

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

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**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

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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<br>- Adjunct to drug therapy<br>- Facilitate medication step-down or withdrawal |
| • Nonhypertensives | - Reduce blood pressure<br>- 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.

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