



## Dietary approaches to stop hypertension (DASH): Mechanisms, benefits, and clinical applications

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### Abstract

Hypertension is one of the leading global public health concerns and a major risk factor for cardiovascular disease, stroke, chronic kidney disease, and premature mortality. Lifestyle and dietary interventions are considered fundamental approaches for the prevention and management of elevated blood pressure. The Dietary Approaches to Stop Hypertension (DASH) diet is an evidence-based dietary pattern developed to reduce blood pressure and improve overall cardiovascular health. The DASH diet emphasizes the consumption of fruits, vegetables, whole grains, low-fat dairy products, lean proteins, nuts, and legumes while limiting sodium, saturated fats, refined sugars, and processed foods. Numerous clinical trials and epidemiological studies have demonstrated that adherence to the DASH dietary pattern significantly lowers systolic and diastolic blood pressure in hypertensive and normotensive individuals. The beneficial effects of the DASH diet are mediated through multiple mechanisms including improved electrolyte balance, enhanced endothelial function, reduced oxidative stress, anti-inflammatory actions, weight management, and modulation of the renin-angiotensin-aldosterone system. Beyond blood pressure control, DASH has shown positive effects on lipid profiles, insulin sensitivity, obesity, metabolic syndrome, and chronic kidney disease. This review discusses the principles, physiological mechanisms, health benefits, and clinical applications of the DASH diet, highlighting its role as a cornerstone nutritional strategy for hypertension management and chronic disease prevention.

**Keywords:** DASH Diet, hypertension, cardiovascular disease, sodium restriction, dietary intervention, blood pressure, nutrition therapy

### Introduction

Hypertension is a chronic medical condition characterized by persistently elevated arterial blood pressure and is recognized as a major contributor to cardiovascular morbidity and mortality worldwide (Mancia *et al.*, 2023) [31]. According to the World Health Organization (WHO, 2023) [31], hypertension affects more than one billion people globally and is responsible for millions of deaths annually due to heart disease, stroke, and kidney disorders. Sedentary lifestyle, obesity, excessive sodium intake, stress, alcohol consumption, and unhealthy dietary patterns are among the primary modifiable risk factors associated with hypertension (Fuchs & Whelton, 2020) [11].

Nutritional therapy has become an essential component in the prevention and treatment of hypertension (Appel *et al.*, 2006) [2]. Among the dietary interventions available, the Dietary Approaches to Stop Hypertension (DASH) diet has gained substantial scientific recognition due to its proven effectiveness in reducing blood pressure and improving cardiometabolic health (Appel *et al.*, 1997; Filippou *et al.*, 2020) [3, 9]. The DASH eating plan was originally developed through research funded by the National Institutes of Health to investigate the influence of dietary patterns on blood pressure control (Sacks *et al.*, 2001) [24].

The DASH diet encourages increased intake of nutrient-rich foods such as fruits, vegetables, whole grains, low-fat dairy products, fish, poultry, nuts, and legumes while limiting sodium, red meat, sweets, sugar-sweetened beverages, and foods high in saturated fat (National Heart, Lung, and Blood Institute [NHLBI], 2006) [21]. The diet is naturally rich in

potassium, magnesium, calcium, dietary fibre, antioxidants, and phytochemicals, which collectively contribute to blood pressure regulation and vascular health (Houston, 2011) [14]. This review aims to discuss the composition of the DASH diet, underlying physiological mechanisms, health benefits, clinical applications, and future perspectives regarding its use in hypertension and chronic disease management.

### Overview of the DASH Diet

#### 1. Historical Background

The DASH diet was developed in the 1990s following clinical investigations into dietary patterns capable of reducing blood pressure without pharmacological intervention (Appel *et al.*, 1997) [3]. Initial DASH trials demonstrated remarkable reductions in systolic and diastolic blood pressure among participants consuming diets rich in fruits, vegetables, and low-fat dairy products (Appel *et al.*, 1997; Sacks *et al.*, 2001) [3, 24].

#### 2. Core Principles of the DASH Diet

The Dietary Approaches to Stop Hypertension (DASH) diet is based on a balanced and nutrient-dense eating pattern designed to promote cardiovascular health and reduce blood pressure (Appel *et al.*, 1997) [3]. The diet emphasizes a high intake of fruits and vegetables, which provide essential vitamins, minerals, antioxidants, and dietary fibre that support vascular function and overall health (Houston, 2011) [14]. It also encourages the consumption of whole grains as a source of complex carbohydrates and fibre, along with low-fat dairy products that supply calcium and protein

with minimal saturated fat (National Heart, Lung, and Blood Institute [NHLBI], 2006) <sup>[21]</sup>.

Moderate amounts of lean meats, fish, and poultry are included to ensure adequate protein intake while limiting unhealthy fats. Additionally, the DASH diet promotes the regular consumption of nuts, seeds, and legumes, which are rich in healthy fats, plant proteins, magnesium, and potassium (Filippou *et al.*, 2020) <sup>[9]</sup>. A key component of the DASH dietary pattern is the reduction of sodium intake to help control blood pressure and minimize fluid retention (Sacks *et al.*, 2001) <sup>[24]</sup>. The diet *also* restricts saturated fats, cholesterol, refined sugars, and processed foods, which are commonly associated with obesity, cardiovascular disease, and metabolic disorders (Fuchs & Whelton, 2020) <sup>[11]</sup>. Overall, the DASH diet provides a scientifically supported nutritional approach for maintaining heart health and preventing hypertension (Appel *et al.*, 2006) <sup>[2]</sup>.

### 3. Nutritional Composition

The DASH diet is nutritionally balanced and specifically designed to support cardiovascular health and blood pressure regulation through the inclusion of essential nutrients and the limitation of harmful dietary components. It is characterized by a high potassium content derived from fruits, vegetables, legumes, and whole grains, which helps counteract the adverse effects of sodium and promotes healthy vascular function (Siervo *et al.*, 2015) <sup>[27]</sup>. The diet *also* provides adequate amounts of calcium and magnesium through low-fat dairy products, nuts, seeds, and green leafy vegetables, contributing to proper muscle contraction, nerve function, and blood vessel relaxation. Increased dietary fibre from whole grains, fruits, vegetables, and legumes improves digestion, enhances satiety, supports weight management, and reduces cholesterol levels. In addition, the DASH diet contains reduced amounts of saturated fat and cholesterol by limiting fatty meats, full-fat dairy products, fried foods, and processed items, thereby lowering the risk of cardiovascular disease (Awuchi *et al.*, 2020) <sup>[6]</sup>. Moderate protein intake is achieved through lean sources such as fish, poultry, legumes, and nuts, ensuring balanced nutrition without excessive fat consumption. Another important feature of the DASH diet is controlled sodium levels, which help prevent fluid retention and maintain healthy blood pressure. Collectively, these nutritional characteristics make the DASH diet an effective dietary strategy for hypertension prevention and overall metabolic health (Akhlaghi, 2020) <sup>[1]</sup>.

#### Mechanisms of DASH Diet in Blood Pressure Reduction

##### 1. Sodium Reduction and Fluid Balance

One of the most important mechanisms of the DASH diet is sodium restriction. Excess sodium intake promotes water retention, increases plasma volume, and elevates blood pressure. Reduced sodium intake decreases extracellular fluid volume and lowers vascular resistance (Filippou *et al.*, 2022) <sup>[10]</sup>.

##### 2. Potassium-Mediated Blood Pressure Regulation

Potassium plays a critical role in balancing sodium levels and relaxing blood vessel walls. High potassium intake promotes natriuresis and improves vascular smooth muscle function, thereby lowering blood pressure (Arifaj, 2024) <sup>[4]</sup>.

##### 3. Magnesium and Vascular Relaxation

Magnesium contributes to vasodilation by regulating calcium transport in vascular smooth muscles. Adequate

magnesium intake improves endothelial function and reduces peripheral vascular resistance (Kostov and Halacheva, 2018) <sup>[16]</sup>.

### 4. Calcium and Cardiovascular Function

Calcium helps maintain proper vascular contraction and relaxation. Low-fat dairy products in the DASH diet provide bioavailable calcium that supports blood pressure control (Mallick *et al.*, 2026) <sup>[18]</sup>.

### 5. Antioxidant and Anti-Inflammatory Effects

Fruits and vegetables in the DASH diet contain antioxidants such as vitamin C, carotenoids, flavonoids, and polyphenols. These compounds reduce oxidative stress and inflammation associated with endothelial dysfunction and hypertension (Bas, 2026) <sup>[8]</sup>.

### 6. Improvement in Endothelial Function

The DASH diet improves nitric oxide bioavailability and endothelial-dependent vasodilation, leading to enhanced arterial flexibility and reduced vascular stiffness (Kakkar *et al.*, 2026) <sup>[15]</sup>.

### 7. Weight Management and Insulin Sensitivity

The DASH diet is rich in fibre and low in energy-dense processed foods, which supports satiety and weight management. Weight reduction improves insulin sensitivity and decreases sympathetic nervous system activity, contributing to blood pressure reduction (Mishra, 2026).

#### Health Benefits of the DASH Diet

##### 1. Reduction in Blood Pressure

Numerous randomized controlled trials have confirmed that the DASH diet significantly reduces systolic and diastolic blood pressure in both hypertensive and normotensive individuals (Zhao *et al.*, 2026) <sup>[33]</sup>.

##### 2. Cardiovascular Disease Prevention

The DASH diet lowers the risk of coronary artery disease, stroke, heart failure, and atherosclerosis by improving lipid profiles and vascular function (Sahebkar *et al.*, 2025) <sup>[25]</sup>.

##### 3. Improvement in Lipid Profile

Adherence to the DASH diet has been strongly associated with significant improvements in lipid profile and overall cardiovascular health. The diet promotes reduced levels of low-density lipoprotein (LDL) cholesterol, commonly known as “bad cholesterol,” by limiting saturated fats, trans fats, and cholesterol-rich processed foods while encouraging the intake of fibre-rich fruits, vegetables, and whole grains (Parihar *et al.*, 2016) <sup>[23]</sup>. Increased dietary fibre helps reduce cholesterol absorption in the intestine and supports healthier blood lipid metabolism. The DASH diet has also been shown to lower triglyceride levels, which are often elevated in individuals with obesity, diabetes, and metabolic syndrome. In addition, the inclusion of healthy fats from nuts, seeds, legumes, and fish may contribute to increased levels of high-density lipoprotein (HDL) cholesterol, or “good cholesterol,” which plays a protective role by removing excess cholesterol from the bloodstream. Furthermore, the combined effect of reduced saturated fat intake, improved nutrient quality, and better weight management contributes to a reduction in total cholesterol levels. These beneficial effects on lipid parameters help

decrease the risk of atherosclerosis, coronary artery disease, stroke, and other cardiovascular complications (Shoaibinobarian *et al.*, 2023) <sup>[26]</sup>.

#### 4. Obesity and Weight Control

The high-fibre and nutrient-dense nature of the DASH diet promotes healthy body weight and reduces obesity-related complications. By prioritizing whole grains, fruits, vegetables, and legumes, the DASH eating pattern naturally increases dietary fibre intake, which enhances satiety, delays gastric emptying, and helps regulate overall caloric intake (Badali *et al.*, 2023). Robust clinical evidence demonstrates that individuals adhering to the DASH framework experience significant reductions in body weight, body mass index (BMI), and waist circumference—particularly when the pattern is paired with moderate energy restriction. Furthermore, managing weight through this dietary approach directly mitigates obesity-related comorbidities by lowering visceral adiposity, improving insulin sensitivity, and reducing markers of systemic inflammation.

#### 5. Diabetes and Insulin Resistance

The Dietary Approaches to Stop Hypertension (DASH) diet has been shown to improve glycemic control and enhance insulin sensitivity, making it a valuable dietary strategy for individuals with type 2 diabetes mellitus and insulin resistance. The diet emphasizes the consumption of whole grains, fruits, vegetables, legumes, low-fat dairy products, lean proteins, and nuts, all of which provide dietary fibre, antioxidants, vitamins, and minerals that help regulate blood glucose levels. The high fibre content slows carbohydrate absorption, reducing postprandial blood sugar spikes and improving overall glucose metabolism. Additionally, the DASH diet is low in saturated fat and added sugars, which contributes to better insulin function and reduced inflammation. Several clinical studies have demonstrated that adherence to the DASH diet can lower fasting blood glucose, glycated hemoglobin (HbA1c), and insulin resistance markers. Furthermore, the diet supports healthy weight management and cardiovascular health, both of which are important for preventing complications associated with diabetes and metabolic syndrome. Consequently, the DASH diet is increasingly recommended as an effective nutritional intervention for improving metabolic health and reducing the risk of diabetes-related complications (Hinderliter *et al.*, 2011) <sup>[13]</sup>.

#### 6. Chronic Kidney Disease Prevention

The DASH diet plays an important role in the prevention and management of chronic kidney disease (CKD) by promoting healthy blood pressure levels and reducing excessive sodium intake. Hypertension is one of the leading causes of kidney damage, and the DASH diet's emphasis on fruits, vegetables, whole grains, and low-fat dairy products helps lower blood pressure and decrease the burden on the kidneys. The diet *also* provides essential nutrients such as potassium, magnesium, and calcium, which support vascular health and improve kidney function. By limiting processed foods and sodium-rich products, the DASH diet reduces fluid retention and minimizes stress on the renal system. Studies have shown that individuals who follow the DASH dietary pattern have a lower risk of developing CKD and may experience a slower progression of existing kidney disease. Therefore, the DASH diet is considered an effective

nutritional approach for maintaining kidney health and reducing the risk of long-term renal complications (Song *et al.*, 2021) <sup>[28]</sup>.

#### 7. Mental Health Benefits

Emerging research indicates that the DASH diet may contribute positively to mental health by reducing inflammation and oxidative stress, two factors closely associated with depression, anxiety, and cognitive decline. The diet is rich in antioxidants, vitamins, minerals, and phytochemicals derived from fruits, vegetables, nuts, and whole grains, which help protect brain cells from oxidative damage. Nutrients such as magnesium, folate, and omega-3 fatty acids support neurotransmitter function and promote healthy brain activity. Additionally, the DASH diet improves cardiovascular health and blood circulation, ensuring adequate oxygen and nutrient delivery to the brain. Several observational studies have linked adherence to the DASH diet with a lower risk of depressive symptoms, better cognitive performance, and a reduced likelihood of developing neurodegenerative disorders. As a result, the DASH diet is increasingly recognized not only for its physical health benefits but also for its potential role in supporting psychological well-being and cognitive health (Tan *et al.*, 2024) <sup>[29]</sup>.

### Clinical Applications of the DASH Diet

#### 1. Management of Hypertension

The DASH diet is widely recognized as one of the most effective non-pharmacological strategies for the prevention and management of hypertension. It is recommended as first-line nutritional therapy by several international health organizations because of its proven ability to significantly reduce systolic and diastolic blood pressure. The diet works by lowering sodium intake while increasing the consumption of potassium, calcium, magnesium, and dietary fibre, all of which contribute to improved vascular function and blood pressure regulation. In individuals with mild hypertension, the DASH diet *alone* may effectively control blood pressure without the immediate need for medication. In cases of moderate or severe hypertension, the diet is commonly used alongside antihypertensive drugs to enhance therapeutic outcomes and reduce cardiovascular risk. Regular adherence to the DASH dietary pattern also supports weight management, improves endothelial function, and decreases inflammation, further contributing to long-term blood pressure control and heart health (Onwuzo *et al.*, 2023) <sup>[31]</sup>.

#### 2. DASH Diet in Elderly Population

The DASH diet provides substantial health benefits for the elderly population by supporting cardiovascular health, preserving kidney function, and improving overall nutritional status. Aging is associated with increased arterial stiffness, elevated blood pressure, and a higher risk of chronic diseases such as heart disease, stroke, and renal dysfunction. The nutrient-rich composition of the DASH diet, including fruits, vegetables, whole grains, and low-fat dairy products, supplies essential vitamins, minerals, antioxidants, and fibre that help reduce oxidative stress and vascular damage. Adequate intake of potassium, magnesium, and calcium contributes to better blood pressure regulation and improved vascular relaxation in older adults. Additionally, the reduced sodium and saturated

fat content of the diet lowers cardiovascular risk and supports healthy cholesterol levels. The DASH diet *also* promotes healthy body weight and may improve metabolic health, thereby enhancing quality of life and reducing disease-related complications among elderly individuals (Xiao *et al.*, 2020) <sup>[32]</sup>.

**3. DASH Diet in Pediatric Hypertension**

Pediatric hypertension has become an increasing public health concern due to rising rates of childhood obesity, sedentary lifestyles, and unhealthy eating habits. The DASH diet offers a balanced and nutritious dietary approach that supports healthy growth and development while helping to reduce elevated blood pressure in children and adolescents. The diet encourages the intake of nutrient-dense foods such as fruits, vegetables, whole grains, lean proteins, and low-fat dairy products, which provide essential nutrients required for proper physical and cognitive development. At the same time, the reduction of sodium, sugary beverages, processed foods, and unhealthy fats helps minimize cardiovascular risk factors from an early age. Studies have shown that children following a DASH-style eating pattern experience improvements in blood pressure, body weight, and overall cardiometabolic health. Early adoption of healthy dietary habits through the DASH diet may also reduce the future risk of hypertension, obesity, diabetes, and cardiovascular diseases in adulthood (Asghari *et al.*, 2016) <sup>[5]</sup>.

**4. DASH Diet During Pregnancy**

The DASH diet may play an important role in promoting maternal health and reducing complications during pregnancy, particularly gestational hypertension and preeclampsia. Pregnancy increases nutritional demands, and balanced intake of essential nutrients is necessary for both maternal well-being and fetal development. The DASH diet provides adequate amounts of vitamins, minerals, fibre, and high-quality proteins through fruits, vegetables, whole grains, low-fat dairy products, and lean protein sources. Its emphasis on controlled sodium intake helps prevent excessive fluid retention and supports healthy blood pressure levels during pregnancy. Additionally, nutrients such as potassium, calcium, and magnesium contribute to vascular relaxation and improved cardiovascular function, which may lower the risk of hypertensive disorders. The DASH dietary pattern may also help maintain appropriate

gestational weight gain and improve metabolic health, thereby supporting a healthier pregnancy outcome for both mother and child (Wiertsema *et al.*, 2011) <sup>[14]</sup>.

**5. DASH Diet and Metabolic Syndrome**

The DASH diet is highly effective in managing metabolic syndrome, a cluster of conditions that includes hypertension, abdominal obesity, dyslipidemia, insulin resistance, and elevated blood glucose levels. The diet emphasizes nutrient-rich and low-energy-density foods that support healthy body weight and improve metabolic function. High dietary fibre intake from fruits, vegetables, whole grains, and legumes enhances satiety, improves glucose metabolism, and reduces cholesterol absorption. In addition, the diet’s low saturated fat and reduced sodium content contribute to improved blood pressure and lipid profiles. The inclusion of healthy fats, lean proteins, and antioxidant-rich foods further helps reduce inflammation and oxidative stress associated with metabolic syndrome. Clinical studies have demonstrated that adherence to the DASH diet can improve insulin sensitivity, lower triglyceride levels, reduce waist circumference, and decrease cardiovascular risk, making it a valuable dietary strategy for the prevention and management of metabolic disorders (Ghorabi *et al.*, 2019) <sup>[12]</sup>.

**6. DASH Diet in Chronic Disease Prevention**

Long-term adherence to the DASH diet contributes significantly to the prevention of various chronic diseases by promoting overall cardiovascular and metabolic health. The diet’s emphasis on fruits, vegetables, whole grains, low-fat dairy products, and lean proteins provides essential nutrients, antioxidants, and phytochemicals that protect against oxidative stress and chronic inflammation. By reducing sodium, saturated fats, and processed foods, the DASH diet lowers the risk of hypertension, atherosclerosis, coronary artery disease, stroke, and kidney disorders. Furthermore, its beneficial effects on body weight, insulin sensitivity, and lipid metabolism help reduce the likelihood of obesity and type 2 diabetes. The high fibre content of the diet *also* supports digestive health and may contribute to reduced risk of certain cancers. As a sustainable and balanced dietary pattern, the DASH diet represents an effective nutritional approach for improving longevity, enhancing quality of life, and reducing the global burden of chronic non-communicable diseases (Lari *et al.*, 2021) <sup>[17]</sup>.

**Table 1:** Comparison of DASH Diet with Other Dietary Approaches

| Dietary Pattern       | Main Features                                      | Effect on Hypertension               |
|-----------------------|----------------------------------------------------|--------------------------------------|
| DASH Diet             | High fruits, vegetables, low-fat dairy, low sodium | Strong evidence for BP reduction     |
| Mediterranean Diet    | Olive oil, fish, nuts, whole grains                | Moderate BP reduction                |
| Low-Carbohydrate Diet | Reduced carbohydrate intake                        | Variable effects                     |
| Vegetarian Diet       | Plant-based foods                                  | Beneficial for cardiovascular health |
| Ketogenic Diet        | High fat, low carbohydrate                         | Short-term weight loss benefits      |

**Future Perspectives**

Future research on the DASH diet should focus on expanding its applications through personalized and technology-driven nutritional approaches. Personalized DASH-based nutrition therapy may help tailor dietary recommendations according to an individual’s genetic profile, metabolic status, age, lifestyle, and disease condition, thereby improving adherence and therapeutic outcomes. The integration of digital health technologies such as mobile health applications, wearable devices,

telehealth platforms, and artificial intelligence-based dietary monitoring systems could enhance patient education, dietary tracking, and long-term compliance with the DASH eating plan. In addition, growing interest in the relationship between diet and the gut microbiome suggests that future studies should investigate how the DASH diet influences gut microbial composition and its subsequent effects on blood pressure regulation, inflammation, metabolism, and immune function. Long-term population-based intervention studies are also necessary to evaluate the sustainability,

effectiveness, and public health impact of the DASH diet across diverse populations and cultural settings. Furthermore, the application of the DASH dietary pattern in precision nutrition and chronic disease prevention may provide innovative strategies for reducing the burden of hypertension, cardiovascular disease, diabetes, obesity, and metabolic disorders at both individual and community levels.

## Conclusion

The Dietary Approaches to Stop Hypertension (DASH) diet represents one of the most effective evidence-based nutritional strategies for hypertension prevention and management. Through multiple physiological mechanisms including sodium reduction, improved electrolyte balance, enhanced endothelial function, antioxidant activity, and weight management, the DASH diet significantly lowers blood pressure and reduces cardiovascular risk. In addition to hypertension control, the DASH diet offers substantial benefits in obesity, diabetes, metabolic syndrome, kidney disease, and overall cardiovascular health. Despite challenges related to adherence and accessibility, the DASH dietary pattern remains a cornerstone of clinical nutrition and preventive healthcare. Broader public health initiatives and individualized nutrition counseling may further enhance its effectiveness and long-term adoption.

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