

Supplement to  
Clinical Cardiology

Volume 22

7'99

# Clinical Cardiology™

A Journal for Advances in Cardiovascular Disease

---

Nonpharmacologic Therapies

The DASH Study to  
Prevent Hypertension

Nut Consumption, Lipids,  
and CHD Risk

DASH in Clinical Practice

## **The DASH Diet: A Clinical Success Story in Hypertension Control**

**L. J. Appel, M. D.**  
*Guest Editor*

July 1999  
Foundation for Advances in  
Medicine and Science, Inc.

# Clinical Cardiology

---

Supplement III

## **The DASH Diet: A Clinical Success Story in Hypertension Control**

L. J. APPEL, **Guest Editor**

*Sponsored by a grant from the Almond Board of California.*

The opinions expressed in this presentation are those of the panelists and are not attributable to the sponsor or the publisher, editor, or editorial board of *Clinical Cardiology*. Clinical judgment must guide each physician in weighing the benefits of treatment against the risk of toxicity. References made in the articles may indicate uses of drugs at dosages, for periods of time, and in combinations not included in the current prescribing information.

# Clinical Cardiology™

A Journal for Advances  
in Cardiovascular Disease

---

## Editors

### Editor-in-Chief

C. R. CONTI  
Gainesville, USA

### Co-Editors

A. J. CAMM  
London, Great Britain

J. W. HURST  
Atlanta, USA

M. YACOUB  
London, Great Britain

### Associate Editors

D. T. MASON  
San Francisco, USA

R. C. SCHLANT  
Atlanta, USA

B. F. WALLER  
Indianapolis, USA

### Guest Editor for this issue:

L. J. APPEL  
Baltimore, USA

The editorial content of supplements is reviewed by the guest editor and approved by C. Richard Conti, M.D., Editor-in-Chief of the Journal. The findings presented in this supplement are those of the contributors and not necessarily those of the sponsor, the publisher, or the editors of Clinical Cardiology.

The Publisher

CLINICAL CARDIOLOGY: A Journal for Advances in Cardiovascular Disease (ISSN 0160-9289) is published monthly and copyrighted © 1999 by the Foundation for Advances in Medicine and Science, Inc., 111 Oweno Road, Mahwah, N.J. 07430. Periodicals postage paid at Mahwah, New Jersey, and additional mailing offices. POSTMASTER: Send address changes to Clinical Cardiology, Box 832, Mahwah, NJ 07430-0832.

Subscription per annum (12 issues plus supplements): Institutional and personal—\$80 U.S. and \$126.50 foreign; single copy \$15.50. Subscriptions calendar year only. Payment for subscriptions should be in U.S. funds drawn on U.S. bank to Clinical Cardiology Publishing Co., Inc., Box 832, Mahwah, N.J. 07430-0832.

**This journal is fully refereed and is included in Index Medicus, Current Contents/Clinical Practice, ISI BioMed, Science Citation Index, Index Internacional de Cardiologia, and EMBASE/Excerpta Medica.**

Neither the editors nor the publisher guarantees, warrants or endorses any product advertised in this publication; nor do they guarantee any claim made by the manufacturer of said product or service.

Manuscript submission: Refer to last page of Table of Contents for Instructions to Authors page listing.

Printed in USA by Mack Printing Co., Easton, PA

July 1999

---

Publisher: Tony Bourgholtzer

Executive Editor: Joey Marie Bourgholtzer, Ph.D.

Art Director: John Romano

Circulation Manager: Lillian Conly

Telecommunications Editor: Lynn M. Savino

Copyreader: Helga Politzer

Advertising rates & information mailed on request.

Contact:

Clinical Cardiology Advertising Department  
Box 832, Mahwah, New Jersey 07430-0832

Tel. (201) 818-1010

Telex 220883 TAUR

Fax (201) 818-0086

E-mail: [clinicalcardiology@fams.org](mailto:clinicalcardiology@fams.org)

Internet: <http://www.clinical-cardiology.org/>

To implement a change of address, please remove the mailing label affixed to your copy and send it together with your new address to Clinical Cardiology, Box 832, Mahwah, NJ 07430-0832.

Authorization to photocopy items (a maximum of six copies) for internal or personal use, or the internal or personal use of specific clients, is granted by Clinical Cardiology Publishing Co., Inc., provided the base fee of \$7.00 U.S. per article, plus \$.05 U.S. per page is paid direct to Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, USA.

# Clinical Cardiology™

A Journal for Advances in Cardiovascular Disease

---

## Contents • Vol. 22, No. 7, July 1999 (Supplement III)

Nonpharmacologic Therapies	<b>Nonpharmacologic Therapies that Reduce Blood Pressure: A Fresh Perspective</b> L. J. APPEL, M.D., M.P.H.	III-1
The DASH Study to Prevent Hypertension	<b>A Dietary Approach to Prevent Hypertension: A Review of the Dietary Approaches to Stop Hypertension (DASH) Study</b> F. M. SACKS, M.D., L. J. APPEL, M.D., T. J. MOORE, M.D., E. OBARZANEK, PH.D., W. M. VOLLMER, PH.D., L. P. SVETKEY, M.D., G. A. BRAY, M.D., T. M. VOGT, M.D., J. A. CUTLER, M.D., M. M. WINDHAUSER, PH.D., PAO-HWA LIN, PH.D., N. KARANA, PH.D.	III-6
Nut Consumption, Lipids, and CHD Risk	<b>Nut Consumption, Lipids, and Risk of a Coronary Event</b> G. E. FRASER, M.B.CH.B., PH.D.	III-11
DASH in Clinical Practice	<b>Dietary Approaches to Stop Hypertension (DASH) in Clinical Practice: A Primary Care Experience</b> K. M. KOLASA, PH.D., R.D., L.D.N.	III-16

# ARTICLES IN BRIEF

## Original Contributions

### III-1 **Nonpharmacologic Therapies that Reduce Blood Pressure: A Fresh Perspective**

L. J. APPEL, M.D., M.P.H.

Traditional lifestyle modifications that reduce blood pressure include sodium reduction, weight loss, moderation of alcohol intake, and increased physical activity. In addition to these recommendations, policy-making bodies now advocate a diet that is rich in fruits, vegetables, and low-fat dairy products, and reduced in saturated fat, total fat, and cholesterol. In the Dietary Approaches to Stop Hypertension (DASH) trial, this dietary pattern substantially lowered blood pressure. These results reinforce the hypothesis that multiple dietary factors affect blood pressure. The current challenge to health care providers, government officials, and the general public is to develop and implement effective strategies that accomplish desirable lifestyle modifications.

### III-6 **A Dietary Approach to Prevent Hypertension: A Review of the Dietary Approaches to Stop Hypertension (DASH) Study**

F. M. SACKS, M.D., L. J. APPEL, M.D., T. J. MOORE, M.D., E. OBARZANEK, PH.D., W. M. VOLLMER, PH.D., L. P. SVETKEY, M.D., G. A. BRAY, M.D., T. M. VOGT, M.D., J. A. CUTLER, M.D., M. M. WINDHAUSER, PH.D., R.D., P.-H. LIN, PH.D., N. KARANJA, PH.D.

The DASH study tested an overall dietary pattern (known as the DASH diet) that is high in fruits, vegetables, nuts, and low-fat dairy products, emphasizes fish and chicken rather than red meat, and is low in saturated fat, cholesterol, sugar, and refined carbohydrate. The DASH diet lowered systolic blood pressure by 6.9 mmHg in African Americans, 3.3 mmHg in Caucasians, and 11.6 mmHg in hypertensives. The blood pressure lowering of the fruits and vegetables diet was about half that of the DASH diet. Thus, the DASH diet may offer an alternative to drug monotherapy for initial therapy of Stage 1 hypertensive patients, and an approach to prevent hypertension in the general population.

### III-11 **Nut Consumption, Lipids, and Risk of a Coronary Event**

G. E. FRASER, M. B. CH. B., PH.D.

The Dietary Approaches to Stop Hypertension (DASH) diet provides a separate food group for nuts, seeds, and dried beans, and recommends regular choices from among these foods as part of a diet to control hypertension. Nuts are relatively high in unsaturated fatty acids, which are predicted to lower blood cholesterol when substituted for more saturated fats. They are also perhaps the best natural source of vitamin E, and are concentrated repositories of dietary fiber, magnesium, and arginine. Human feeding studies confirm the ability of nut consumption to lower low-density lipoprotein cholesterol. Four large cohort studies show impressive reductions in coronary heart disease rates in subjects consuming nuts more frequently.

### III-16 **Dietary Approaches to Stop Hypertension (DASH) in Clinical Practice: A Primary Care Experience**

K. M. KOLASA, PH.D., R.D., L.D.N.

The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI), from the National Institutes of Health, recommends lifestyle modifications to prevent and treat hypertension. A healthy diet is an integral part of this strategy, and JNC VI refers to the Dietary Approaches to Stop Hypertension (DASH) diet as an intervention that was clinically proven to significantly lower blood pressure. The changes in behavior and materials required to implement DASH in the primary care setting are described.

## Nonpharmacologic Therapies that Reduce Blood Pressure: A Fresh Perspective

LAWRENCE J. APPEL, M.D., M.P.H.

Welch Center for Prevention, Epidemiology and Clinical Research, Johns Hopkins University, Baltimore, Maryland, USA

**Summary:** Traditional approaches to control the epidemic of blood pressure-related atherosclerotic cardiovascular disease (ASCVD) have largely focused on drug therapy in persons with hypertension. Still, nonpharmacologic therapy, also termed lifestyle modification, has an important and expanding role that complements drug therapy. Specifically, nonpharmacologic therapies can serve as initial therapy in Stage 1 hypertensive patients, facilitate medication step down or withdrawal in patients with well-controlled hypertension, prevent hypertension in high-risk populations, and reduce blood pressure in normotensive individuals and thereby lower their risk of ASCVD. Traditional lifestyle modifications that reduce blood pressure include sodium reduction, weight loss, moderation of alcohol intake, and increased physical activity. Such strategies have been prominently advocated in the Fifth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Recommendations to increase potassium, magnesium, and calcium intake were based primarily on general health considerations, not for control of high blood pressure. In its sixth and most recent report (JNC VI) published in 1997, the Joint National Committee has extended its recommendations.<sup>1</sup> In addition to the traditional lifestyle recommendations, the JNC VI advocates increased potassium intake for control of high blood pressure. Furthermore, this policy-making body now recommends a healthy dietary pattern, that is, one that is rich in fruits, vegetables, and low-fat dairy products, and reduced in saturated fat, total fat, and cholesterol. This diet, which was rigorously evaluated in the Dietary Approaches to Stop Hypertension (DASH) clinical trial, substantially lowered blood pressure in normotensive and hypertensive individuals. These recent developments reinforce the hypothesis that multiple dietary factors influence blood pressure. Nonpharmacologic approaches

have enormous potential as a means to reduce blood pressure and control hypertension, thereby preventing the occurrence of ASCVD. The current challenge to health care providers, government officials, and the general public is to develop and implement effective clinical and public health strategies that lead to desirable lifestyle modifications.

**Key words:** blood pressure, diet, nutrition, hypertension

### Introduction

Elevated blood pressure (BP) is among the most common and important risk factors for atherosclerotic cardiovascular disease (ASCVD). According to the Third National Health and Nutrition Examination Survey (NHANES III, 1988–1991), approximately 24% of the population, or an estimated 43 million Americans, has hypertension defined as a systolic BP  $\geq 140$  mmHg, a diastolic BP  $\geq 90$  mmHg, and/or current use of antihypertensive medication.<sup>2</sup> Only 47% of adults have optimal BP, that is, a systolic BP  $< 120$  mmHg and diastolic BP  $< 80$  mmHg. As age increases, the prevalence of hypertension rises progressively, such that only  $< 20\%$  of adults aged  $\geq 70$  years have an optimal BP.

Adverse patterns of BP disproportionately affect certain groups. In particular, African-Americans have a higher prevalence and greater severity of hypertension than other minorities (e.g., Mexican Americans) and Caucasians.<sup>2</sup> As well, women aged  $\geq 60$  years tend to have a higher prevalence of hypertension than men of similar age, while the reverse is true at younger ages. In certain groups, the prevalence of hypertension is almost ubiquitous; for example, nearly 80% of black women aged  $\geq 60$  years have hypertension.

Efforts to control the epidemic of BP-related ASCVD have largely focused on implementation of pharmacologic therapy in persons with hypertension. Such efforts reflect a compelling body of evidence that drug therapy is an effective means for preventing stroke and coronary heart disease. A typical diastolic BP reduction of 5 mmHg from drug treatment has been estimated to reduce the incidence of coronary heart disease events by 15% and cerebrovascular disease by 45%.<sup>3</sup>

Nonetheless, reliance on drug therapy is an incomplete solution to the problem of BP-related ASCVD. It is increasingly well recognized that the risk of cardiovascular disease increases progressively throughout the range of BP, including ranges

---

Address for reprints:

Lawrence J. Appel, M.D., M.P.H.  
Johns Hopkins University  
2024 East Monument Street, Suite 2-600  
Baltimore, MD 21205-2223, USA

of BP previously considered normal.<sup>4</sup> Furthermore, a substantial fraction of adults have a BP that is above optimal and yet below the traditional threshold for drug treatment. Such BP levels nonetheless place individuals at increased risk of vascular disease. Stamler *et al.*<sup>5</sup> have estimated that 32% of BP-related deaths from coronary heart disease occur in individuals with a systolic BP between 110 and 139 mmHg. In view of these considerations, national policy-making bodies recommend certain lifestyle, or nonpharmacologic, therapies to prevent and treat hypertension.

### Roles of Nonpharmacologic Therapies

Nonpharmacologic or lifestyle therapies have several important roles in both nonhypertensive individuals and hypertensive individuals (Table I). In hypertensives, nonpharmacologic therapies can serve as initial therapy in Stage 1 hypertension before the addition of medication and as an adjunct to medication in persons already on drug therapy. In hypertensives with controlled blood pressure, nonpharmacologic therapies can facilitate medication step down or even withdrawal in certain individuals. In nonhypertensives, nonpharmacologic interventions have the potential to prevent the onset of hypertension, and more broadly to reduce BP and thereby lower the risk of ASCVD in the general population. Indeed, even an apparently small reduction in BP, if applied to a whole population, could have an enormous, beneficial impact on cardiovascular events. Stamler<sup>6</sup> has estimated that a 3 mmHg reduction in systolic BP could lead to an 8% reduction in stroke mortality and 5% reduction in mortality from coronary heart disease.

### Traditional Approaches

The Fifth Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure (JNC V)<sup>7</sup> and the Working Group Report on Primary Prevention of Hypertension<sup>8</sup> concluded that four lifestyle therapies could effectively lower BP: reduced sodium intake, weight loss, reduced alcohol consumption, and increased physical activity (Table II). Although JNC V also recommended increased dietary intake of potassium, magnesium, and calcium, these recommendations were based primarily on general health considerations, not for control of high blood pressure.<sup>7</sup>

TABLE I Roles of nonpharmacologic ("lifestyle") therapies

• Hypertensives	- Initial therapy - Adjunct to drug therapy - Facilitate medication step-down or withdrawal
• Nonhypertensives	- Reduce blood pressure - Prevent hypertension

Other dietary factors were considered; however, the evidence supporting possible recommendations was deemed insufficient or inconsistent.

### Reduced Sodium Intake

The preponderance of available evidence indicates that a high intake of salt (sodium chloride) adversely affects blood pressure. Such data include results from observational studies of diet and blood pressure and clinical trials of reduced salt intake. In meta-analyses of randomized trials, a reduced sodium intake is typically associated with systolic and diastolic BP reductions of approximately 4 and 2 mmHg in hypertensives and lesser reductions in normotensives.<sup>9,10</sup> More importantly, a reduced sodium intake appears to blunt the age-related rise in BP.<sup>11</sup> Many groups of individuals are particularly sensitive to the effects of salt on BP (e.g., older-aged persons, African-Americans, and persons with renal disease). Still, on an individual basis, there is no easy way to identify individuals who are more salt-sensitive from those who are less sensitive.

Although national data on dietary intake of sodium are limited, most adult Americans consume well over the maximum recommended daily intake of 100 mmol of sodium. From 24-hr dietary recalls, the average daily intake of adults, ages 40–49, is 3,960 mg/day in men and 2,919 mg/day in women.<sup>12</sup> On average, salt intake tends to rise until ages 16–19, at which point salt intake slightly diminishes with advancing age. Approximately 75% of dietary sodium is added during food processing by manufacturers; only 10% is inherent in the food itself before processing. Just 15% is discretionary, that is, added by individuals as they prepare or eat food. Recent trials show that behavior change interventions can reduce intake by approximately 30–50 mmol/day.<sup>13–16</sup> However, even motivated individuals find it difficult to reduce sodium intake to below the recommended limit because of the huge amount of nondiscretionary salt added during food processing. Hence, any meaningful strategy to reduce salt intake must rely on food manufacturers to reduce the amount added during preparation.

### Weight Loss

A persuasive and consistent body of evidence from both observational and experimental studies indicates that weight

TABLE II Effective nonpharmacologic ("lifestyle") therapies that reduce blood pressure (BP)

• Reduce sodium <sup>a</sup>	• Increased physical activity <sup>a</sup>
• Weight loss <sup>a</sup>	• Increased potassium <sup>b</sup>
• Limited alcohol intake <sup>a</sup>	• Desirable dietary pattern <sup>b</sup>

<sup>a</sup> Recommended for BP control in the 5th and 6th reports of the Joint National Committee.

<sup>b</sup> Recommended for BP control in the 6th Report of the Joint National Committee.

is positively (directly) associated with BP and hypertension.<sup>17</sup> The importance of this relationship is reinforced by the high and increasing prevalence of overweight in the United States.<sup>18</sup> According to the NHANES III survey data, the combined prevalence of overweight and obesity [a body mass index (BMI) > 25 kg/m<sup>2</sup>] is 59.4% in men and 50.7% in women.<sup>19</sup> Furthermore, overweight is highly prevalent in all race–gender groups.

Virtually every clinical trial that has examined the influence of weight loss on BP has documented a substantial and significant relationship between change in weight and change in BP. Reductions in BP occur before (and without) attainment of desirable body weight. In one study that aggregated results across 11 weight loss trials, average systolic and diastolic BP reduction per kg of weight loss was 1.6/1.1 mmHg.<sup>20</sup> Recent lifestyle intervention trials have uniformly achieved short-term weight loss. In several instances,<sup>13–16</sup> substantial weight loss has also been sustained over the long term (3 or more years).

### Increased Physical Activity

Evidence from observational studies and, to a lesser extent, experimental studies, indicates that increased physical activity can lower BP. Numerous studies have found a negative correlation between habitual physical activity and the development of hypertension. In addition to the observational evidence, over 30 experimental studies have evaluated the impact of physical activity on BP.<sup>21</sup> Most of these studies used aerobic training at moderate-to-high intensities. Those trials that have examined different intensities of exercise have shown that moderate-intensity activity decreases BP to a similar extent as higher-intensity exercise.<sup>22–24</sup> Recent trials suggest that lifestyle interventions may even be as effective as traditional structured exercise programs.<sup>25, 26</sup> Because over 50% of Americans have little or no leisure-time physical activity, defined as < three episodes per week,<sup>27</sup> the potential impact of increased physical activity on BP could be enormous.

### Limited Alcohol Intake

The relationship between high alcohol intake (typically three or more drinks per day) and elevated BP has been reported in a large number of observational studies.<sup>28, 29</sup> A few trials have also demonstrated that reductions in alcohol intake among heavy drinkers can lower BP in normotensive and hypertensive men.<sup>30, 31</sup> In the Prevention and Treatment of Hypertension Study (PATHS), a reduction in alcohol intake among nondependent moderate–heavy drinkers also reduced BP to a small, nonsignificant extent.<sup>4</sup>

### Recent Advances

After publication of JNC V in 1993, additional research has highlighted the importance of two other aspects of diet, namely, potassium intake and dietary patterns.<sup>33, 34</sup> The evidence

was deemed sufficiently compelling as to warrant an update of national policy pertaining to lifestyle recommendations that influence BP.

### Increased Potassium Intake

In contrast to the direct relationship of sodium intake with BP, the relationship between potassium intake and BP is inverse, that is, high levels of potassium are associated with low BP. While observational data have been reasonably consistent, the data from clinical trials have been less consistent and persuasive. However, a recent meta-analysis has documented a significant impact of potassium pill supplements on BP.<sup>34</sup> On average, supplementation of diet with a typical dose of 60 to 120 mmol/day of potassium reduced systolic and diastolic BP by 4.4 and 2.5 mmHg, respectively, in hypertensives and by 1.8 and 1.0 mmHg, respectively, in normotensives. This study also documented greater BP reduction from potassium supplementation at higher levels of salt intake. Because a high dietary intake of potassium can be achieved through diet rather than pills and because potassium derived from foods also comes with a variety of other nutrients, the preferred strategy of increasing potassium intake is foods rather than supplements.

### Desirable Dietary Pattern

Certain dietary patterns have been associated with low BP. For instance, in observational studies, vegetarian diets have been associated with lower BP even after controlling for other factors known to affect BP.<sup>35</sup> In clinical trials, vegetarian diets also reduced BP.<sup>36, 37</sup> Such findings spawned efforts to identify the nutrients responsible for the BP reduction, especially since vegetarian diets are not widely accepted by the general population.

The nutrients responsible for the BP-lowering effects of these diets have remained elusive. Attention has focused on macronutrients (particularly the type and amount of fat), micronutrients (potassium, magnesium, and calcium) and fiber. Modification of fat intake, particularly saturated and total fat intake, has been tested in several trials but the results have generally been disappointing.<sup>38</sup> Trials of micronutrients have likewise been inconclusive. Only a few well-designed trials of magnesium supplementation have been conducted, and results tend to be inconsistent. The effects of calcium on BP have likewise been equivocal. In a meta-analysis of 23 observational studies, Cappuccio *et al.*<sup>39</sup> documented an inverse association between BP and dietary calcium intake (as measured by 24-h dietary recalls or food frequency questionnaires). However, the effect size was relatively small, and there was evidence of publication bias and of heterogeneity across studies. Subsequently, meta-analyses of randomized trials have documented that calcium supplementation (typically, 1–1.5 g/day) reduces systolic BP by approximately 1 mmHg but not diastolic BP.<sup>40</sup> A high intake of potassium, as documented above, may be partially responsible for the BP-lowering effects of vegetarian diets.

In view of these perplexing data, the Dietary Approaches to Stop Hypertension (DASH) study was designed to test the impact of modifying whole dietary patterns. This was a controlled feeding study which demonstrated that a healthy dietary pattern can substantially reduce BP. This dietary pattern emphasizes fruits, vegetables, and low-fat dairy products. It includes whole grains, poultry, fish, and nuts, and is reduced in fat, red meat, sweets, and sugar-containing beverages. Among nonhypertensive individuals, this dietary pattern reduced systolic and diastolic BP by 3.5 and 2.1 mmHg, respectively. Corresponding BP reductions in hypertensives were striking, that is, 11.4 and 5.5, respectively, in persons with Stage 1 hypertension. African-Americans had greater BP reductions than non-African-Americans.<sup>41</sup> The impressive results from DASH have both public health and clinical significance. A population-wide reduction in systolic BP of the magnitude observed in DASH normotensives could substantially reduce the occurrence of ASCVD in the general population. The BP reductions observed in hypertensives have obvious clinical significance and are similar in magnitude to the BP reductions from drug monotherapy.

### Unresolved Issues

While results from DASH have rekindled interest in the role of nonpharmacologic therapies as a means to reduce BP, these results have also generated several important research questions. First, what are principal nutrients or foods responsible for the BP-lowering effect of the DASH diet? The DASH study was not designed to answer this question. Hence, such speculation must rely predominantly on the results of other studies rather than on results from DASH. Second, what is the effect of the DASH diet in free-living individuals selecting their own foods? Third, what are the main and interactive effects of reducing sodium and following the DASH diet? Fourth, what is the combined effect of simultaneously implementing all known lifestyle interventions that influence BP?

### Conclusion

Nonpharmacologic approaches to reduce BP have enormous potential as a means for preventing hypertension and controlling BP, thereby reducing the occurrence of ASCVD. Now, the greatest challenge is developing and implementing strategies that lead to a reduced salt intake, reduced weight, increased physical activity, moderate alcohol intake among those who drink, and an overall healthy dietary pattern.

### References

1. JNC VI - Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. The Sixth Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med* 1997;157:2413-2446
2. Burt VL, Whelton P, Roccella EJ, Brown C, Cutler JA, Higgins M, Horan MJ, Labarthe D: Prevalence of hypertension in the US adult population. *Hypertension* 1995;25:305-313
3. Collins R, Peto R, MacMahon S, Hebert P, Fiebich NH, Eberlein KA, Godwin J, Qizilbash N, Taylor JO, Hennekens C: Blood pressure, stroke, and coronary heart disease. Part 2: Short-term reductions in blood pressure: Overview of randomised drug trials in their epidemiological context. *Lancet* 1990;335:827-838
4. MacMahon S, Peto R, Cutler J, Collins R, Sorlie P, Neaton J, Abbott R, Goodwin J, Dyer A, Stamler J: Blood pressure, stroke, and coronary heart disease. Part 1: Prolonged differences in blood pressure: Prospective observational studies corrected for the regression dilution bias. *Lancet* 1990;335:765-774
5. Stamler J, Stamler R, Neaton JD: Blood pressure, systolic and diastolic, and cardiovascular risks. *Arch Intern Med* 1993;153:598-615
6. Stamler J: Implications of the INTERSALT study. *Hypertension* 1991;17:116-120
7. JNC V - Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. The Fifth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med* 1993;153:154-183
8. Working Group on Primary Prevention of Hypertension, National High Blood Pressure Education Program: Working group report on primary prevention of hypertension. *Arch Intern Med* 1993;153:186-208
9. Cutler JA, Follmann, Allender PS: Randomized trials of sodium reduction: An overview. *Am J Clin Nutr* 1997;65:643S-651S
10. Graudal NA, Galloe AM, Garred P: Effects of sodium restriction on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride: A meta-analysis. *J Am Med Assoc* 1998;279:1383-1391
11. INTERSALT Cooperative Research Group. INTERSALT: An international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. *Br Med J* 1988;297:319-328
12. Evans M, Cutler JA, Cohen JD, Roccella EJ, Kumanyika S: Implementing recommendations for dietary salt reduction. Where are we? Where are we going? How do we get there? A summary of an NHLBI workshop. *NIH Publications* No. 55-728N; 1996
13. Neaton J, Grimm R, Prineas R, Stamler J, Grandits G, Elmer PJ, Cutler J, Flack J, Schoenberger J, McDonald R, Lewis C, Liebson P, for the Treatment of Mild Hypertension Research Group: Treatment of Mild Hypertension Study (TOMHS): Final results. *J Am Med Assoc* 1993;270(6):713-724
14. TOHP1- The Trials of Hypertension Prevention Collaborative Research Group: The effects of nonpharmacologic interventions on blood pressure of persons with high normal levels. *J Am Med Assoc* 1992;267:1213-1220
15. TOHP2- The Trials of Hypertension Prevention Collaborative Research Group: Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, Phase II. *Arch Intern Med* 1997;157:657-667
16. Whelton PK, Appel LJ, Espeland MA, Applegate W, Ettinger W, Kostis JB, Kumanyika S, Lacy CR, Johnson K, Folmar S, Culter J, for the TONE Collaborative Research Group: Efficacy of sodium reduction and weight loss in the treatment of hypertension in older persons: Main results of the randomized, controlled Trial of Non-pharmacologic Interventions in the Elderly (TONE). *J Am Med Assoc* 1998;279(11):839-846
17. Stamler J: Epidemiologic findings on body mass and blood pressure in adults. *Ann Epidemiol* 1991;1:347-362
18. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL: Increasing prevalence of overweight among U.S. adults: The National Health and Nutrition Examination Surveys, 1960 to 1991. *J Am Med Assoc* 1994;272:206-211
19. NHLBI. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report. *J Obes Res* 1998;6(2):51S-209S

20. Staessen J, Fagard R, Lijnen P, Amery A: Body weight, sodium intake, and blood pressure. *J Hypertens* 1989;7:S19–S23
21. Arroll B, Beaglehole R: Does physical activity lower blood pressure? A critical review of the clinical trials. *J Clin Epidemiol* 1992;45:439–447
22. Braith RW, Pollock ML, Lownthal DT, Graves JE, Limacher MC: Moderate and high-intensity exercise lowers blood pressure in normotensive subjects 60 to 79 years of age. *Am J Cardiol* 1994;73:1124–1128
23. Hagberg JM, Montain SJ, Martin WH, Ehsani AA: Effect of exercise training in 60- to 69-year-old persons with essential hypertension. *Am J Cardiol* 1989;64:348–353
24. Roman O, Camuzzi AL, Villalon E, Klenner C: Physical training program in arterial hypertension. A long-term prospective follow-up. *Cardiology* 1981;67:230–243
25. Anderson RE, Wadden TA, Bartlett SJ, Zemel B, Verde TJ, Frankowiak SC: Effects of lifestyle activity vs. structured aerobic exercise in obese women: A randomized trial. *J Am Med Assoc* 1999;281:335–340
26. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, Blair SN: Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: A randomized trial. *J Am Med Assoc* 1999;281:327–334
27. Crespo CJ, Keteyian SJ, Heath GW, Sempos CT: Leisure time physical activity among US adults. *Arch Intern Med* 1996;156:93–98
28. MacMahon S: Alcohol consumption and hypertension. *Hypertension* 1987;9:111–121
29. Klatsky AL, Friedman GD, Siegelau AB, Gerard MJ: Alcohol consumption and blood pressure. *N Engl J Med* 1977;296:1194–1200
30. Puddey IB, Beilin LJ, Vandongen R, Rouse IL, Rogers P: Evidence for a direct effect of alcohol consumption on blood pressure in normotensive men: A randomized controlled trial. *Hypertension* 1985;7:707–713
31. Puddey IB, Beilin LJ, Vandongen R: Regular alcohol use raises blood pressure in treated hypertensive subjects. *Lancet* 1987;1:647–651
32. Cushman WC, Cutler JA, Hanna E, Bingham SF, Follmann D, Harford T, Dubbert P, Allender S, Dufour M, Collins JF, Walsh SM, Kirk GF, Burg M, Felicetta JV, Hamilton BP, Katz LA Jr, Perry HM, Willenbring ML, Lakshman R, Hamburger RJ, for the PATHS Group: The Prevention and Treatment of Hypertension Study (PATHS): Effects of an alcohol treatment program on blood pressure. *Arch Intern Med* 1998;158:1197–1207
33. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Windhauser MM, Pao-Hwa L, Karanja N, for the DASH Collaborative Research Group: A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;336:1117–1124
34. Whelton PK, He J, Cutler JA, Brancati FL, Appel LJ, Follmann D, Klag MJ: Effects of oral potassium on blood pressure. Meta-analysis of randomized controlled clinical trials. *J Am Med Assoc* 1997;277(20):1624–1632
35. Sacks FM, Rosner B, Kass EH: Blood pressure in vegetarians. *Am J Epidemiol* 1974;100:390–398
36. Rouse IL, Beilin LJ, Armstrong BK, Vandongen R: Blood pressure-lowering effect of a vegetarian diet: Controlled diet in normotensive subjects. *Lancet* 1983;1:5–10
37. Margetts BM, Beilin LJ, Vandongen R, Armstrong BK: Vegetarian diet in mild hypertension: A randomised controlled trial. *Br Med J* 1986;293:1468–1471
38. Morris MC, Sacks FM: Dietary fats and blood pressure. In *Textbook of Hypertension* (Ed. Swales J), p.605–618 Oxford, UK: Blackwell, 1994
39. Cappuccio FP, Elliott P, Allender P, Pryer J, Follman DA, Cutler JA: Epidemiologic association between dietary calcium intake and blood pressure: A meta-analysis of published data. *Am J Epidemiol* 1995;142:935–945
40. Allender PS, Cutler JA, Follmann D, Cappuccio FP, Pryer J, Elliott P: Dietary calcium and blood pressure: A meta-analysis of randomized clinical trials. *Ann Intern Med* 1996;124:825–831
41. Svetkey LP, Simons-Morton D, Vollmer WM, Appel LJ, Conlin PR, Ryan DH, Ard J, Kennedy BM, for the DASH Research Group: Effects of dietary patterns on blood pressure: Subgroup analysis of the dietary approaches to stop hypertension (DASH) randomized clinical trial. *Arch Intern Med* 1999;159:285–293

## A Dietary Approach to Prevent Hypertension: A Review of the Dietary Approaches to Stop Hypertension (DASH) Study

FRANK M. SACKS, M.D., LAWRENCE J. APPEL, M.D.,\* THOMAS J. MOORE, M.D., EVA OBARZANEK, PH.D.,# WILLIAM M. VOLLMER, PH.D.,§  
LAURA P. SVETKEY, M.D.,‡ GEORGE A. BRAY, M.D.,† THOMAS M. VOGT, M.D.,§ JEFFREY A. CUTLER, M.D.,#  
MARLENE M. WINDHAUSER PH.D., R.D.,† PAO-HWA LIN, PH.D.,‡ NJERI KARANJA, PH.D. §

Brigham and Women's Hospital, Boston, Massachusetts; \*Johns Hopkins University, Baltimore, Maryland; †Pennington Biomedical Research Center, Baton Rouge, Louisiana; ‡Duke University Medical Center, Durham, North Carolina; §Kaiser Permanente Center for Health Research, Portland, Oregon; #National Heart, Lung, and Blood Institute, Bethesda, Maryland, USA

### Summary

**Background:** Populations eating mainly vegetarian diets have lower blood pressure levels than those eating omnivorous diets. Epidemiologic findings suggest that eating fruits and vegetables lowers blood pressure.

**Hypothesis:** Two hypotheses were tested: (1) that high intake of fruits and vegetables lowers blood pressure, and (2) that an overall dietary pattern (known as the DASH diet, or DASH combination diet) that is high in fruits, vegetables, nuts, and low-fat dairy products, emphasizes fish and chicken rather than red meat, and is low in saturated fat, cholesterol, sugar, and refined carbohydrate lowers blood pressure.

**Methods:** Participants were 459 adults with untreated systolic blood pressure < 160 mmHg and diastolic blood pressure 80–95 mmHg. After a 3-week run-in on a control diet typical of Americans, they were randomized to 8 weeks receiving either the control diet, or a diet rich in fruits and vegetables, or the DASH diet. The participants were given all of their foods to eat, and body weight and sodium intake were held constant. Blood pressure was measured at the clinic and by 24-h ambulatory monitoring.

**Results:** The DASH diet lowered systolic blood pressure significantly in the total group by 5.5/3.0 mmHg, in African Americans by 6.9/3.7 mmHg, in Caucasians by 3.3/2.4 mmHg, in hypertensives by 11.6/5.3 mmHg, and in nonhypertensives

by 3.5/2.2 mmHg. The fruits and vegetables diet also reduced blood pressure in the same subgroups, but to a lesser extent. The DASH diet lowered blood pressure similarly throughout the day and night.

**Conclusions:** The DASH diet may offer an alternative to drug therapy in hypertensives and, as a population approach, may prevent hypertension, particularly in African Americans.

**Key words:** hypertension, nutrition, blood pressure, Dietary Approaches to Stop Hypertension

### Introduction

High blood pressure affects around 50 million adults in the United States, increasing their risk of coronary heart disease, heart failure, heart attack, stroke, and kidney failure.<sup>1</sup> Above-average blood pressure levels, not high enough to be classified as hypertension, also are associated with increased cardiovascular risk in the population. The Dietary Approaches to Stop Hypertension (DASH) diet was born from an initiative of the National Heart, Lung, and Blood Institute (NHLBI) to examine dietary factors that affect blood pressure. It had long been known that populations who ate diets based on vegetable products had lower blood pressure levels than usually found in western countries, and lower incidences of hypertension and stroke.<sup>2</sup> Several vegetarian populations in the U.S., Australia, and Israel had lower blood pressures than nonvegetarians in the same area,<sup>2</sup> but it was difficult to identify particular nutrients or foods that accounted for the favorable blood pressures associated with a vegetarian diet. Epidemiologic studies found that minerals such as potassium, magnesium, and calcium, and fiber (inversely), and dietary fats (directly) had associations with blood pressure or hypertension.<sup>3–5</sup> However, clinical trials found that the blood pressure effects of these and other nutrients studied individually were small and inconsistent, only establishing that potassium has a modest blood pressure-lowering effect.<sup>6</sup> Thus, the large potential effect of the vegetarian dietary pattern could not be broken

---

The DASH trial was funded by the National Heart, Lung, and Blood Institute.

Address for reprints:

Frank M. Sacks, M.D.  
Nutrition Department  
Harvard School of Public Health  
665 Huntington Ave.  
Boston, MA 02115, USA

down into individual nutrients. The DASH planning group considered that the blood pressure effect of diet may be due to the total mix or interactions of nutrients or due to some unknown constituents. Although vegetarian diets did provide some original inspiration for us to conduct DASH, the planning group strongly intended that the results of the trial would be acceptable to the US population, and therefore opted against testing a vegetarian diet. Furthermore, small studies of meat and its protein and fat components overall did not find adverse effects on blood pressure. Prospective epidemiologic studies in the U.S., one in men<sup>3</sup> and the other in women,<sup>4</sup> found that high intake of fruits and vegetables was associated with lower blood pressure and less change in blood pressure with age. These and other studies demonstrated the need to conduct clinical trials of dietary patterns and blood pressure. Thus, the goal of DASH was to identify a dietary pattern that could lower blood pressure and would be palatable to the general population. The major findings have been published<sup>7, 8</sup> and are summarized in this article.

### The Design of DASH

The study design has been published in detail.<sup>7, 9</sup> The strongest evidence from epidemiology for foods that lower blood pressure favored fruits and vegetables. Thus, a high intake of fruits and vegetables was a central part of the dietary interventions. Other hypotheses included increasing calcium intake, increasing vegetable oils or decreasing animal fats, increasing n-3 fatty acids as in fish oils, and increasing total or vegetable protein. DASH was a randomized clinical trial that tested (1) a “combination” diet (the DASH diet) that was high in fruits, vegetables, nuts, whole-cereal products, low-fat dairy products, fish, chicken, and lean meats designed to be reduced in saturated fat, total fat, and cholesterol, moderately high in protein, and high in minerals and fiber, and (2) a “fruits and vegetables” diet that tested the effect of fruits and vegetables alone. The dietary patterns were constructed with commonly consumed food items, so that the results could be conveniently integrated in dietary recommendations to the general public. These two intervention diets were compared with a control dietary pattern that resembled customary intake in the U.S. The control diet contained selected nutrients such as potassium, magnesium, and calcium in amounts that approximated the 25th percentile of the U.S. diet. The composition of the diets is shown in Figure 1. All three diets contained similar amounts of sodium (approximately 3,000 mg/day), and energy intake was adjusted to maintain the initial body weight of each participant. All food for the experimental diets was provided to the participants, and they were expected to eat all of and only this food. A run-in period of 3 weeks during which the participants were fed the control diet preceded the intervention feeding period of 8 weeks. DASH was conducted at four clinical sites and a coordinating center with the participation of the NHLBI and the oversight of a Data and Safety Monitoring Board. The IRB of each center approved the protocol, and each participant gave informed consent in writing.

### Study Population

Inclusion criteria were blood pressure < 160 mmHg systolic and 80–95 mmHg diastolic as determined from 6 days of measurement during screening and run-in, using a random-zero device in the clinic. Exclusion criteria were age < 22 years; use of antihypertensive medication or other medication that affects blood pressure; use of and unwilling to stop vitamin or food supplements; alcoholic beverage intake > 14 drinks per week; poorly-controlled diabetes mellitus, hyperlipidemia; and body mass index (BMI) > 35 kg/m<sup>2</sup>. The study was designed to include 2/3 minority participants because of the disproportionate burden of hypertension in African Americans.

### Outcomes

The primary endpoint was the change in diastolic blood pressure from baseline to the end of the 8-week intervention period. Change in systolic blood pressure was a prespecified secondary endpoint. Baseline blood pressure was defined as the average of 7 days of measurements, 3 during screening and 4 during run-in. On each day, two measurements were taken 5 min apart. Blood pressure was measured weekly during the first 6 weeks, and on 5 days during Weeks 7 and 8 of intervention. These last five sets of measurements were used to compute end of study blood pressure, and the effect of the diets. Random-zero sphygmomanometers were used for blood pressure measurements of the primary endpoints. Blood pressures were measured by personnel who were trained to follow standardized procedures and continuously monitored for technique and digit preference. All measurements were taken by staff blinded to the participants’ diet assignments. Ambulatory blood pressure was recorded during a 24-h period at the end of run-in and intervention in a subset of participants, and was used as an ancillary outcome variable. The intended sample size of 456 was designed to provide 85% power to detect a 2 mmHg difference between diets in diastolic blood pressure. All analyses were performed using the intention-to-treat principle. Thus, all participants who started the intervention were included regardless of time spent in the study.

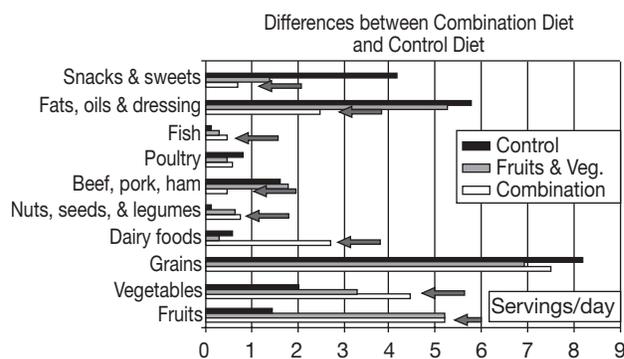


FIG. 1 The number of servings of foods of the diets in the DASH study. Arrows point to the major foods that differed between the DASH combination and control diets.

TABLE I Baseline characteristics of randomized participants by race and sex subgroups

Variable	Non-Hispanic Caucasians	African Americans	Other minority	Female	Male	Total group
No. of patients	156	275	28	225	234	459
Age, years	46 (11.9)	44 (9.7)	43 (10.0)	45 (9.7)	44 (11.3)	45 (10.6)
Race, % African American	—	—	—	72	48	60
Sex, % female	33	59	36	—	—	49
Baseline SBP, mmHg <sup>a</sup>	130.9 (10.8)	131.8 (10.7)	128.6 (10.6)	133.0 (12.0)	129.6 (9.2)	131.3 (10.7)
Baseline DBP, mmHg <sup>a</sup>	84.5 (4.3)	84.8 (4.9)	84.2 (5.3)	84.5 (4.9)	84.8 (4.6)	84.7 (4.7)
Hypertensive, % <sup>b</sup>	26	32	18	36	23	29
Family history HTN, %	71	71	57	75	65	70
BMI mg/kg <sup>2</sup>						
Females	27.9 (4.6)	29.0 (3.8)	27.7 (4.1)	—	—	28.7 (4.0)
% obese <sup>c</sup>	54	66	40	—	—	62
Males	27.4 (3.7)	28.3 (3.7)	26.1 (3.5)	—	—	27.7 (3.7)
% obese <sup>c</sup>	46	57	28	—	—	50
Physical activity, kcal/kg/day	38.0 (6)	37.6 (7)	36.2 (4)	35.5 (4)	39.7 (8)	37.7 (7)
Alcohol intake, % w/any	48	33	39	30	47	39
Family income ≥ \$45,000/year (%)	50	33	43	32	47	39
Education, % with some college	89	77	89	79	84	82

All continuous variables expressed as mean (standard deviation).

<sup>a</sup> Baseline blood pressure defined as the average of the screening and end-of-run-in blood pressures.

<sup>b</sup> Hypertensive defined as systolic (S) blood pressure (BP) ≥ 140 and/or diastolic (D) BP ≥ 90 at baseline. HTN = hypertension.

<sup>c</sup> Obesity defined as body mass index (BMI) ≥ 27.3 kg/m<sup>2</sup> for women and ≥ 27.8 kg/m<sup>2</sup> for men.

Reprinted from Ref. No. 8 with permission.

## Results

The study population consisted of 459 healthy men and women, mean age 44 years (Table I). The average blood pressure was 132/85 mmHg. About 29% had mild hypertension. The blood pressures of the study population were classified as either Stage 1 hypertension, high normal, or normal. African Americans comprised 60% of the population. The participants on average were mildly overweight with an average body mass index of 27–28 kg/m<sup>2</sup>.

Dietary adherence was excellent; over 95% attended the required meals and ate all of the meals. Urinary potassium increased in proportion to the intended increase in dietary intake.<sup>7</sup> Sodium excretion was constant and body weight was stable, as intended.

Both intervention diets lowered blood pressure significantly compared with the control diet. The effect was relatively rapid, with the full effect apparent after only 2 weeks (Fig. 2).

Compared with the control diet, the DASH combination diet significantly reduced blood pressure by 5.5 mm systolic and 3.0 mm diastolic using measurements made in the clinics, and 4.5 mm systolic and 2.7 mm diastolic for 24-h ambulatory measurements. The effects of the diets were similar in men and women. The blood pressure reductions in the African American participants were significantly greater than in the Caucasian participants, 6.9/3.7 vs. 3.3/2.4 mmHg (Fig. 3).<sup>8</sup>

The DASH diet was more effective in hypertensive patients than in those with high normal blood pressure: 11.6/5.3 vs. 3.5/2.2 mmHg.<sup>8</sup> Among African Americans with hyper-

tension, the DASH combination diet reduced blood pressure by 13.2/6.1 mmHg. Among normotensive African Americans, the combination diet reduced blood pressure by 4.3/2.6 mmHg. Among Caucasians, blood pressure decreased 6.3/4.4 mmHg in hypertensives and 2.0/1.2 mmHg in normotensives. The therapeutic effects of the DASH diet in the hyper-

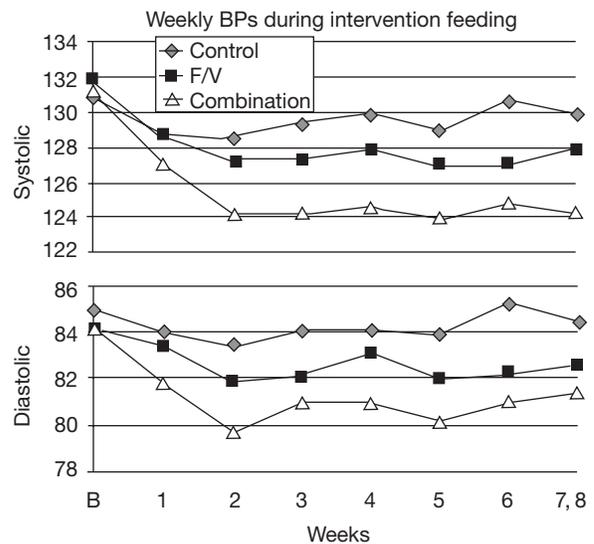


FIG. 2 Weekly change in blood pressure during the DASH trial. F/V = fruits and vegetables diet. Reprinted from Ref. No. 7 with permission.

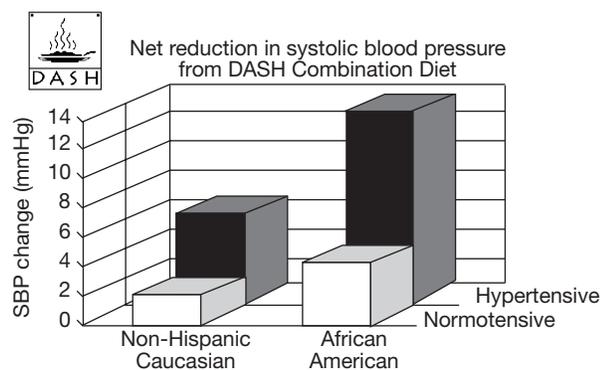


FIG. 3 Blood pressure changes on the DASH combination diet in race/blood pressure groups. SBP = systolic blood pressure.

tensive patients, African-American or Caucasian, approached the magnitude of monotherapy with a drug.

The fruits and vegetables diet reduced blood pressure by about half the amount of the DASH diet,  $-2.8/-1.1$  mmHg for clinic, and  $-3.1/-2.1$  mmHg for ambulatory readings, for the entire study population. The fruits and vegetables diet was particularly effective in hypertensives, lowering blood pressure by  $8.0/3.4$  mmHg among hypertensive African Americans, and by  $5.9/3.1$  mmHg among hypertensive Caucasians.

## Discussion

### Clinical and Public Health Relevance

The DASH diet substantially and significantly lowered blood pressure in the study population as well as in all participant groups. It was particularly effective in African Americans and in hypertensive individuals, Caucasian or African American. The magnitude of the blood pressure lowering has clinical application in hypertensives and public health applicability for the general population. The DASH diet could replace pharmacologic therapy as initial antihypertensive treatment, or decrease the need for combination drug therapy, for those patients who would adhere to it. In the general population, the DASH diet could prevent the development of hypertension and its associated cardiovascular disease. Despite the greater effect in hypertensives, the DASH diet was also effective in those with high normal or normal blood pressure, suggesting a role for this dietary intervention in primary prevention both in clinical populations and in the general population.

### What Foods or Nutrients in the DASH Diet Reduce Blood Pressure? (Figs. 1 and 4)

**Fruits and vegetables:** The “Fruits and Vegetables” diet arm proved that fruits and vegetables, including nuts, lower blood pressure and are responsible for at least half of the total effect of the DASH diet. Fruits, vegetables and nuts are high in potassium, magnesium, fiber, and many other nutrients. Of these,

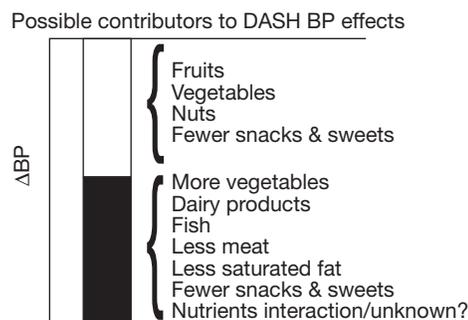


FIG. 4 Foods responsible for the blood pressure-lowering of the DASH combination diet and the Fruits & Vegetables diet. The upper 50% of the bar represent the effect of the Fruits and Vegetables diet, and the bottom 50% of the bar represent the incremental effect of the DASH combination diet over the effect of the Fruits and Vegetables diet.

potassium is best established for lowering blood pressure, particularly in persons with low intake, in hypertensive persons, and in African Americans.<sup>6, 10, 11</sup> The DASH diet increased potassium intake from a low daily amount of approximately 1,700 mg to a high level of 4,100 mg. The magnitude of the blood pressure reduction on the fruits and vegetables diet could be caused mostly by potassium, judging from the effects of potassium supplementation in hypertensives or in persons with low customary potassium intake.<sup>6, 10, 11</sup>

**Other foods and nutrients:** Aside from testing a diet high in fruits and vegetables, the DASH study was not designed to determine other specific foods that reduce blood pressure. Compared with the fruits and vegetables diet, the DASH diet had more vegetables, low-fat dairy products, and fish, and was lower in red meat, sugar, and refined carbohydrates (Figs. 1 and 4). Consequently, it was higher in protein, complex carbohydrate, and calcium, and was lower in sugar, saturated and monounsaturated fatty acids, total fat, and cholesterol. Trials that tested these nutrients individually have not found effects on blood pressure that could account for the effects of the DASH diet. Perhaps very small hypotensive effects of several nutrients, too small to be detected in a clinical trial or in a meta-analysis, for example,  $0.5-1$  mm Hg, could combine to reduce blood pressure substantially, or perhaps nutrients may exist that are not known or not recognized as having a blood pressure-lowering effect.

## Conclusions

The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure endorsed the results of DASH and recommended its use, in combination with other nonpharmacologic treatments such as weight loss and reduced sodium intake, for the population and in clinical practice.<sup>1</sup> The DASH diet is reasonably low in cost, with a retail price of about \$130 per week for a family of 4. It is compatible with diet therapy to treat hyperlipidemia and to reduce

coronary heart disease, and with recommendations to prevent cancer. The DASH diet is currently being studied in combination with dietary sodium reduction, and behavioral programs are being developed to teach free-living populations how to follow the diet.\*

\* Information about the DASH diet is available on the web site: <http://dash@bwh.harvard.edu>.

## References

1. Joint National Committee: The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Institutes of Health, National Heart, Lung, and Blood Institute, National High Blood Pressure Education Program. 1997. *NIH Publication* No. 98-4080
2. Sacks FM, Kass EH: Low blood pressure in vegetarians: Effects of specific foods and nutrients. *Am J Clin Nutr* 1988;48:795-800
3. Ascherio A, Rimm EB, Giovannucci EL, Colditz GA, Rosner B, Willett WC, Sacks FM, Stampfer MJ: A prospective study of nutritional factors and hypertension among US men. *Circulation* 1992;86:1475-1484
4. Ascherio A, Hennekens CH, Willett WC, Sacks FM, Rosner B, Manson J, Witteman J, Stampfer MJ: A prospective study of nutritional factors, blood pressure, and hypertension among US women. *Hypertension* 1996;27:1065-1072
5. Stamler J, Caggiula A, Grandits GA, Kjelsberg M, Cutler JA, for the MRFIT Research Group: Relationship to blood pressure of combinations of dietary macronutrients. Findings of the Multiple Risk Factor Intervention Trial (MRFIT). *Circulation* 1996;94:2417-2423
6. Whelton PW, He J, Cutler JA, Brancati FL, Appel LJ, Follmann D, Klag MJ: The effects of oral potassium on blood pressure: Meta-analysis of randomized controlled clinical trials. *J Am Med Assoc* 1997;277:1624-1632
7. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin P-H, Karanja N: The effect of dietary patterns on blood pressure: Results from the Dietary Approaches to Stop Hypertension (DASH) trial. *N Engl J Med* 1997;336:1117-1124
8. Svetkey LP, Simons-Morton D, Vollmer WM, Appel LJ, Conlin PR, Ryan DH, Ard J, Kennedy BM for the DASH research group: Effects of dietary patterns on blood pressure: Subgroup analysis of the Dietary Approaches to Stop Hypertension (DASH) randomized clinical trial. *Arch Intern Med* 1999;159:285-293
9. Sacks FM, Obarzanek E, Windhauser MM, Svetkey LP, Vollmer WM, McCullough M, Karanja N, Lin PH, Steele P, Proschan MA, Evans MA, Appel LJ, Bray GA, Vogt TM, Moore TJ: Rationale and design of the Dietary Approaches to Stop Hypertension trial (DASH). *Ann Epidemiol* 1995;5:108-118
10. Sacks FM, Willett WC, Smith A, Brown LE, Rosner B, Moore TJ: Effect on blood pressure of potassium, calcium, magnesium in women with low habitual intake. *Hypertension* 1998;31:131-138
11. Brancati FL, Appel LJ, Seidler AJ, Whelton PK: Effect of potassium supplementation on blood pressure in African-Americans on a low-potassium diet. A randomized, double-blind placebo-controlled trial. *Arch Intern Med* 1996;156:61-67

## Nut Consumption, Lipids, and Risk of a Coronary Event

GARY E. FRASER, M.B. CH.B., PH.D.

Center for Health Research, School of Public Health, Loma Linda University, Loma Linda, California, USA

**Summary:** In the past, many have avoided nuts because of their high fat content. The Dietary Approaches to Stop Hypertension (DASH) diet, however, recommends regular consumption of this food along with seeds and dried beans (4–5 servings per week) as part of a diet to control hypertension. Nuts are nutrient-dense and most of their fat is unsaturated. They are also perhaps the best natural source of vitamin E and are relatively concentrated repositories of dietary fiber, magnesium, potassium, and arginine, the dietary precursor of nitric oxide. Human feeding studies have demonstrated reductions of 8–12% in low-density lipoprotein (LDL) cholesterol when almonds and walnuts are substituted for more traditional fats. Other studies show that macadamias and hazelnuts appear at least as beneficial as fats in commonly recommended diets. Whether consuming modest quantities of nuts daily may promote weight gain is not known with certainty, but preliminary data suggest that this is unlikely. Four of the best and largest cohort studies in nutritional epidemiology have now reported that eating nuts frequently is associated with a decreased risk of coronary heart disease of the order of 30–50%. The findings are very consistent in subgroup analyses and unlikely to be due to confounding. Possible mechanisms include reduction in LDL cholesterol, the antioxidant actions of vitamin E, and the effects on the endothelium and platelet function of higher levels of nitric oxide. Although nuts may account for a relatively small percentage of dietary calories, the potential interacting effects of these factors on disease risk may be considerable.

**Key words:** nuts, lipids, coronary heart disease, vitamin E

### Introduction

For many years there has been a strong opinion that dietary habits affect coronary risk factors and hence probably the risk of a coronary event. The evidence is now overwhelming that consumption of dietary fats, oats, and other sources of fiber, as well as a small number of phytochemicals, affect blood lipids, and that consumption of alcohol, potassium, sodium, and a vegetarian diet influence blood pressure levels. However, there is much less direct evidence that diet affects the frequency of coronary events. This is probably largely related to the difficulties of accurately measuring dietary habits. A few good population studies have implicated dietary fats,<sup>1,2</sup> as expected on the basis of nutritional research. Others could not show these effects. There is some support for the idea that fish consumption may be protective,<sup>3</sup> but surprisingly such an effect may be mainly seen at quite low intake.

Much of the practice of preventive cardiology is burdened with the problem of coercing reluctant patients to change habits which they enjoy (smoking, eating food high in saturated fat, physical inactivity). It is a pleasing change to note increasing evidence for a probably protective food that most people will eat more frequently with little persuasion. I refer to the consumption of modest quantities of nuts.

### A Brief Note on the Chemistry of Nuts

Nuts are fatty foods and as such have been treated with caution in most previous dietary recommendations. Indeed, about 80% of the calories in most nuts come from fat, but this is largely monounsaturated (polyunsaturated in walnuts). Nuts also contain significant quantities of dietary fiber, potassium, magnesium, and copper. They are perhaps the best natural source of antioxidant vitamin E, and are also rich in arginine, the dietary precursor of nitric oxide.

In Tables I and II, as an example, the content of these factors is examined in almonds compared with a number of other common fatty foods of animal origin. In most cases, the contrast is quite dramatic, demonstrating that it is probably not appropriate to group nuts with meats and dairy products as is currently the case in the USDA food pyramid. More recent dietary recommendations such as those developed for the Dietary Approaches to Stop Hypertension (DASH) diet,<sup>4,5</sup> by Oldways Foundation,<sup>6</sup> or those for vegetarians,<sup>7</sup> place nuts more appropriately with seeds and legumes. In addition, along

---

Address for reprints:

Gary E. Fraser, M.B. CH.B., Ph.D.  
Center for Health Research  
School of Public Health, NH 2008  
Loma Linda University  
Loma Linda, CA 92350, USA

TABLE I The fat content (calories) of selected nuts and other common fatty foods of animal origin (per 100 g of food)<sup>a</sup>

	Total fat	SFA	MUFA	PUFA	UFA/SFA
Almonds	473	45	307	99	9.06
Walnuts	557	50	128	352	9.52
Filberts	563	41	442	54	11.98
Pecans	608	49	380	150	10.91
Pistachios	436	55	294	66	6.53
Macadamias	663	99	524	12	5.41
Peanuts	443	61	220	140	5.87
Beef, T-bone (trimmed)	191	77	80	7	1.14
Chicken, roasted	120	33	47	26	2.19
Whole milk	30	19	9	1	0.52
Eggs	101	30	40	13	1.76
Cheddar cheese	298	190	85	8	0.49

<sup>a</sup> Values taken from U.S. Dept. of Agriculture Handbooks: Composition of Foods.

*Abbreviations:* SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids, UFA = unsaturated fatty acids.

with many other vegetable foods, nuts are a storehouse for a large number of phytochemicals that are presently less well defined. However, these substances include at least certain flavonoids, other polyphenols, and sterols that may well have biological activity.

### The Effect of Nut Consumption on Blood Cholesterol Levels

Several studies of various design have evaluated the effect of consumption of almonds, walnuts, hazelnuts and macadamias on blood cholesterol levels. A study of pecans is underway. Some have simply recommended nuts and nut oils as a supplement to be incorporated into the diet; others control the other fats in the diet and/or the foods for which the nuts are substituted.

Berry *et al.*<sup>8,9</sup> used either almonds, olive oil, or avocados as a source of fat in a diet, thus increasing the quantities of monounsaturated fats (MUFA), or walnuts, safflower, and soy to increase polyunsaturated fats (PUFA). These two diets were compared with each other or with a third high-carbohydrate diet in two separate studies. These studies were randomized crossover feeding trials involving 17 or 18 young men over two 12-week feeding periods. The investigators controlled the whole diet, with the MUFA and PUFA diets having 34% and 33% of calories as total fat, respectively. Compared with the baseline diet, both the high MUFA and high PUFA diets had quite similar effects, lowering total and LDL cholesterol levels 10–20% and not changing high-density lipoprotein (HDL) cholesterol. When compared with the high-carbohydrate diet, the high MUFA diet lowered total and LDL cholesterol.

TABLE II Contents of selected food constituents in nuts and other common fatty foods of animal origin (per 100 g of food)<sup>a</sup>

	Vitamin E (mg) <sup>b</sup>	Dietary fiber (g) <sup>c</sup>	Mg <sup>2+</sup> (mg)	Arginine (g)	Cholesterol (mg)
Almonds	16.1	11.2	296	2.5	0
Walnuts	3.1	4.8	169	2.1	0
Filberts	21.9	6.4	285	2.2	0
Pecans	2.7	6.5	128	1.1	0
Pistachios	4.5	10.8	158	2.2	0
Macadamias	<sup>d</sup>	5.2	117	0.8	0
Peanuts	6.3	8.8	180	3.5	0
Beef, T-bone (trimmed)	0.3	0	25	1.6	83
Chicken, roasted	0.4	0	23	1.7	107
Whole milk	0.04	0	13	0.1	14
Eggs	0.7	0	12	0.8	548
Cheddar cheese	0.4	0	28	0.9	105

<sup>a</sup> Data from U.S. Dept. of Agriculture Handbooks: Composition of Foods.

<sup>b</sup> Alpha-tocopherol equivalents. From the Nutrition Data System, Nutrition Coordinating Center. Univ. of Minnesota. Version 2.5, 1993.

<sup>c</sup> Dietary fiber taken from Spiller GA: Appendix I of *Handbook of Dietary Fiber in Human Nutrition*, Boca Raton, Fla.: CRC Press, 1993.

<sup>d</sup> Not available.

Spiller *et al.* have reported three studies with an emphasis on the effect of almonds/almond oil on blood lipids. In the first study,<sup>10</sup> two groups totaling 30 hypercholesterolemic subjects were given careful dietary advice and quite different fatty supplements in a parallel study design. Each group participated in the study for 4 weeks. The first group adhered to a low-fat base diet plus a 100 g/day supplement of almonds. The second group had the same low-fat base diet, plus 48 g of fat from butter and cheese. While on the diets, the first group experienced a 15% drop in total cholesterol compared with the second group.

In the second study,<sup>11</sup> the almonds were supplemental to a partially controlled “usual” diet for which limited dietary advice was given. The foundation of the recommended “usual” diet was grains, beans, vegetables, fruit, and low-fat milk products. Meat and high-fat dairy products were minimized. The 26 men and women from a cardiac rehabilitation unit took a supplement of 100 g/day of almonds and almond oil for 9 weeks, on average consuming 37% of total calories as fat. Again, compared with the “usual diet”, total and LDL cholesterol declined 9% and 12%, respectively.

For the third study,<sup>12</sup> Spiller *et al.* enrolled 48 hypercholesterolemic subjects with mean baseline total cholesterol of 251 mg/dl. Careful instructions were given to help subjects conform to a recommended baseline diet, which was then supplemented with either (1) 100 g almonds, (2) 48 g olive oil and 113 g cottage cheese, or (3) 85 g cheddar cheese, 28 g butter, each day for four weeks in a parallel study design. By the end of the study, total cholesterol levels had changed to

222 mg/dl, 240 mg/dl, and 263 mg/dl, respectively (differences significant  $p < 0.001$ ). Similar significant changes were seen for LDL cholesterol, but there was virtually no effect on HDL cholesterol.

Sabaté *et al.*<sup>13</sup> conducted a carefully controlled crossover feeding study in 18 young men. All meals were fed during two 4-week dietary periods. In one diet, a basic diet was supplemented with 85 g/day of walnuts, and during the control period by equivalent fat calories from more traditional foods. Although both the control and the walnut diets contained only 30% of calories as fat, much of the fat in the latter was polyunsaturated, while the control diet had 10% of calories from each of saturated fatty acids, MUFA, and PUFA. Total cholesterol dropped 12.4%, LDL 16.3%, and a nonsignificant smaller drop was also seen in HDL cholesterol.

Another recently completed study of walnut supplementation in subjects with elevated serum cholesterol has also demonstrated significant lowering of lipid levels.<sup>14</sup> Abbey *et al.*<sup>15</sup> in Australia trained 16 men to record their fat consumption and then provided supplements to be added to the basic diet. The first supplement was constructed to match the fatty acid profile of the Australian diet, the second consisted of 84 g of MUFA-rich almonds, and the third of 68 g of PUFA-rich walnuts. During successive 3-week periods, LDL cholesterol was lower by 10.3% and 8.9%, respectively, with almonds and walnuts, whereas HDL cholesterol did not change.

Two other studies have evaluated the effects of supplementing relatively low-fat, high-carbohydrate diets with macadamia nuts.<sup>16,17</sup> In each case, despite the increase in total fat, as most of this was monounsaturated, blood lipid levels did not change, except for a nonsignificant 9% rise in HDL cholesterol. Finally, a feeding study of 70 children and 104 adults, in which the intervention was a supplement of hazelnuts, will soon be reported. Again the effects on blood lipids appeared beneficial, with an increase in HDL and a fall in LDL cholesterol. There was no significant change in body weight.<sup>18</sup>

### Nut Consumption and Obesity

Some worry that advocating increased use of a fatty food may further aggravate the serious problem of obesity in the United States. This important question cannot yet be clearly addressed with data, but a few clues suggest that this may not be the case. A study in rats indicates that just as different types of dietary fatty acids affect blood cholesterol differently, the same may be true of their effects on body fat. When fed calories as saturated fat, they increased body fat much more and “burned” much less (as indicated by the respiratory quotient), than those fed equivalent polyunsaturated fat calories.<sup>19</sup>

Several investigators have noted that in certain human nut feeding studies that included only limited dietary advice, weight gain was not a problem despite supplements of several hundred calories of nuts and/or nut fat each day.<sup>11, 17, 20</sup> We have almost completed a study that formally tested the hypothesis that adding a supplement of 320 calories of almonds daily with no dietary advice does not change body weight. Preliminary

results suggest that this is so.<sup>21</sup> Suggested explanations for such a possible result include a satiety effect of nuts compensating for the additional nut calories by decreased intake of other foods; limited absorption of the fat due to the nut fiber or poor mastication; or an unexplained metabolic effect whereby nut fats are “burned” rather than stored, perhaps associated with a higher metabolic rate.

### Directly Observed Associations between Nut Consumption and Risk of Coronary Heart Disease Events

We first observed<sup>22</sup> that those who consume nuts frequently had an approximately 50% lower risk of either a fatal or a non-fatal coronary event than those who eat nuts rarely. There was an apparent dose–response association (Fig. 1) shown in a cohort study of 34,000 non-Hispanic, Caucasian California Seventh-Day Adventists. The number of events in Figure 1 is, of course, reflective of the total number of subjects at risk in each group as well as the CHD risk. Of these Adventist subjects, nearly 25% ate nuts five times each week or more. However, many others rarely ate nuts, so a comparison with good statistical power was possible. It was impressive to us that however we divided the data, the “nut effect” was always seen. Men, women, vegetarians, omnivores, hypertensives, nonhypertensives, relatively obese or relatively thin subjects, older or younger subjects, who ate large quantities of nuts, all had a substantially lower CHD risk than their counterparts eating lower quantities of nuts (Table III). Multivariate analyses, adjusting for traditional risk factors and several other foods, did not change these findings in any important way. We have subsequently reported<sup>23</sup> that a protective association with nut consumption is still clearly found in the oldest-old Adventists (over age 84 years), and that in multivariate analyses, African American Adventists who consume nuts more frequently experience a lower total mortality.<sup>24</sup> Other results show that the consumers of larger quantities of nuts in the non-Hispanic, Caucasian Adventists population have lower total mortality.<sup>25</sup> Lifetable analyses indicate that consumers of high quantities

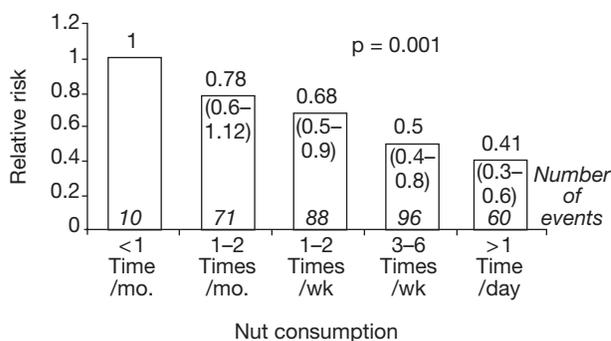


FIG. 1 Estimated relative risk for all fatal coronary heart diseases, stratified for age and sex: The Adventist Health Study.

TABLE III Associations between nut consumption and risk of coronary heart disease in various subgroups of the Adventist Health Study Population

Subgroup	Relative risk			p Values
	Frequency of nut consumption			
	< 1/week	1-4/week	> 4/week	
Men	1.00	0.87	0.40	<0.001
Women	1.00	0.56	0.51	<0.001
Age < 80 years	1.00	0.88	0.48	<0.001
Age ≥ 80 years	1.00	0.56	0.45	<0.001
Normotensive	1.00	0.79	0.40	<0.001
Hypertensive	1.00	0.75	0.81	NS
Vegetarian	1.00	0.58	0.42	<0.001
Nonvegetarian	1.00	0.97	0.54	<0.05
BMI ≤ 23.9	1.00	0.58	0.47	<0.001
BMI > 23.9	1.00	0.80	0.52	<0.01
Low exercise	1.00	0.62	0.63	<0.05
Higher exercise	1.00	0.77	0.38	<0.001
White bread only	1.00	0.57	0.46	0.07
Other breads or mixed	1.00	0.74	0.48	<0.001

Abbreviations: BMI = body mass index, which had a mean value of 23.9 in this population, p = test of differences between categories of nut consumption, NS = not significant.

of nuts experience an extra 5.6 years of life expectancy free of coronary disease and an 18% lifetime risk of CHD compared with 30% in consumers of low quantities of nuts.<sup>26</sup>

The Iowa Women's Study<sup>27,28</sup> of 34,000 women also found that higher nut consumption was associated with a 40% reduction in risk. This was despite the fact that, in this population, the highest category of nut consumption was relatively low at greater than once per week. They speculated that this was partly due to the vitamin E content of nuts, as adjustment for vitamin E reduced the apparent protection to 28%.

Findings from the 86,000 nurses in the Nurses' Health Study<sup>29</sup> confirm previous observations. After adjusting for traditional risk factors, those consuming nuts frequently (at least five ounces/week) had a 39% reduction ( $p = 0.007$ ) in fatal CHD events and a 32% reduction ( $p = 0.04$ ) in nonfatal myocardial infarction compared with those eating less than 1 ounce of nuts per week. Further adjustment for intake of dietary fats, fiber, vegetables, and fruits did not greatly change these results. The authors also reported results in 32 different subgroups of the population. In every case, those consuming higher quantities of nuts had a lower risk than those "almost never" consuming nuts, and in 25 and 29 of these subgroups  $p$  for trend was  $< 0.05$  or  $0.01$ , respectively, a remarkable degree of consistency. Their analyses suggested that these findings applied to peanuts as well as tree nuts. Peanuts are legumes but have a nutrient profile broadly similar to other nuts.

Finally, the Physicians' Health Study of 22,000 male physicians found a significantly decreasing risk of cardiac death and sudden death as nut consumption increased.<sup>30</sup> These trends persisted on multivariate adjustment.

## Discussion

Data from several feeding trials, in which quantities of various types of nuts were added to the diet, consistently suggest that such supplements are at least as effective as or superior to fats in the recommended Step I American Heart Association diet. Levels of LDL are equal to or better than those observed when subjects eat the recommended diet. In view of the nutrient profile of nuts, this is not a surprise and indeed is predicted by the Keys equation.<sup>31</sup>

In addition, the consistent findings now from four of the largest and best cohort studies in nutritional epidemiology are impressive by directly associating nut consumption with reduced risk of CHD events. As far as we know, there are no other foods that have been so consistently associated with a marked reduction in CHD risk. When seeking evidence of causality, it is wise to require repetition of the finding in good studies from diverse populations. While further evidence is awaited with interest, such findings in California Seventh-Day Adventists (men and women separately), women in Iowa, and large groups of U.S. nurses and physicians, already supply a good deal of diversity. The robustness of the findings among many subgroups in two of these studies makes it exceedingly unlikely that these results are due to chance alone.

However, the epidemiologic studies are observational and confounding could still be a problem in theory. Are the nut-eaters different in some other way that accounts for the decreased risk? Theoretical consideration<sup>32</sup> suggests that a spurious two-fold effect due only to confounding requires the confounding factor to be a very strong risk factor and to be tightly linked or correlating with the factor of interest, in this case nut consumption. Such an unknown strong confounder is very elusive and we doubt that it exists. The four cohort studies have all adjusted for most of the known CHD risk factors, with only modest change in the magnitude of the apparent effect. Indeed the Nurses' Health Study even adjusted for hyperlipidemia, even though this may be an intermediary on any causal path between nut consumption and decreased risk.

As most persons who eat nuts eat relatively small quantities, how may these produce such strong apparent effects on risk of CHD? Based on the various nut-feeding studies, one would expect that the quantities of nuts that even daily consumers generally eat would reduce total cholesterol at most by 10%. This would be expected to result in a reduction in CHD events of approximately 25%, yet the studies observe 35-50% reductions. This suggests that other factors influence these findings. A 50 g serving of nuts will exceed the recommended daily allowance for vitamin E, and this may well add or even interact with the antiatherogenic effects of lower blood cholesterol levels. Finally, there is also the possibility that the relatively high content of arginine in nuts may help raise levels of endogenous nitric oxide, which promotes normal endothelial function and has effects to inhibit platelet aggregation, monocyte adherence, chemotaxis, and vascular smooth muscle proliferation.<sup>33</sup> That this may occur with oral supplementation requires further support but has been shown to be effective in rabbits and mice,<sup>34</sup> and possibly in humans with baseline en-

dothelial dysfunction.<sup>35-37</sup> Some of these studies have also found that the oral arginine inhibits platelet aggregation.<sup>35,36</sup> Thus there is the possibility that nuts may provide antiatherogenic effects by lowering blood LDL cholesterol levels, reducing LDL particle oxidation, reducing platelet aggregability, and improving endothelial function. If all this were to prove the case, the salutary effects of nuts when eaten in modest quantities would be less surprising.

## References

1. Shekelle RB, Shryock AM, Paul O, Lepper M, Stamler J, Liu S, Rayner WJ: Diet, serum cholesterol and death from coronary heart disease. The Western Electric Study. *N Engl J Med* 1981;304:65-70
2. Hu FB, Stampfer MJ, Manson JE, Rimm E, Colditz GA, Rosner BA, Hennekens CH, Willett WC: Dietary fat intake and risk of coronary heart disease in women. *N Engl J Med* 1997;337:1491-1499
3. Katan MB: Fish and heart disease: What is the real story? *Nutr Rev* 1995;53:228-230
4. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin P-H, Karanja N: A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;336:1117-1124
5. The DASH Diet: U.S. Dept. HHS. *NIH Publication #98-4082*, 1998. Bethesda, Md.
6. Gifford KD: Release of the traditional healthy vegetarian diet pyramid. *International Conference on Vegetarian Diets*, Austin, Texas. 1997 Oldways Foundation, Cambridge, Mass.
7. Whitten C, Haddad E, Sabaté J: Developing a vegetarian food guide pyramid: A conceptual framework. *Veget Nutr* 1997;1:25-29
8. Berry EM, Eisenberg S, Harats D, Friedlander Y, Norman Y, Kaufmann NA, Stein Y: Effects of diets rich in monounsaturated fatty acids on plasma lipoprotein—The Jerusalem Nutrition Study. High MUFAs vs. high PUFAs. *Am J Clin Nutr* 1991;53:899-907
9. Berry EM, Eisenberg S, Friedlander Y, Harats D, Kaufmann NA, Norman Y, Stein Y: Effects of diets rich in monounsaturated fatty acids on plasma lipoproteins—The Jerusalem Nutrition Study. II. Monounsaturated fatty acids vs. carbohydrates. *Am J Clin Nutr* 1992;56:394-403
10. Spiller GA, Gates JE, Jenkins DAJ, Bosello O, Nichols SF, Cragen L: Effect of two foods high in monounsaturated fat on plasma cholesterol and lipoproteins in adult humans (abstr). *Am J Clin Nutr* 1990;51:524
11. Spiller GA, Jenkins DAJ, Cragen LN, Gates JE, Bosello O, Berra K, Rudd C, Stevenson M, Superko R: Effects of a diet high in monounsaturated fat from almonds on plasma cholesterol and lipoproteins. *J Am Coll Nutr* 1992;11:126-130
12. Spiller GA, Jenkins DAJ, Bosello O, Gates JE, Cragen LN, Bruce B: Nuts and plasma lipids: An almond-based diet lowers LDL-C while preserving HDL-C. *J Am Coll Nutr* 1998;17:285-290
13. Sabaté J, Fraser GE, Burke K, Knutsen S, Bennett H, Lindsted KD: Effects of walnuts on serum lipid levels and blood pressure in normal men. *N Engl J Med* 1993;328:603-607
14. Zambon D, Campero B, Perez-Heras A, Rodriguez-Villar C, Ros E, Casals E, Munoz S, Laguna JC, Sabaté J: Effects of walnuts on the serum lipid profile of hypercholesterolemic subjects: The Barcelona Walnut Trial. (abstr) *FASEB J* 1998;12(4):A506
15. Abbey M, Noakes M, Belling GB, Nestel PJ: Partial replacement of saturated fatty acids with almonds or walnuts lowers total plasma cholesterol and low-density-lipoprotein cholesterol. *Am J Clin Nutr* 1994;59:995-999
16. Colquhoun D, Moores D, Humphries J, Someset S: Comparison of a high monounsaturated fatty acid diet (enriched with macadamia nuts) and a high carbohydrate diet on blood lipids (abstr). *Proceedings of the 59th European Atherosclerosis Congress*. May 1992: 17-21 Nice, France
17. Curb JD, Wergowski G, Abbott RD, Dobbs JC, Tung J, Austin MA, Marcovina S: High mono-unsaturated fat macadamia nut diets; effects on serum lipids and lipoproteins (abstr). *The FASEB J Abstracts Part I*, 1998;April:A506
18. Solà R, Cabré P, Masana L: Hazelnut intake and plasma lipids and lipoproteins. *Am J Clin Nutr* (submitted)
19. Shimomura Y, Tamura T, Suzuki M: Less body fat accumulation in rats fed safflower oil diet than in rats fed a beef tallow diet. *J Nutr* 1990;120:1291-1296
20. Curb JD, Wergowski G, Hankin J: The effect of dietary supplementation with macadamia kernels on serum lipid levels in humans. In *Proceedings of the First International Macadamia Research Conference, Kailua-Kona, Hawaii*, July 1992 (Ed. Bittenbender HC)
21. Fraser GE, Jaceldo K, Sabaté J, Bennett H, Polehna P: Changes in body weight with a daily supplement of 340 calories from almonds for six months (abstr). *FASEB J* 1999;13(4):A539
22. Fraser GE, Sabaté J, Beeson WL, Strahan TM: A possible protective effect of nut consumption on risk of coronary heart disease. *Arch Intern Med* 1992;152:1416-1424
23. Fraser GE, Shavlik DJ: Risk factors for all-cause and coronary heart disease mortality in the oldest-old. *Arch Intern Med* 1997;157:2249-2258
24. Fraser GE, Sumbureru D, Pribis P, Neil RL, Frankson MAC: Associations between health habits, risk factors, and all-cause mortality in a black California population. *Epidemiology* 1997;8:168-174
25. Fraser GE, Sabaté J, Beeson WL: Nuts, nuts good for your heart (response to letter). *Arch Intern Med* 1992;152:2507-2508
26. Fraser GE, Lindsted KD, Beeson WL: Effect of risk factor values on lifetime risk of and age at first coronary event. *Am J Epidemiol* 1995;142:746-758
27. Kushi L, Folsom AR, Prineas RJ, Mink PJ, Wu Y, Bostick RM: Dietary antioxidant vitamins and death from coronary heart disease in post-menopausal women. *N Engl J Med* 1996;334:1156-1162
28. Prineas RJ, Kushi LH, Folsom AR, Bostick RM, Wu Y: Walnuts and serum lipids (letter). *N Engl J Med* 1993;329:359
29. Hu FB, Stampfer MJ, Manson JE, Rimm EB, Colditz GA, Rosner BA, Speizer FE, Hennekens CH, Willett WC: Frequent nut consumption and risk of coronary heart disease in women: Prospective cohort study. *Br Med J* 1998;317:1341-1345
30. Albert CM, Willett WC, Manson JE, Hennekens CH: Nut consumption and the risk of sudden and total cardiac death in the Physician's Health Study. *Circulation* 1998;98(suppl 1):I-582
31. Jacobs DR, Anderson JT, Blackburn H: Diet and serum cholesterol: Do zero correlations negate the relationship? *Am J Epidemiol* 1979;110:77-87
32. Flanders WD, Khoury MJ: Indirect assessment with confounding: Graphic description and limits on effect of adjusting for covariates. *Epidemiology* 1990;1:239-246
33. Loscalzo J: Nitric oxide and vascular disease. *N Engl J Med* 1995;333:251-253
34. Cook JP, Tsao PS: Arginine: A new therapy for atherosclerosis? *Circulation* 1997;95:311-312
35. Wolf A, Zalpur C, Theilmeier G, Wang B-Y, Adrian MA, Anderson B, Tsao PS, Cooke JP: Dietary arginine supplementation normalizes platelet aggregation in hypercholesterolemic humans. *J Am Coll Cardiol* 1997;29:479-485
36. Adams MR, Forsyth CJ, Jessup W, Robinson J, Celermajer DS: Oral L-arginine inhibits platelet aggregation but does not enhance endothelium-dependent dilation in healthy young men. *J Am Coll Cardiol* 1995;26:1054-1061
37. Rector TS, Bank AJ, Muller KA, Tschumperlin LK, Sih R, Pillai K, Kubo SH: Randomized, double-blind, placebo-controlled study of supplemental oral L-arginine in patients with heart failure. *Circulation* 1996;93:2135-2141

## Dietary Approaches to Stop Hypertension (DASH) in Clinical Practice: A Primary Care Experience

KATHRYN M. KOLASA, PH.D., R.D., L.D.N.

Department of Family Medicine, East Carolina University, School of Medicine, Greenville, North Carolina, USA

### Summary

**Background:** The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure placed increased emphasis on lifestyle modification for the prevention and management of hypertension. The Dietary Approaches to Stop Hypertension (DASH) diet, rich in fruits, vegetables, nuts, and low-fat dairy foods, with reduced saturated and total fats, was found in clinical trials to lower blood pressure substantially and significantly. The DASH diet appears appropriate for use in the primary care setting, although it is unknown whether results will mirror those found in clinical trial.

**Methods:** A review of the literature of successful physician-based dietary interventions and of the Stages of Change model as it applies to dietary behavior was completed. Some changes needed to adapt the DASH diet to the outpatient family practice setting were identified and implemented among a predominantly non-Caucasian (56%), female (61%) population. The most common concerns and diagnoses among this population are essential hypertension, diabetes, and general medical examination.

**Results:** Under study conditions, DASH reported that patients experienced an average reduction of 6 mmHg systolic and 3 mmHg diastolic blood pressure. Results were better in those with high blood pressure—systolic dropped by 11 mmHg and diastolic dropped by 6 mmHg. This reduction occurred within 2 weeks of starting the plan. Our clinical experience matches these published results.

**Conclusions:** The DASH diet can be used successfully by patients in the primary care setting to lower blood pressure. The challenge of incorporating this intervention into primary care by more practitioners remains. The challenges for the patient and provider to sustain lifestyle modifications are formidable and also continuing.

**Key words:** Dietary Approaches to Stop Hypertension, Stages of Change model, patient education, primary care, blood pressure, diet, nutrition, hypertension

### Introduction

Hypertension is a common problem among patients visiting primary care offices, ranking as the number one reason for office visits in a survey of 84 Ohio family practices.<sup>1</sup> We believe we have a similar prevalence in our own practice, which serves a population at high risk for the chronic conditions of obesity, hypertension, type 2 diabetes, and cardiovascular disease. The publication of the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI)<sup>2</sup> prompted us to explore the adaptation of these national guidelines to our practice.

Like many primary care practices, we are shifting our office focus from acute care to prevention and management of chronic condition care. We are in the process of piloting an ambulatory care pathway for type 2 diabetes and planning a pathway for hypertension. Lifestyle modification, including a significant emphasis on dietary behaviors, is to be included in these pathways based, in part, on JNC VI's expanded emphasis on lifestyle modification for hypertension prevention and management. The JNC VI guidelines included publication of the Dietary Approaches to Stop Hypertension (DASH) diet in its Appendix. A medical record audit of our practice noted that while diet and weight advice were provided to most of our patients with hypertension, there remained many opportunities for improvement in compliance and outcomes. As a result, we decided to test DASH in our primary care setting to see whether patients could adhere to the eating pattern and benefit their blood pressure status.

---

The work described in this paper was done without grant support. The work was supported by the Department of Family Medicine, East Carolina University.

Address for reprints:

Kathryn M. Kolasa  
Department of Family Medicine  
East Carolina University  
Greenville, NC 27858, USA

**Materials and Methods**

We have adopted an evidence-based approach to evaluating clinical research as we make changes in our clinical care. Evidence-based medicine combines individual clinical expertise with the best available clinical evidence gathered from systematic research into a topic. Following the guidelines for teaching evidence-based medicine,<sup>3</sup> we completed a review of the paper *Clinical Trial of the Effects of Dietary Patterns on Blood Pressure*,<sup>4</sup> as well as the paper that described the DASH trial design more fully.<sup>5</sup> In addition, we reviewed the recent literature on the Stages of Change Model as applied to dietary behaviors.<sup>6-10</sup> Moreover, we reviewed the literature that described successful nutrition interventions in primary care offices.\* A search of the World Wide Web for patient education materials to support the implementation of DASH was completed. The materials identified along with our current diet and hypertension patient education materials were reviewed for appropriateness to our patient population, which is primarily non-Caucasian (56%), female, (61%), and young (51% between 25 and 54 years; 20% ≥ 55 years). Moreover, essential hypertension is the most common concern/diagnosis at our Family Practice Center.

**Results and Discussion**

We judged the DASH diet (Fig. 1) to be an appropriate intervention for our patient population since the clinical trial<sup>4</sup> described lowered blood pressure outcomes that would be important for our patients. However, we identified several behaviors and beliefs of our patient-care providers that would need modification for the successful use of DASH. First, providers would need to assess and counsel patients on the dietary pattern as a whole, rather than on the restriction of salt or sodium; that is, the caregivers needed to adopt a philosophy that included encouraging the consumption of a health-promoting dietary pattern rather than restricting individual foods or nutrients. Second, some modification of current patient teaching would be required. While most patient education materials for diet and hypertension provide general guidelines that are consistent with DASH (e.g., choose more vegetables and fruits; choose more whole grains, breads and cereals, pasta, rice, dry beans, and peas), some give specific advice that is not compatible. For instance, the DASH diet includes a category of “Nuts, Seeds, and Dry Beans” separate from the “Fats and Oils” group and recommends 4–5 servings from this category per week. This recommendation is based on the high levels of energy, protein, fiber, magnesium, calcium and potassium in these foods. The American Heart Association’s (AHA) “Dietary Treatment of High Blood Pressure and High Cholesterol”<sup>11</sup> food groupings, however, are not completely consistent with the DASH pattern. The AHA Step I diet planning system places nuts and seeds in the “Fats and

Oils” group and the number of servings from this group is restricted, rather than recommended as in DASH. In AHA Step I, all the fat and oil servings generally are used for cooking and flavoring, unless an individual patient has a high caloric need. This leads to dietary advice that would restrict the consumption of nuts and seeds. Third, the literature suggests that physicians wait until a patient has a chronic disease before giving nutrition advice. A shift toward physicians providing more preventive nutrition advice is needed.

Finally, several researchers have documented that the use of simple dietary assessment and counseling tools in office practice are important in creating successful patient outcomes. Dietary screeners have been widely used in cardiovascular disease counseling.<sup>12-14</sup> These screeners needed modification to meet the DASH eating pattern by including more servings of fruits, vegetables, and grains, and a transfer of seeds and nuts out of the snack group into a distinct seeds, nuts, and dried beans group (Fig. 2). Only a limited number of patient education materials that specifically support the DASH diet is available (Fig. 3), although more are expected in coming months.

Prochaska’s Stages of Change Model (Table I) has been found to be applicable to dietary behavior; however, its application to inappropriate eating habits is more complex than with other unhealthful behaviors, including smoking cessation and substance abuse.<sup>6-10</sup> Individuals do not necessarily progress through the stages of precontemplation, contemplation, preparation, action, and maintenance in a linear fashion when food consumption is considered. In addition, an indi-

*This eating plan is from the “Dietary Approaches to Stop Hypertension” (DASH) clinical study, supported by the National Institutes of Health. The DASH combination diet lowered blood pressure and so may help prevent and control high blood pressure.*

*The DASH eating plan shown below is based on 2,000 calories a day. Depending on your caloric needs, your number of daily servings in a food group may vary from those listed.*

Food Group	Daily Servings	Serving Sizes	Examples and Notes	Significance of Each Food Group to the DASH Diet Pattern
Grains & grain products	7-8	1 slice bread 1 C dry cereal* 1/2 C cooked rice, pasta, or cereal	whole wheat bread, English muffin, pita bread, bagel, cereals, grits, oatmeal	major sources of energy and fiber
Vegetables	4-5	1 C raw leafy veg. 1/2 C cooked veg. 6 oz veg. juice	tomatoes, potatoes, carrots, peas, squash, broccoli, turnip greens, collards, kale, spinach, artichokes, beans, sweet potatoes	rich sources of potassium, magnesium, and fiber
Fruits	4-5	6 oz fruit juice 1 medium fruit 1/4 C dried fruit 1/2 C fresh, frozen, or canned fruit	apricots, bananas, dates, grapes, oranges, orange juice, grapefruit, grapefruit juice, mangoes, melons, peaches, pineapples, raisins, strawberries, tangerines	important sources of potassium, magnesium, and fiber
Low-fat or nonfat dairy foods	2-3	8 oz milk 1 C yogurt 1.5 oz cheese	skim or 1% milk, skim or low-fat buttermilk, nonfat or low-fat yogurt, part-skim mozzarella cheese, nonfat cheese	major sources of calcium and protein
Meats, poultry, and fish	2 or less	3 oz cooked meats, poultry, or fish	select only lean; trim away visible fats; broil, roast, or boil, instead of frying; remove skin from poultry	rich sources of protein and magnesium
Nuts, seeds, and legumes	4-5 per week	1.5 oz or 1/3 C nuts 1/2 oz or 2 Tbsp seeds 1/2 C cooked dry beans	almonds, filberts, mixed nuts, peanuts, walnuts, sunflower seeds, kidney beans, lentils and peas	rich sources of energy, magnesium, potassium, protein, and fiber
Fats & oils**	2-3	1 tsp soft margarine 1 Tbsp lowfat mayonnaise 2 Tbsp light salad dressing 1 tsp vegetable oil	soft margarine, lowfat mayonnaise, light salad dressing, vegetable oil (such as olive, corn, canola, or safflower)	Besides fats added to foods, remember to choose foods that contain less fats
Sweets	5 per week	1 Tbsp sugar 1 Tbsp jelly or jam 1/2 oz jelly beans 8 oz lemonade	maple syrup, sugar, jelly jam, fruit-flavored gelatin, jelly beans, hard candy, fruit punch, sorbet, ices	Sweets should be low in fat

\* Serving sizes vary between 1/2 - 1 1/4 cups. Check the product's nutrition label.  
\*\* Fat content changes serving counts for fats and oil. For example, 1 Tbsp of regular salad dressing equals 1 serving; 1 Tbsp of a low-fat dressing equals 1/2 serving; 1 Tbsp of a fat free dressing equals 0 serving.

\* Many of these interventions have been catalogued at [www.PreventiveNutrition.com](http://www.PreventiveNutrition.com).

Fig. 1 Dietary Approaches to Stop Hypertension (DASH) diet.

Take the following survey to see how close your diet is to DASH recommendations.

# do you **DASH** ?

Eating a heart-healthy diet is in the news a lot these days. Do you need help fixing your diet so you can eat more healthfully? The government's main health research organization (the National Institutes of Health) suggests that all adults follow the DASH Diet. DASH is a way of eating that is low in fat and rich in fruits, vegetables, and low-fat dairy foods.

DASH, which stands for Dietary Approaches to Stop Hypertension, was found in studies to lower blood pressure in men and women of all races after only two weeks. The DASH Diet can probably prevent high blood pressure as well, and is an excellent everyday diet for everyone.

To see how close your diet is to DASH

1. Write down the number of servings of each food type listed below that you eat each day. Do this for each of the six food groups. (Sample foods and serving sizes are provided.)
2. Add up the number of servings you recorded within each food group. Compare your total to the DASH recommendation at your calorie level for that food group.
3. Take the 'Fat and Dietary Fiber' survey. See how many DASH-friendly eating choices you make.



## Grain and Grain Products Group (major sources of energy and dietary fiber)

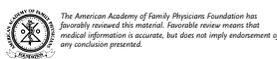
If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	6	
2,000 calories	8	
2,600 calories	10	
3,100 calories	13	

Sample Food Types	Serving Size	Your # Servings/Day
Bread	1 slice	_____
Regular Bagel or English muffin	1	_____
Rice, Pasta	1/2 cup	_____
Cereal (cooked or dry)	1/2 cup	_____

*your total daily servings: \_\_\_\_\_*

Choose whole-grain products, such as brown rice, whole-wheat breads, and cereals like oatmeal and bran flakes that are high in dietary fiber.



# do you **DASH** ?

## Vegetable Group (rich sources of potassium, magnesium, and dietary fiber)

If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	4	
2,000 calories	5	
2,600 calories	5	
3,100 calories	6	

Sample Food Types	Serving Size	Your # Servings/Day
Raw leafy: spinach, collard or turnip greens, kale	1 cup	_____
Cooked: carrots, peas, squash, broccoli, sweet potatoes	1/2 cup	_____
Vegetable juice	6 ounces	_____

*your total daily servings: \_\_\_\_\_*

Diets high in vegetables, fruits, and dietary fiber may reduce the risk of developing heart disease and some kinds of cancer. They may also help with blood pressure control. Canned, fresh, and frozen vegetables are all healthy choices.



## Fruit Group (important sources of potassium, magnesium, and dietary fiber)

If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	4	
2,000 calories	5	
2,600 calories	5	
3,100 calories	6	

Sample Food Type	Serving Size	Your # Servings/Day
Orange, tangerine, apple, pear, banana, peach, plum	1 medium	_____
Grapes, melon, berries, pineapple	1/2 cup	_____
Dates, raisins, prunes, apricots, other dried fruits	1/2 cup	_____
Fruit juice	6 ounces	_____

*your total daily servings: \_\_\_\_\_*

Diets high in vegetables, fruits, and dietary fiber may reduce the risk of developing heart disease and some kinds of cancer. They may also help with blood pressure control. Canned, fresh, and frozen fruits are all healthy choices.



# do you **DASH** ?

## Low-fat or Non-fat Dairy Foods Group (major sources of calcium and protein)

If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	2	
2,000 calories	3	
2,600 calories	3	
3,100 calories	4	

Sample Food Type	Serving Size	Your # servings/day
Milk (low-fat or nonfat)	1 cup	_____
Cheese (low-fat mozzarella, cheddar, swiss)	1 1/2 ounces	_____
Cottage cheese, sour cream (low-fat or nonfat)	1/2 cup	_____
Frozen yogurt, ice cream	1 cup	_____

*your total daily servings: \_\_\_\_\_*

Choose nonfat milk, low-fat cheeses, low-fat or nonfat sour cream, and low-fat or nonfat yogurt and ice cream.



# do you **DASH** ?

## Nuts, Seeds, and Legumes Group (rich sources of energy, magnesium, potassium, protein, and dietary fiber)

If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	1/2	
2,000 calories	1	
2,600 calories	1	
3,100 calories	1	

Sample Food Type	Serving Size	Your # Servings/Day
Almonds, filberts, peanuts, walnuts	1 1/2 ounces or 1/3 cup	_____
Sunflower seeds	1/2 ounces or 2 Tbsp.	_____
Kidney beans, lentils (cooked)	1/2 cup	_____

*your total daily servings: \_\_\_\_\_*

Nuts and seeds make great snacks. Nuts, seeds, and legumes can also be added to main meal dishes to cut down on saturated fat and provide protein. Remember to stick to the recommended portion sizes if you need to lose weight.

## Meats, Poultry, and Fish Group (rich sources of protein and magnesium)

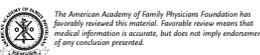
If most days you eat...	DASH recommends this # of servings/day	
1,600 calories	1	
2,000 calories	2	
2,600 calories	2	
3,100 calories	2	

Sample Food Type	Serving Size	Your # Servings/Day
Beef, pork, lamb, veal (lean)	3 ounces	_____
Lunch/Breakfast meats (low-fat)	3 ounces	_____
Chicken, turkey	3 ounces	_____
Seafood, fish	3 ounces	_____

*your total daily servings: \_\_\_\_\_*

Keep serving sizes small. Select lean cuts; trim away excess fat; bake, broil, steam, poach, or microwave; and remove all skin from poultry before eating.



# fat and dietary fiber

See how your food choices compare to the DASH Diet recommendations. Check the box next to the foods you usually eat. For each check mark you make in the DASH-UNFRIENDLY column on the left, look at the DASH-FRIENDLY column directly to the right. You will find ideas on how to DASH your way to a healthy diet!

**I usually choose to eat...**

DASH-UNFRIENDLY	DASH-FRIENDLY
<input type="checkbox"/> Refined products such as white bread, rice, or pasta	<input type="checkbox"/> Whole grains such as whole-wheat bread and pasta; brown or wild rice; cereals like oatmeal and bran flakes; wheat germ; and salads made from barley, kasha, or bulgar, mixed with vegetables, fruits, or almonds and other nuts
<input type="checkbox"/> Snack foods like potato chips or tortilla chips made with oil; cheese puffs; or buttered popcorn	<input type="checkbox"/> Snack foods like almonds and other nuts; fruit including apricots, bananas, oranges, grapefruit, and prunes; low-salt pretzels; baked chips; or air-popped/low-fat popcorn
<input type="checkbox"/> Vegetables, seafood, or chicken that is fried	<input type="checkbox"/> Vegetables, seafood, or chicken that is baked, broiled, steamed, grilled, or microwaved
<input type="checkbox"/> Vegetables with cream, butter, or cheese sauce	<input type="checkbox"/> Vegetables prepared plain, with lower-fat sauces, or seasoned with herbs and spices
<input type="checkbox"/> Milk, cheese, or ice cream made from whole milk	<input type="checkbox"/> Skim or low-fat milk, low-fat or nonfat yogurt and ice cream, or low-fat cheese
<input type="checkbox"/> Large portions of high-fat meats like hot dogs, hamburgers, sausage and ribs	<input type="checkbox"/> Moderate portions of lean cuts of meat; mixed dishes with less meat or with meat alternatives, such as veggie burgers, beans, and almonds and other nuts
<input type="checkbox"/> Cream, cheese or pink sauce on pasta	<input type="checkbox"/> Red, tomato-based sauces or olive oil on pasta
<input type="checkbox"/> Pizza with extra cheese or with meats like pepperoni, sausage and meatballs	<input type="checkbox"/> Pizza with added vegetables, including onions, broccoli, and spinach
<input type="checkbox"/> Creamy salad dressings	<input type="checkbox"/> Low-fat or nonfat salad dressings; oil and vinegar (olive, canola)
<input type="checkbox"/> Hamburgers, cheeseburgers, fried chicken, hard tacos, or french fries at fast food restaurants	<input type="checkbox"/> Grilled chicken, salads, soft tacos, or baked potatoes at fast food restaurants
<input type="checkbox"/> Chinese food that is either fried or contains fatty sauces	<input type="checkbox"/> Chinese food that is steamed or made with little added fat
<input type="checkbox"/> Soda, coffee, or tea	<input type="checkbox"/> Vegetable or fruit juice, fruit smoothies, or low-fat milk shakes

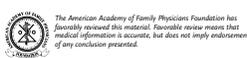


FIG. 2 Dietary Approaches to Stop Hypertension (DASH) screener produced by the Almond Board.

vidual could be in one stage (e.g., action) for a particular dietary behavior, such as eating more fruit, but be in different stage (e.g., precontemplation) for another dietary behavior, such as eating more legumes, nuts, or seeds. Studies to date, however, document that food knowledge and an increasingly positive attitude about the role of diet in disease prevention increase across the stages. To apply these research findings, then, health care providers must assist patients to advance from one stage to the next to help assure a successful nutrition intervention. The following three DASH-related cases from our practice illustrate such a process for both patient and provider.

Ms. B. (Table II) is in the precontemplation stage. She was unaware both that her blood pressure was elevated and that following the DASH diet could help lower her blood pressure. She was aware, however, that she was overweight. Dieting was not an option for Ms. B. who was afraid that any diet would leave her hungry and, therefore, was not motivated to embark on one. The appropriate role for her health care provider is to describe the role DASH might play in lowering her blood pressure and to provide an appropriate patient education handout. On the subsequent office visit, it was not surprising that the patient had made no changes in her diet; however, she did present with a willingness to hear more about DASH. She indicated she was pleased that she was not told

Note that most materials about diet and heart disease produced by NHLBI and organizations like the American Heart Association that do not specify a dietary plan support the concept of DASH.

DASH-specific:

Almond Board of California. 1998. **The DASH diet to prevent and treat hypertension** kit. This patient and physician education kit includes: DASH diet screener, DASH diet meal plan, blood pressure sheet (disk included). Patient education materials bear the seal and citation from the American Academy of Family Physicians, indicating a favorable review. See: [www.AlmondsAreIn.com](http://www.AlmondsAreIn.com) or call (209) 549-8262.

Harvard. 1998. **Following the DASH Diet.** See: <http://dash.bwh.harvard.edu/dashdietservings.html>

Harvard. 1998. **Hints for Success.** See: <http://dash.bwh.harvard.edu/dashdietservings.html>

Harvard. 1998. **Dash Diet Overview.** See: <http://dash.bwh.harvard.edu/dashdietoverview.html>

NHLBI. **Facts about the DASH Diet.** Single copy free. \$1/25 copies. Order # 4082. Call NHLBI Information Center 301-251-1222. Printer Disk available (4082D/\$40)

Other

Alliance for Aging Research. 1997. **Controlling High Blood Pressure: A Guide for Older Women.** Call NHLBI Information Line at 1-800-575-WELL or write Alliance for Aging Research, 2021 K Street NW, Suite 305, Washington DC 20006-1003.

Alliance for Aging Research. 1998. **Controlling High Blood Pressure. A Guide for Older Women. You Have What It Takes.** English/Spanish. NHLBI and DHHS Office of Minority Health Information Line. 1-800-282-9126.

Moser M. 1998. **High Blood Pressure. What You Should Know About It and What You Can Do To Help Your Doctor Treat It.** Jacq Communications, Inc. 777 West Putnam Avenue, Greenwich CT 06830. (203)531-0450

NHLBI. 1995. **Eat Right to Help Lower Your High Blood Pressure.** Low literacy pamphlet. National High Blood Pressure Education Program. PO Box 30105. Bethesda, MD 20824-0105.

NHLBI. 1997. **Embrace your Health! Lose Weight if You Are Overweight.** Minority focus. NIH Publication No. 97-4063

FIG. 3 List of patient education materials.

she had to lose weight. Moreover, she believed she would not be hungry following the DASH plan because it appeared to allow adherents to consume a substantial amount of food. The provider's role at this stage is to reinforce Ms. B.'s interest in DASH and negotiate the first behavior change.

Mr. T.K. (Table III) is in the contemplation stage. He had noticed DASH handouts in the office waiting room and completed a DASH screener while waiting. He asked the physician if DASH was appropriate for him. Together they reviewed which dietary changes would be most helpful for Mr. T.K. to make. He was intrigued that if he adopted the entire diet he

TABLE I Application of Prochaska's Stages of Change Model

Readiness level	Behavior
Precontemplation	Patient has not yet identified that change is needed. Health professional can provide information to raise awareness of needs.
Contemplation	Patient shows some awareness of needed change and considers the idea of making change. Health professional can provide information on advantages of change to help tip the balance in favorable direction.
Preparation	Patient ready to define set of goals and action-oriented strategy to achieve goals. Health professional can help define goals/strategy.
Action	Patient acts to make appropriate changes. Health professional can support actions with information, referrals, and feedback.
Maintenance	Patient encounters and meets challenges of maintaining appropriate changes. Health professional can continue to provide support.
Relapse	Patient "falls off wagon" and needs to overcome negative feelings to reengage in appropriate change. Health professional can encourage patient to "forgive self and forget transgression" and to reinstate action plan.

TABLE II Case No. 1: Approach to patient in precontemplation stage

Ms. B. age 27 years	African American female		
Weight: 285 lbs.	Height: 64 in	Body mass index (BMI): 49	
BP: 140/88	FBS: 118	TC:215	
Problems:	Asthma	Obesity	
Family history:	HTN	Type 2 diabetes	
Social history:	11th grade	Occupation as cook	Never dieted before
	Eats 1 meal/day with snacking		No physical activity
Plan:	Move Ms. B. toward contemplation stage by describing DASH diet health benefits and eating pattern; providing handouts to review before next visit.		

TABLE III Case No. 2: Approach to patient in contemplation stage

Mr. T.K. age 48 years	white male		
Weight: 190 lbs.	Height: 68 in	Body mass index (BMI): 29	
BP: 130/78			
Data from workplace screening:	TC: 270		
Lipid panel in office:	TC: 248	LDL:158	HDL:35 TG:200
Scored 28 on dietary screener (room for improvement)			
Problems:	Sinusitis		
	No physical activity		
Plan:	Move to preparation and action stages by confirming he is DASH-appropriate; providing informative handouts; offering referral to dietitian (declined); and negotiating three dietary changes.		

could likely determine its effectiveness in a 2-week period. The physician provided handout materials and inquired if Mr. T.K. would like a referral to a registered dietitian who could assist him efficiently with the dietary change.

Mr. B. (Table IV) is in the preparation stage. Without nutrition counseling he had made several changes after his last office visit, when he was diagnosed with type 2 diabetes. He

had increased his fruit and vegetable consumption from two servings to five servings per day. He was unsure, however, that he could increase the number of servings to 10 each day. He had also purchased a wide array of dietary supplements. The physician congratulated him on dietary changes made and inquired about his confidence and ability to make further changes. In this case, it appears that the patient needs assis-

TABLE IV Case No. 3: Approach to patient in preparation stage

Mr. B. age 43 years	African American male
Weight: 201 lbs.	Height: 68 in      Body mass index (BMI):31
BP: 150/95	TC:232
Meds:	Glucophage 500 mg b.i.d.
OTC:	GNC herbal plus pau d' arco extract; Chroma slim for men; fish body oils; bilberry 500 mg, Mega Men Premium multiple vitamins and minerals, Super Blue Green Cell Tech, Kwai garlic, l-lysine 500 mg, echinacea 380 mg, ginseng root 300 mg, bee pollen 200 mg, ginkgo biloba, Cran actin, cayenne 500 mg
Plan:	Move to action stage by encouraging a two-week trial of DASH; referring to a registered dietitian to plan dietary behavior and physical activity changes.

tance in problem solving and confidence building, which requires more time and skill than the physician could offer. In actuality, the patient was consuming more than five servings of fruits and vegetables, but was confused about serving size. A referral to a registered dietitian was indicated here.

A variety of researchers have documented the need for several counseling visits so they can provide patients optimally with the needed knowledge, skills, and attitudes to make agreed-upon dietary changes. Too often, however, the support ends when the patient has entered the action stage. Patients in the action phase have made changes that have lasted 6 months. The physician needs to assist these patients into the maintenance phase by congratulating them and ensuring them that they have the support (e.g., frequency of appointments, patient education materials, referral to a registered dietitian) needed to continue adoption of the DASH diet. Patients in the maintenance phase are pleased with the results of adopting DASH. They have made the changes for more than 6 months, but their need for reinforcement and continued education has not ended. They need reinforcement from the physician to maintain the behaviors or, as needed, to recover from a relapse. For example, a patient facing a first holiday season or vacation after adopting the DASH diet may need specialized handouts or reminders of the importance of the changes to long-term health. A "tune-up" referral to a registered dietitian can help yield sustained lifestyle modification.

Patients need to be given specific information about reasonable expectations for blood pressure lowering when they follow the DASH diet. Furberg *et al.*<sup>15</sup> summarized the outcomes of more than 100 published, randomized clinical trials evaluating hypertension prevention and treatment, and described the effects as modest. The lifestyle modifications included weight loss, exercise, reduced alcohol or sodium, and supplementation of potassium, magnesium, calcium, fish oil, or dietary fiber. Appel *et al.*<sup>4</sup> found that a diet rich in fruits, vegetables, and low-fat dairy foods with reduced saturated and total fat substantially lowered blood pressure in their study populations, which contained both normotensive and hypertensive individuals. For those with hypertension, the DASH diet reduced systolic and diastolic blood pressure by 11 and 5.5 mmHg, respectively, more than the control diet. For those without hypertension, the DASH diet resulted in a 3.5 mmHg systolic and a 2.1 mmHg diastolic reduction.

At this time, there are no published reports describing the impact of DASH in a nonstudy environment. We have had limited experience in the outpatient setting over the last 9 months. Generally, we have found that patients are more positive about attempting the DASH diet than they were about previous restrictive diets. While we do not have statistics to confirm our impressions, some of our providers have recommended the DASH diet to their patients who have matched or exceeded the blood pressure lowering effect described in the DASH trial. Some providers have not yet adopted DASH as a tool for their patients, and some patients continue to be unable or unwilling to modify their dietary behavior.

## Conclusion

It is our impression that DASH can be adapted for use in the primary care setting by making several changes, both in the attitudes of providers and patients and in educational materials. Some patients appear to benefit from this approach to lifestyle modification. However, several challenges remain. The first is to determine the best way to incorporate the DASH diet into the primary care practice and assess its effectiveness. The second is how to provide patients and providers with the strategies they need to sustain positive lifestyle modifications.

## References

1. Stange KC, Zyzanski SJ, Jaen CR, Callahan EJ, Kelly RB, Gillanders WR, Shank JC, Crabtree BF, Flocke SA, Gilchrist VJ, Langa DM, Goodwin MA: Illuminating the black box. A description of 4,454 patient visits to 138 family physicians. *J Family Pract* 1998; 46:377-389
2. National Heart Lung and Blood Institute: The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med* 1997;157: 2413-2446
3. Sackett DL, Richardson WS, Rosenberg W, Haynes RB: *Evidence-Based Medicine*. New York: Churchill Livingstone, 1997
4. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin P-H, Karanja N, for the DASH Collaborative Group: A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;336:1117-1124

5. Sacks FM, Obarzanek E, Windhauser MM, Svetkey LP, Vollmer WM, McCullough M, Karanja N, Lin P-H, Steele P, Proschan MA, Evans MA, Appel LJ, Bray GA, Vogt TM, Moore TJ, for the DASH investigators: Rationale and design of the Dietary Approaches to Stop Hypertension trial (DASH): A multicenter controlled feeding study of dietary patterns to lower blood pressure. *Ann Epidemiol* 1995;5:108-118
6. Auld GW, Nitzke SA, McNulty J, Bock MA, Bruhn CM, Gabel K, Lauritzen G, Lee YF, Medeiros D, Newman R, Ortiz M, Read M, Schutz H, Sheehan E: A stage of change classification system based on actions and beliefs regarding dietary fat and fiber. *Am J Health Prom* 1998;12(3):192-201
7. Boyle RG, O'Connor PJ, Pronk MP, Tan A: Stages of change for physical activity, diet, and smoking among HMO members with chronic conditions. *Am J Health Prom* 1998;12(3):170-175
8. Glanz K: Behavioral research contributions and needs in cancer prevention and control: Dietary change. *Prevent Med* 1997;26 (suppl):s43-s55
9. Greene GW, Rossi SR: Stages of change for reducing dietary fat intake over 18 months. *J Am Diet Assoc* 1998;98:529-534
10. Campbell MK, Symons M, Demark-Wahnefried W, Polhamus B, Bernhardt JM, McClelland JW, Washington C: Stage of change and psychosocial correlates of fruit and vegetable consumption among rural African-American church members. *Am J Health Prom* 1998; 12(3):185-191
11. American Heart Association: *Dietary Treatment of High Blood Pressure and High Cholesterol*. Dallas, Texas: American Heart Association, 1990
12. Pawtucket Heart Health Program: *SCORE...For a Healthy Heart*. Memorial Hospital of Rhode Island, Pawtucket, Rhode Island, 1988
13. Stanford University Medical School: *The Five City Project*, Stanford, California, 1992
14. Heyserling TC, Ammerman AS, Davis CE, Mok C, Garrett J, Simpson R: A randomized controlled trial of a physician directed treatment program for low income patients with high blood cholesterol: The Southeast Cholesterol Project. *Arch Fam Med* 1997; 6:135-145
15. Furberg CD, Psaty BM, Cutler JA: Blood pressure and cardiovascular disease. In *Evidence Based Cardiology* (Eds. Yusuf S, Cairns JA, Camm AJ, Fallen EL, Gersh BJ), p. 226-238. London: BMJ Books, 1998