



A NEW LOOK AT DIETARY PATTERNS AND HYPERTENSION

SUMMARY

An estimated 50 million American adults have hypertension (high blood pressure), a risk factor for cardiovascular disease, stroke, and kidney disease. Lifestyle approaches to prevent or treat hypertension include dietary changes, losing weight if overweight, stopping smoking, limiting alcohol intake, and increasing physical activity. Traditionally, dietary changes have focused on single nutrients, such as limiting salt/sodium intake.

Almost 20 years ago, researchers reported that changes in the overall dietary pattern to include more dairy foods, fruits and vegetables could lower blood pressure. Support for this strategy has recently been provided by a large-scale study in the U.S. called DASH (Dietary Approaches to Stop Hypertension). This government-sponsored multicenter study involved over 450 adults randomly assigned to one of three dietary regimens for eight weeks. Findings revealed that consuming a low fat diet rich in lowfat

dairy foods, fruits, and vegetables (i.e., the so-called DASH diet) reduced blood pressure. Although a diet rich in fruits and vegetables also lowered blood pressure, it was less effective than the DASH combination diet containing dairy foods.

The blood pressure-lowering effect of the DASH diet was particularly beneficial for hypertensives and African Americans who are at high risk for hypertension. The DASH diet has also been found to lower blood homocysteine levels. High blood levels of this amino acid are associated with increased risk of cardiovascular disease.

A follow-up study, called the DASH-Sodium trial, has confirmed the blood pressure-lowering effect of the DASH diet. Reducing sodium intake in combination with the DASH diet lowered blood pressure even further. According to the researchers, consuming the DASH diet along with restricting sodium intake to about 1.5 g/day (i.e., a level below the current recommendation of 2.4 g/day) is an effective strategy to reduce blood pressure. However, they acknowledge that the long-term health benefits of this dietary pattern, as well as various practical considerations, such as people's willingness to consistently choose lower-sodium foods, are unknown.

The DASH diet is high in nutrients such as calcium, potassium, and magnesium. Studies have demonstrated that these nutrients, which are found in dairy foods, reduce blood pressure. In fact, there is compelling agreement in the scientific literature to support recommended intakes of calcium (1,000 to 1,500 mg/day) from foods such as dairy foods to reduce blood pressure and the risk for hypertension.

Since the first DASH trial was published in 1997, support for the DASH dietary pattern by a variety of health professional groups, such as the American Heart Association, has continued to grow. Today, the strategy of choice to prevent and treat hypertension is not just dietary restrictions, but more importantly, consumption of foods such as lowfat dairy foods, fruits, and vegetables. **D**



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INTRODUCTION

Hypertension is defined as a blood pressure equal to or greater than 140 mm mercury (Hg) systolic (contracting) and/or 90 mm Hg diastolic (resting) and/or taking antihypertensive medication (1). An estimated 50 million American adults — or about one-in-four — have high blood pressure (2). If uncontrolled, hypertension can lead to coronary heart disease, stroke, cardiac failure, or kidney failure (1).

Researchers estimate that small decreases in blood pressure can substantially reduce the prevalence of hypertension, heart disease, and stroke (3,4). Considering the high prevalence of hypertension and its adverse health and economic consequences, prevention of this disease is a public health priority. One of the goals of the U.S. Department of Health and Human Services' *Healthy People 2010* is to reduce the proportion of adults with high blood pressure from 28% to 16% (5). Although pharmacological treatment for hypertension can significantly reduce morbidity and mortality, it also can have undesirable side effects and be expensive. For these reasons, attention has focused on lifestyle modifications, including dietary changes, weight reduction if overweight, increased physical activity, cessation of smoking, and limitation of alcohol intake to control blood pressure (1). A recent three-year trial of over 1,000 overweight adults with high-normal blood pressure found that modest weight loss (i.e., about 10 pounds) resulted in substantial reductions in blood pressure and in the incidence of hypertension (6).

Two recent U.S. government-sponsored dietary trials, called Dietary Approaches to Stop Hypertension (DASH), demonstrate that a dietary pattern rich in lowfat dairy products, fruits, and vegetables is effective in lowering blood pressure (7,8). This total dietary pattern approach to blood pressure control actually was predicted nearly 20 years ago (9,10). This *Digest* reviews findings from the DASH trials, how food nutrients contribute to the blood pressure-lowering effect of the DASH diet, and support in the health professional community for this dietary approach to lower the risk for hypertension.



The DASH (Dietary Approaches to Stop Hypertension) study was the first large-scale trial in the U.S. to examine the effect of specific dietary patterns including readily available foods on blood pressure.

DIETARY APPROACHES TO STOP HYPERTENSION (DASH) TRIALS

The DASH Trial. The first multicenter DASH trial sponsored by the National Heart, Lung, and Blood Institute (NHLBI) was published in 1997 (7). In this trial, 459 adults with a systolic blood pressure of less than 160 mm Hg and diastolic pressure of 80-95 mm Hg were randomly assigned to one of the following three dietary plans for eight weeks: a control diet typical of what most Americans eat (i.e., low in fruits, vegetables, and dairy products and containing 36% of calories from fat); a diet similar to what Americans consume but higher in fruits and vegetables; or a combination diet high in lowfat dairy foods, fruits and vegetables, and reduced in total fat (26% of calories), saturated fat and cholesterol (i.e., the so-called DASH diet) (7). The DASH combination diet also includes whole grains, poultry, fish, and nuts and only small amounts of red meat, sweets, and sugar-containing beverages (7). Sodium intake (approximately 3 g/day), body weight, and physical activity remained constant throughout the study. An in-depth description of the DASH feeding trial can be found in a supplement to the *Journal of the American Dietetic Association* (11).

At the end of the eight weeks, the DASH combination diet, which included lowfat dairy foods, fruits and vegetables, produced the largest reductions in blood pressure (7). Overall, this diet reduced systolic blood pressure by 5.5 mm Hg and diastolic blood pressure by 3.0 mm Hg compared to the control diet. The fruits and vegetables diet also reduced systolic blood pressure (by 2.8 mm Hg) and diastolic blood pressure (by 1.1 mm Hg), although by a lesser amount than that achieved with the combination diet (7). Participants following the combination diet (at the 2,000 calorie level) consumed almost three servings of dairy foods a day and 8 to 10 servings/day of fruits and vegetables.

The reduction in blood pressure on the DASH combination diet occurred quickly (i.e., within two weeks), remained lower as long as the participants stayed on the diet, and rivaled that achieved with antihypertensive medications (7).

The potential savings in healthcare costs attributed to the DASH diet can be expected to be substantial considering that 70% of subjects with high blood pressure responded to the DASH diet such that they no longer needed pharmacological management of their hypertension (12). Also, over 78% of the cases of systolic hypertension were eliminated by the DASH diet (12). Researchers estimate that if Americans eating a typical Western diet adopt the DASH dietary pattern, heart disease could be reduced by 15% and stroke by 27% (7).

The DASH-Sodium Trial. To answer questions raised by the DASH trial (7), a follow-up multicenter, randomized controlled trial of 412 adults with high or normal blood pressure was initiated (8). The participants, more than half of whom were women and more than half of whom were African American, were randomly assigned to either a typical American diet (control) or the DASH diet. Within each of these diets, participants ate foods with high (~3.3 g), intermediate (~2.4 g), or low (~1.5 g) sodium for 30 days each in random order.

The DASH diet significantly lowered systolic blood pressure regardless of the level of sodium consumed (8). This finding confirms and extends the findings of the previous DASH trial that demonstrated that the first step in blood pressure control is improving the overall diet by increasing intake of lowfat dairy foods, fruits, and vegetables (8). With both the control and the DASH diet, reducing sodium intake lowered blood pressure in a step-wise fashion (8). The DASH diet at the highest sodium level reduced systolic blood pressure by 5.9 mm Hg compared to the control diet at the same sodium level. For participants consuming the DASH diet, reducing sodium intake to the intermediate level lowered systolic blood pressure by an additional 1.3 mm Hg, and reducing sodium to the lowest level resulted in an additional 1.7 mm Hg drop in systolic blood pressure (8). Compared to the high sodium control diet, the low sodium DASH diet led to greater reductions in systolic and diastolic blood pressure than either the DASH diet alone or low sodium alone (8). However, the effect was not strictly additive.

The DASH eating pattern, which is rich in lowfat dairy foods, fruits, and vegetables, substantially lowers blood pressure without weight loss or reduced sodium intake. A combination of the DASH diet and sodium reduction can lower blood pressure even further.

The greatest reduction in blood pressure, which was found with the DASH diet at the lowest sodium intake compared to the control diet at high sodium intake, was similar to that achieved with blood pressure-lowering drugs (4,8).

The findings of the DASH-Sodium trial support intake of the DASH diet in combination with reduced dietary sodium to prevent and treat hypertension (8). However, the researchers acknowledge that the long-term health benefits of this dietary pattern have yet to be demonstrated and will depend on people's willingness to consistently choose lower-sodium foods and the food industry's commitment to increase the availability of lower-sodium foods (8). One author (4) states that reducing sodium intake below the currently recommended level (2.4 g/day) (13) will require "aggressive action by the government in terms of legislation or labeling requirements." A so-called Premier Study, a behavioral intervention trial, is currently underway to investigate the ability of free-living adults to adopt and maintain the DASH combination diet with other effective lifestyle interventions (e.g., weight loss, sodium reduction, increased physical activity, limited alcohol intake) (14).

Who Benefits From the DASH Dietary Pattern? All participants in the DASH trials experienced a reduction in blood pressure leading the researchers to suggest that the findings from these trials could apply to most people in the U.S. (7,8). However, the blood pressure-lowering effect of the DASH dietary pattern was greater for some population groups than for others (7,8).

The DASH diet lowered blood pressure more in persons with hypertension than in those without hypertension (7,8,15). In subjects without hypertension, the DASH combination diet lowered systolic and diastolic blood pressures by 3.5 mm Hg and 2.1 mm Hg, respectively, compared to the control diet (7). However, in hypertensive subjects, systolic and diastolic blood pressures were reduced by 11.4 mm Hg and 5.5 mm Hg, respectively, compared to the control diet (7). A recent subgroup analysis of 133 hypertensive participants in the DASH trial supports the benefits of this

THE DASH DIFFERENCE

The overall pattern differs from the typical American diet in several key ways. The DASH diet is rich in fruits, vegetables, and low-fat dairy products, and is low in saturated fat, total fat, and sodium. The typical American diet is high in saturated fat, total fat, and sodium, and is low in fruits, vegetables, and low-fat dairy products.

The DASH Eating Style	Typical American Diet	Key Differences
Fruit and Veg	~1 cup	+1 cup
Lowfat Dairy	~1 cup	+1 cup
Whole Grains	~1/2 cup	+1/2 cup
Protein	~1/2 cup	+1/2 cup
Sodium	~3,300 mg	-1,800 mg
Saturated Fat	~60g	-20g
Total Fat	~100g	-30g

10 Ways to DASH Up Your Diet:

1. **Get More Dairy:** Choose lowfat dairy products like milk, yogurt, and cheese.
2. **Fill Up on Fruit:** Eat a variety of fruits, including apples, oranges, and berries.
3. **Swap Some Meat:** Choose lean meats like turkey, chicken, and fish.
4. **Take it with Salt:** Use herbs and spices to flavor your food instead of salt.
5. **Get More Whole Grains:** Choose whole grain bread, pasta, and rice.
6. **Choose a Healthier Protein:** Choose lean meats, fish, and plant-based proteins like beans and tofu.
7. **Shake up Your Fat:** Choose healthy fats like olive oil, canola oil, and nuts.
8. **Limit Alcohol:** Drink alcohol in moderation.
9. **Get Moving:** Exercise regularly to help lower blood pressure.
10. **Don't Smoke:** Quitting smoking can help lower blood pressure.

dietary pattern for individuals with hypertension (12). The effectiveness of the DASH eating pattern for hypertensives was also observed in the DASH-Sodium trial (8). Compared to the control diet with a high sodium level, the DASH diet with a low sodium level decreased systolic blood pressure by 7.1 mm Hg in nonhypertensive participants, whereas systolic blood pressure was reduced by 11.5 mm Hg in participants with hypertension (8).

The DASH dietary pattern is particularly effective for minorities such as African Americans who are at higher risk of developing hypertension and its complications than are their white counterparts (8,15-18). According to a recent subgroup analysis of the DASH trial, the DASH combination diet lowered systolic blood pressure significantly more in African Americans (6.8 mm Hg) than in whites (3.0 mm Hg) (15). Similar findings are reported in the DASH-Sodium trial (8). The increased effectiveness of the DASH combination diet for African Americans supports other findings suggesting racial differences in blood pressure responses to diet (17,18). African Americans' high risk for hypertension may be explained in part by deficiencies of multiple nutrients (19). A study of 180 minority adolescents at risk of developing high blood pressure found that blood pressure was lower in the teens who had higher intakes of potassium, calcium, magnesium, and vitamins (19). The researchers suggested that "diets rich in a combination of nutrients derived from fruits, vegetables, and lowfat dairy products could contribute to primary prevention of hypertension when instituted at an early age" (19).

Consistency with Other Studies.

The beneficial effect of a dietary intake pattern similar to the DASH diet was recognized in the early 1980s when investigators analyzed data from the first National Health and Nutrition Examination Survey (9). In another investigation involving 560 adults with hypertension, dyslipidemia, or diabetes at 10 medical centers in the U.S., intake of a pre-packaged meal plan that was

accompanied by improvements in dietary levels of calcium, potassium, and magnesium approximating intakes achieved in the DASH trial improved cardiovascular risk factors, including blood pressure (20). The researchers concluded that intake of nutritionally balanced meals that meet the recommendations of national health organizations can improve blood pressure status (20).

The DASH Diet Reduces Blood Homocysteine Levels.

An added benefit of the DASH combination diet is its ability to lower blood levels of homocysteine (21). Abnormally high blood levels of this amino acid, which is synthesized when the body metabolizes protein, are associated with increased risk for heart disease and stroke. According to a recent randomized, controlled feeding trial of 118 adults, intake of a low fat diet rich in fruits, vegetables, and lowfat dairy products significantly reduced blood levels of homocysteine when compared to a typical Western diet (21). Because inadequate intakes of folate, vitamin B₁₂, and vitamin B₆ are linked to increased homocysteine levels in the bloodstream, the ability of the DASH diet to lower blood homocysteine levels may be explained by increased intake of these nutrients found in fruits, vegetables, and dairy products. Based on the reduction in homocysteine levels, the researchers estimate that intake of the DASH diet could lower atherosclerotic cardiovascular disease by 7 to 9% (21), in addition to the 15 to 27% reduction in heart disease estimated by the DASH-induced decrease in blood pressure (7).

FOOD NUTRIENTS CONTRIBUTE TO DASH BENEFITS

The DASH trial was not designed to identify specific dietary components responsible for the observed effects. However, this diet is rich in nutrients such as calcium, potassium, and magnesium, which have been demonstrated to lower blood pressure (22). A recent analysis of a comparable study established that the degree to which dietary improvements

The blood pressure-lowering effect of the DASH diet is applicable to most people in the U.S. However, this eating pattern is particularly effective for individuals with hypertension and for African Americans who are at high risk for hypertension.

lower blood pressure is associated most strongly with an improvement in an individual's mineral metabolism, particularly calcium balance (23). Interactions among nutrients in foods and in diets such as the DASH diet may increase their ability to lower blood pressure. An extensive body of scientific evidence indicates that intake of dairy products, which are rich in calcium, potassium, and magnesium, lowers blood pressure (22,24).

Calcium. As noted by one author (10), the magnitude of the reduction in blood pressure observed with the DASH diet and the actual systolic blood pressure levels achieved are remarkably consistent with observational data on dietary calcium's beneficial effect on blood pressure control. According to a review of recently published epidemiological studies, clinical trials, and analyses of the relationship between calcium and blood pressure, the authors concluded that, after nearly 20 years of controversy, it is now confirmed that a calcium intake of 1,000 to 1,500 mg/day through diet lowers blood pressure (25).

The blood pressure-lowering effects of calcium have been demonstrated in human hypertensives, normotensives, women with pregnancy-related hypertension (preeclampsia and toxemia), and children (22). However, calcium's beneficial effect on blood pressure appears to be greatest in persons who regularly consume low intakes of dietary calcium, of which dairy foods are the major source (25,26). Also, increasing calcium intake through foods such as dairy products appears to have a greater and more consistent blood pressure-lowering effect than calcium supplements (27,28). Increasing calcium intake is particularly effective in lowering the blood pressure of groups at risk of high blood pressure such as African Americans (29) and women at risk of developing pregnancy-induced hypertension (30,31).

Potassium. Increasing dietary potassium or the dietary potassium to sodium ratio modestly lowers blood pressure, particularly in individuals whose

Dairy food nutrients such as calcium, potassium, and magnesium, either alone or in combination in dairy foods, contribute to the blood pressure-lowering effect of the DASH dietary pattern.

diets are high in sodium and relatively low in potassium (1,22,32-36). The Food and Drug Administration has approved a health claim for foods that are good sources of potassium and the reduction of high blood pressure and stroke (37). Foods making this claim must contain at least 350 mg of potassium per serving, have no more than 140 mg of sodium per serving, and be low in fat, saturated fat, and cholesterol (37). Lowfat and non-fat milk as well as some yogurts qualify to make this claim.

Magnesium. Magnesium may have a beneficial effect on blood pressure, particularly in individuals whose dietary intake of this nutrient is low (34,38). An analysis of data from more than 41,000 females participating in the Nurses' Health Study found an inverse association between magnesium intake and blood pressure (39).

What About Dietary Sodium?

Current dietary guidelines recommend that healthy adults limit their intake of salt (sodium chloride) to less than 6 g/day or 2.4 g of sodium/day (13,40). However, the relationship between dietary salt/sodium intake and high blood pressure, as well as how much sodium Americans should consume, have been debated for years (41-45). This controversy stems in part from the enormous variation in blood pressure responses to changes in dietary sodium intake. Some individuals, in particular older adults, African Americans, and those with hypertension are salt sensitive (i.e., their blood pressure changes in response to changes in sodium intake) (22,41). In contrast, other individuals such as younger adults and those with normal blood pressure levels tend to be salt-resistant (i.e., changes in sodium intake result in little or no change in blood pressure). Unfortunately, there is no uniformly agreed upon test to identify salt sensitive and salt resistant individuals.

There is agreement that Americans consume excess sodium (43). The issue is whether scientific evidence supports a single universal prescription for sodium intake (46). Before the general population is advised to lower sodium

intake to a level below current dietary recommendations (<2.4 g/day), as suggested in the DASH-Sodium report (8), more research is needed to determine the practicality, long-term safety, and effect on quality of life. For the vast majority of individuals, overall improvements in their diet, as achieved with the DASH combination diet, would appear to be a more appropriate first step than restricting sodium intake (7,8,47).

SUPPORT FOR THE DASH DIET BY HEALTH PROFESSIONAL ORGANIZATIONS

Since publication of the DASH study in 1997 (7), the DASH combination diet has been acknowledged or incorporated into a number of dietary recommendations issued by health professional organizations and health advisory groups (1,24,40,48). For example, the *Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure* (1) acknowledges the DASH diet and recommends adequate intakes of calcium, magnesium, and potassium. Also, the American Heart Association, in its revised 2000 dietary guidelines statement to healthcare professionals, supports the inclusion of lowfat dairy foods, fruits, and vegetables in a heart-healthy diet (40). A dietary pattern consistent with the DASH diet has been demonstrated to reduce all cause mortality (49). Further, the DASH diet is consistent with current dietary recommendations to prevent and treat other disorders such as osteoporosis, heart disease, and colon cancer (9,49). D

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