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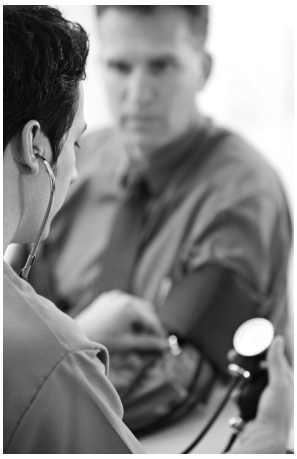
SPOTLIGHT ON DAIRY FOODS, DAIRY NUTRIENTS & BLOOD PRESSURE



SUMMARY

High blood pressure or hypertension is a common disorder affecting many Americans, both children and adults. Because of its high prevalence, serious health consequences, and economic burden, lifestyle changes, including dietary modifications, are recommended to help prevent and treat hypertension. Over the past decade, the importance of consuming a healthful diet containing three daily servings of low-fat or fat-free milk or equivalent milk products – as recommended in the 2005 Dietary Guidelines for Americans – has emerged as a potential effective strategy together with recommended lifestyle practices to help lower blood pressure.

The Dietary Approaches to Stop Hypertension (DASH) Trial demonstrated that a low-fat dietary pattern high in low-fat or fat-free dairy foods (two to three servings/day) and fruits and vegetables (eight to ten servings/day) – the so-called DASH dietary pattern – produced significant reductions in systolic and diastolic blood pressure in adults with pre-hypertension or hypertension. The blood pressure-lowering effect of the DASH dietary pattern was particularly effective for those with hypertension and African Americans, a group at high risk for hypertension. A number of health professional organizations, including the American Heart Association, support the DASH dietary pattern to help prevent and treat hypertension.

Consuming DASH-like dietary patterns characterized by high intakes of dairy foods, fruits, and vegetables has been shown to have beneficial effects on blood pressure in adults, as well as children and adolescents.

In a recent study of adolescents with pre-hypertension or hypertension, consumption of a DASH-like dietary pattern for three months reduced systolic blood pressure and improved the quality of their diets.

A number of observational studies reinforce the importance of consuming recommended servings of low-fat dairy foods to help lower blood pressure and hypertension risk. A cross-sectional study of more than 4,700 adults participating in the National Heart, Lung, and Blood Institute Family Heart Study found that consuming three or more servings of dairy foods a day was associated with significantly lower systolic blood pressure and prevalence of hypertension when compared to consuming less than one-half serving of dairy foods a day.

Dairy foods provide a number of essential nutrients including calcium, potassium, magnesium, phosphorus, vitamin D, and high quality protein. Studies have linked intake of these nutrients to lower blood pressure. Moreover, findings suggest that food sources of some of these nutrients may have a greater blood pressure-lowering effect than do supplements. Thus, the observed blood pressure benefits of dairy foods may be explained by their complete package of nutrients.

Preventing high blood pressure is important at any age. Accumulating scientific evidence suggests that small changes in lifestyle, including diet, can have a beneficial effect on blood pressure. Consuming a healthful diet consistent with a DASH dietary pattern including three servings of low-fat or fat-free dairy foods a day is one approach that may help achieve and maintain a healthy blood pressure. D

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INTRODUCTION

About 73 million people age 20 and older in the United States or nearly one in three U.S. adults has high blood pressure or hypertension (1). Hypertension is defined as a systolic blood pressure of 140 mm Hg or higher, diastolic blood pressure of 90 mm Hg or higher, or use of antihypertensive medication. In addition to the 33.6% of American adults with hypertension, approximately 37.4% have pre-hypertension (i.e., systolic blood pressure of 120 to 139 mm Hg or diastolic blood pressure of 80 to 89 mm Hg, not on medication) (1).

Older adults, African Americans, and overweight children and adolescents are among those at increased risk of hypertension (1). High blood pressure is a risk factor for heart disease, stroke, congestive heart failure, and kidney disease (2). Researchers estimate that reducing systolic blood pressure in the population by 5 mm Hg could lower mortality due to stroke by 14%, mortality due to heart disease by 9%, and all-cause mortality by 7% (2). For 2008, the estimated direct and indirect cost of high blood pressure was $69.4 billion (1).

Although the cause of 90 to 95% of the cases of high blood pressure is unknown, genetic and environmental factors, and their interactions are determinants of blood pressure (3). Among the environmental factors, diet plays a key role. Weight loss, the Dietary Approaches to Stop Hypertension (DASH) eating plan (i.e., a low-fat diet rich in fruits and vegetables and low-fat dairy foods), moderate salt (sodium chloride) intake (no more than 6 g sodium chloride or 2.4 g sodium), and moderation in alcohol consumption (for adults who drink) are dietary modifications demonstrated to lower blood pressure (2,3). Considering the high prevalence and economic burden of hypertension and its co-morbidities, efforts to reduce blood pressure in both pre-hypertensive and hypertensive individuals are encouraged. For more than a decade, health professionals have focused their advice on adopting a healthy lifestyle, including a healthful low-fat diet containing recommended servings of low-fat or fat-free dairy foods, to help prevent and manage high blood pressure (4-6).

The increasing prevalence of high blood pressure in children and adults and its cardiovascular co-morbidities underscore the need for effective preventative measures, including adoption of a healthful dietary pattern.

This *Digest* reviews recent research supporting a beneficial role for dairy foods and dairy food components as part of a healthful diet and lifestyle in achieving a desirable blood pressure level. The blood pressure benefits of a dairy-rich diet for specific groups such as African Americans, older adults, and children and adolescents are discussed, as well as recommendations from health professional organizations.

THE DASH DIET AND RELATED DIETARY PATTERNS

The landmark, U.S. government-sponsored, controlled-feeding study called the DASH Trial provides compelling support for a blood pressure-lowering effect of dairy foods (6). This scientific breakthrough was preceded by volumes of research beginning in the early 1980s which demonstrated a beneficial role for dairy foods and dairy food nutrients such as calcium and potassium in blood pressure regulation (4,7,8).

In the DASH multi-center trial of 459 pre-hypertensive and hypertensive adults, participants were randomly assigned to one of the following three diets for eight weeks: a control or typical American diet (i.e., low in fruits, vegetables, and dairy foods and containing 36% of calories from total fat); a fruits and vegetables diet (eight to ten servings a day, low in dairy foods, and similar in total fat to the control diet); and the DASH dietary pattern, a low fat (26% of calories) eating plan high in fruits and vegetables (eight to ten servings a day) and dairy foods (two to three servings a day) (6). The DASH dietary pattern produced the largest reductions in both systolic blood pressure (5.5 mm Hg) and diastolic blood pressure (3 mm Hg). The fruits and vegetables diet (i.e., low in dairy foods) produced blood pressure reductions of roughly half that achieved with the DASH dietary pattern (6). The reduction in blood pressure on the DASH dietary pattern occurred quickly (within two weeks), remained lower as long as the participants stayed on the diet, and had effects similar to single antihypertensive drug therapy (6,9). The blood pressure-lowering effect of the

DASH diet was independent of body weight, sodium intake, or alcohol intake, each of which was held constant between groups (6).

The blood pressure effects of the DASH dietary pattern were further examined in the multi-center DASH-Sodium Trial (10). This trial involved 412 adults whose blood pressure exceeded 120/80 mm Hg. The subjects were randomly assigned to either a typical American diet (control) or the DASH dietary pattern with various levels of sodium (10). Consistent with the first DASH Trial (6), blood pressure was significantly reduced in persons consuming the DASH dietary pattern compared to the control diet and this occurred across all levels of sodium intake. The PREMIER Trial, a randomized controlled study in free-living persons with pre-hypertension or hypertension, showed that a combination of lifestyle interventions, including the DASH dietary pattern, reduced blood pressure (11,12). Further, these lifestyle interventions were sustained for more than 18 months (12).

The DASH dietary pattern has been shown to lower blood pressure more in persons with hypertension than in those without hypertension (6,10,13). Also, the DASH dietary pattern is particularly effective in lowering blood pressure in African Americans, a group at higher risk of developing hypertension and its complications than their Caucasian counterparts (10,13,14).

The DASH dietary pattern has been acknowledged or incorporated into a number of dietary recommendations issued by health professional organizations and health advisory groups (2,3,15-18). According to the National Heart, Lung, and Blood Institute (NHLBI)'s 7th Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure for adults, the DASH dietary pattern is more effective than the long-standing recommendation to reduce sodium intake (2). The 2005 edition of the Dietary Guidelines for Americans (16) refers to the DASH dietary pattern as an example of an eating plan that exemplifies the recommendations in the Guidelines. In addition, the American Heart Association supports the DASH dietary pattern in its recommendations to prevent and treat hypertension and heart disease (3,17,18).

Research demonstrates that the low-fat Dietary Approaches to Stop Hypertension (DASH) eating plan, which includes two to three servings of low-fat or fat-free dairy foods and eight to ten servings of fruits and vegetables, may help to lower blood pressure.

The beneficial blood pressure effect of a dietary pattern similar to the DASH diet has been demonstrated in other studies (4,19-22). In a 12-week clinical weight-loss trial in 54 overweight/obese middle-aged men with pre-hypertension or hypertension fed either a DASH-like dietary pattern or a conventional low-fat diet, body weight decreased by a similar amount for both groups, but reductions in systolic and diastolic blood pressure were greater for the group consuming the DASH-like dietary pattern than the conventional low-fat diet (19).

Consuming a DASH-like dietary pattern characterized by high intakes of dairy foods, fruits, and vegetables has been shown to have beneficial effects on blood pressure throughout childhood (21,22). This is of importance given that the prevalence of high blood pressure among children and adolescents in the U.S. has increased, concomitant with the rise in childhood obesity (23), and that high blood pressure in the early years increases the risk of hypertension later in life (24).

In a recent study of 57 adolescents 11 to 18 years with pre-hypertension or hypertension, subjects were randomly assigned to follow a DASH-like dietary pattern high in low-fat dairy foods, fruits, and vegetables or routine outpatient hospital-based nutrition care (routine care intervention) (22). After three months, the DASH-like group had a greater decrease in systolic blood pressure (-7.9% vs. -1.5%) and better diet quality than the routine care group. The adolescents following the DASH-like dietary pattern had greater intakes of potassium and magnesium, lower intakes of total and saturated fat, and increased fruit (by ~2 servings/day) and dairy product (by ~0.5 servings/day) intakes (22). By post-treatment (six months), blood pressure was normal in 50% of the DASH group compared to 36% of the routine care group (22).

These findings support those of an earlier prospective investigation which examined eight years of follow-up data from 95 children who were initially enrolled at 3 to 6 years of age in the Framingham Children's

study (21). By early adolescence, children who consumed a DASH-like dietary pattern higher in fruits and vegetables and dairy products had a lower systolic blood pressure than those whose intake of these food groups was lower (21). Results of the above two investigations lend support to the 2004 recommendation by the National High Blood Pressure Education Program Working Group to encourage children and adolescents to adopt the DASH eating plan to prevent and treat high blood pressure (15).

DAIRY FOODS AND BLOOD PRESSURE

Recent observational studies support an association between increased consumption of dairy foods and lower blood pressure (systolic, diastolic, or both) and hypertension risk (25-33). However, it is important to note that a variety of factors (e.g., the type of specific dairy food and amount consumed) influence this association (5).

A cross-sectional study among 4,797 adult participants of the NHLBI Family Heart Study found that consuming three or more servings of dairy foods per day was associated with significantly lower systolic blood pressure (-2.6 mm Hg) and prevalence of high blood pressure when compared to consuming less than one-half serving of dairy foods per day (25). Dairy food intake had little effect on diastolic blood pressure (25). A statistically significant inverse association between consumption of low-fat dairy foods and systolic blood pressure was found in a 12-month study in Spain which included 2,290 participants aged 55 to 80 years at high risk of cardiovascular disease (26). Dairy foods and dietary calcium were both significantly and independently associated with low levels of systolic blood pressure in 912 French men aged 45 to 64 years who participated in a cross-sectional survey of cardiovascular disease risk factors (27).

According to a cross-sectional study of determinants of blood pressure in 7,601 women in Tuscany, Italy who reported that they were not hypertensive, consumption of milk and cheese were inversely associated with both systolic and diastolic blood pressure, while yogurt was inversely associated with systolic blood pressure (28). In another cross-sectional study which included 1,896 Dutch subjects, high total dairy consumption was significantly associated with lower diastolic blood pressure (30).

Numerous studies suggest a beneficial role for dairy foods in helping to achieve a healthy blood pressure and reduce the risk for hypertension. This is one more reason to consume three servings a day of low-fat or fat-free dairy foods, as recommended in the 2005 Dietary Guidelines for Americans.

A limited number of prospective studies have examined the association between dairy food consumption and risk of hypertension (31-33). The incidence of high blood pressure was inversely associated with total dairy food intake in overweight young U.S. adults followed for ten years in the Coronary Artery Risk Development in Young Adults (CARDIA) study (31). In a 27-month prospective study of 5,880 middle-aged adults in Spain, consumption of low-fat dairy foods, but not total or whole-fat dairy foods or calcium intake, was associated with reduced risk of incident hypertension (32). A 10-year prospective study in more than 28,000 U.S. women aged 45 years and older found that increased intake of low-fat dairy foods, but not high-fat dairy foods, was linked to a lower subsequent risk of hypertension (33). The highest vs. the lowest intake of low-fat dairy foods was associated with an 11% reduced risk of developing high blood pressure after adjusting for other factors influencing blood pressure (33). The researchers suggest that their findings support the 2005 Dietary Guidelines to consume three cups of low-fat or fat-free milk and equivalent milk products per day (33).

DAIRY FOOD NUTRIENTS AND BLOOD PRESSURE

The potential beneficial effect of dairy foods on blood pressure is generally attributed to their major nutrients, including calcium, potassium, magnesium, phosphorus, vitamin D, and protein (4,5,34). In the DASH dietary pattern, dairy foods are among the top sources of calcium, potassium, and magnesium, nutrients which may play an important role in blood pressure regulation (34). Milk, for example, is the number one dietary source of calcium, phosphorus, potassium, and magnesium,

and the number three source of protein for U.S. adults, according to data from USDA's Continuing Survey of Food Intakes by Individuals, 1994-1996 (35).

Since the early 1980s, numerous findings from experimental animal studies, observational studies, clinical trials, and meta-analyses have suggested that increasing calcium intake lowers blood pressure (3,4,7,8,36,37). Modest reductions in systolic and diastolic blood pressures with increased calcium intakes of 400 to 2,000 mg per day are reported in meta-analyses of clinical trials (3,38,39). According to one meta-analysis of 40 randomized clinical trials, calcium supplementation (1,200 mg/day) reduced systolic (-1.86 mm Hg) and diastolic (-0.99 mm Hg) pressures (39). The blood pressure response to calcium was greater in groups with habitually low baseline calcium intakes (<800 mg/day) compared to those with higher intakes. Also, calcium intake from foods (primarily dairy) had a greater lowering effect on systolic blood pressure than did calcium supplements (39). This finding is consistent with that of an earlier meta-analysis of 42 randomized controlled trials (38). According to the Women's Health Study, a 10-year prospective investigation of more than 28,000 middle-aged and older U.S. women, intakes of dietary calcium, vitamin D, and low-fat dairy foods were each inversely related to hypertension risk (30).

A growing body of scientific evidence indicates that high potassium diets lower blood pressure (3,4,36,40,41). An early meta-analysis of 31 randomized controlled studies reported significant reductions in mean systolic (-3.11 mm Hg) and diastolic (-1.97 mm Hg) blood pressures in groups with increased potassium intakes (40). The blood pressure-lowering effect was greater in African Americans than in Caucasians, in those consuming a high salt (sodium chloride) diet, and in hypertensives than normotensives (40).

Ensuring an adequate intake of potassium (i.e., 4.7 g/day for those aged 14 and older), preferentially from foods such as vegetables, fruits, and dairy products (milk, yogurt), is recommended to help reduce the risk of hypertension (3,16,42). Unfortunately, no single age group of Americans is meeting this potassium recommendation (43). However, a recent study using data from NHANES 1999-2002 reports that mean potassium intakes were significantly higher in people who met the recommended three servings of dairy products a day compared to those who did not (43). In fact, according to nationwide food consumption surveys, milk is the number one food source of potassium for Americans of all age groups (35,44). Based on evidence indicating that diets rich in potassium and low in sodium reduce blood pressure and risk of stroke, the Food and Drug Administration has approved the use of the health claim "diets containing foods that are a good source of potassium and that are low in sodium may reduce the risk of high blood pressure and stroke" for qualifying foods such as fat-free milk (45).

Dairy foods' potential beneficial effect on blood pressure may be explained by their combined content of calcium, potassium, magnesium, phosphorus, vitamin D, and protein – nutrients linked to reduced blood pressure.

Compared to calcium or potassium, evidence examining a potential beneficial effect of magnesium in the regulation of blood pressure is less consistent (3,4,36,46,47), and the relationship between phosphorus and blood pressure has been largely unexplored. However, a recent cross-over international epidemiologic study of 4,680 adults ages 40 to 59 years reports a significant inverse relationship between dietary phosphorus intake and systolic and diastolic blood pressures (48). The study also found that a combination of phosphorus, calcium, and magnesium was inversely associated with systolic and diastolic blood pressure (48).

Emerging evidence from recent epidemiological studies suggests that higher vitamin D status, as measured by serum 25-hydroxyvitamin D (25[OH] D) concentration, is associated with lower blood pressure and reduced risk of hypertension (49-51). Vitamin D-fortified milk is a major dietary source of vitamin D (52). Nearly all fluid milk, irrespective of its fat content, marketed in the U.S. is fortified with vitamin D to obtain the standardized amount of 400

I.U. per quart so that each cup of milk is an excellent source of vitamin D (52,53). Also, some cheeses and yogurts are fortified with vitamin D.

Protein components have been demonstrated to lower blood pressure (54,55). Studies have shown that milk proteins, both casein and whey, are a rich source of peptides that inhibit the vasoconstrictor angiotensin-I-converting enzyme (ACE). ACE has a role in regulating blood pressure by converting angiotensin I to angiotensin II, which constricts blood vessels (54). A recent meta-analysis of 12 randomized controlled trials in Japan and Finland found that the casein tripeptides, isoleucine-proline-proline and valine-proline-proline, significantly lowered systolic and diastolic blood pressure (55).

CONCLUSION

Research indicates that the DASH eating plan helps to lower blood pressure. Additional studies of DASH-like dietary patterns, dairy foods, and dairy food nutrients (e.g., calcium, potassium, magnesium, phosphorus, vitamin D, protein) support dairy foods' role in blood pressure regulation. As part of an overall strategy to help achieve and maintain a healthy blood pressure, people are encouraged to consume three cups of low-fat or fat-free milk or milk equivalents a day, as recommended in the 2005 Dietary Guidelines for Americans, and meet all other diet and lifestyle guidelines. D

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RELATED RESOURCES

www.nationaldairycouncil.org/DASH

- This DASH Education Toolkit includes education materials, fact sheets and advertorials, a turnkey PowerPoint presentation on the DASH Eating Plan, scientific research, Dairy Council Digests, and healthy recipes from 3aday.org.

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CHILD NUTRITION: A FOCUS ON DAIRY FOODS

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