with beta-agonists for intermittent asthma and inhaled corticosteroids and a combination of inhaled corticosteroids and long-acting beta-2 agonists for persistent asthma are recommended. Additional and alternative treatments with leukotriene modifiers, anticholinergics, biologics, and bronchial thermoplasty are also available [54]. A plant-based diet should be prescribed for all asthma patients. Medications used to treat the asthma patient may need to be titrated down as the treatment effects of a plant-based diet become evident. When treating patients with common comorbidities such as type II diabetes or coronary artery disease, medications specifically for these conditions will also need to be titrated as the treatment effects on these comorbidities become evident. For instance, plant-based diet is more efficacious in treating type 2 diabetes and as efficacious as Lovastatin in treating hypercholesterolemia [19, 55].

## Discussion

Asthma is a chronic disease and has an effect on quality of life for the patient. The cost of treatment can be considerable, especially over time and for the uninsured or under-insured. Treating the patient with a plant-based diet can reduce symptoms, the need for medication and, for adult patients, prevent and treat common comorbidities. While medication will always have its place, a plant-based diet can be a valuable adjunct to standard care or, in some cases, a monotherapy. This is especially the case considering that it has no adverse reactions or contraindications. Vegetarian and vegan diets are no longer out of the mainstream of awareness, as was the case many years ago, and a plant-based diet cost no more than a meat-centered one. It can therefore be offered as a treatment to all patients.

One weakness of this review is that many studies do not differentiate between different phenotypes of asthma. Therefore, we cannot tell if a plant-based diet is a more efficacious in preventing or treating some phenotypes than others.

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