Chapter 12
Diet and Blood Pressure: The High and Low of it

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Key Points

- Hypertension poses significant risks for stroke and heart disease.
- Weight gain and obesity increase blood pressure (BP); weight loss can reverse it.
- Diets high in fruits and vegetables and low-fat dairy products and low in red meat and sugar-containing foods (DASH Diet) can significantly lower BP.
- Dietary sodium has an important impact on BP in some people, and lowering sodium intake can lower BP.
- Alcohol intake increases BP.

Keywords Hypertension • Stroke • Sodium • Blood pressure • Antihypertensive therapy

Introduction

Hypertension is a global public health problem. Roughly one billion people worldwide are estimated to have clinically significant elevations in blood pressure (BP) with about 50 million of them in the United States [1]. Hypertension, in turn, is the most important of 67 risk factors for worldwide risk of coronary heart disease (CHD), stroke, renal disease, and all-cause mortality [2]. BP is significantly affected by nutrition which is the subject of this chapter.

The public health burden of hypertension is clearly enormous. Although perhaps impossible to tease out due to associations with other risk factors, including overweight, hypertension is a major contributor to most categories of chronic disease [3]. Diseases of the heart and cerebrovascular diseases are the first and third leading causes of mortality in the United States, accounting for more than one-third of all deaths. Hypertension is a major risk factor for both of these diseases. Therefore, reduction in hypertension constitutes a major health goal [3].

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In clinical trials, antihypertensive therapy can result in reductions of incidence of stroke, myocardial infarction, and heart failure [4]. In this meta-analysis, a 10 mmHg reduction in systolic BP (SBP) reduced risk of major cardiovascular disease by 20%, coronary heart disease by 17%, stroke 27%, and heart failure 28%, which, in the populations studied, led to a significant 13% reduction in all-cause mortality.

Definitions of Hypertension

The JNC (Joint National Committee) VIII [5] report divides BP into several categories and proposes primarily pharmacological treatment regimens for each. In brief, they propose contrasting drug therapies for those:

1. In the general population >60 years with a goal of reducing SBP <150 mmHg and diastolic BP (DBP) <90 mmHg.
2. In the general population <60 years with a goal of reducing DBP <90 mm.
3. In the general population <60 years with a goal of reducing SBP <140 mm.
4. In the population aged ≥18 years with chronic kidney disease (CKD) a goal of reducing SBP <140 mm and DBP <90 mm.
5. In the population aged ≥18 years with diabetes with a goal of reducing SBP <140 mm and DBP <90 mm.
6. In the general nonblack population, including those with diabetes, initial antihypertensive treatment should include a thiazide-type diuretic, calcium channel blocker (CCB), angiotensin-converting enzyme inhibitor (ACEI), or angiotensin receptor blocker (ARB).
7. In the general black population, including those with diabetes, initial antihypertensive treatment should include a thiazide-type diuretic or CCB.
8. In the population aged ≥18 years with CKD, initial (or add-on) antihypertensive treatment should include an ACEI or ARB to improve kidney outcomes. This applies to all CKD patients with hypertension regardless of race or diabetes status.
9. In the general population, a more detailed pharmacologic approach to treating resistant elevated BP.

JNC VIII guidelines focus primarily on pharmacological treatment of BP. They support the general population definition of HBP as >140/>90 mm.

Overweight is an increasingly prevalent condition throughout the world. In the United States, recent data indicate that 37.7% of the adult population is obese and 7.7% have a BMI > 40 kg/m^2 [6].

There is a positive relationship between overweight or obesity, on the one hand, and BP and risk for hypertension, on the other. The Framingham Study found that in both sexes hypertension is about twice as prevalent in the obese as the nonobese. Stamler and colleagues [5] noted an odds ratio for hypertension of obese relative to nonobese (BMI of <25) of 2.4 for younger adults and 1.5 for older ones. The Nurses' Health Study compared women with BMIs of <22 with those >29 and found a two- to sixfold greater prevalence of hypertension among the obese. More recent data from the Framingham Study add further support to this relationship. Divided into BMI quintiles, Framingham participants of both sexes demonstrated increasing BPs with increased overweight. In this instance, those in the highest BMI quintile exhibited 16 mmHg higher SBP and 9 mm higher DBP than those in the lowest BMI quintile. For SBP, this translated into an increase of 4 mm for each 4.5 kg of increased weight. In younger Canadian adults, there is a fivefold greater prevalence of hypertension in individuals of both sexes with BMIs of >30 relative to those <20.

Consistent with the above findings numerous clinical interventions have reported that weight loss is associated with a decrease in BP [7]. In a meta-analysis of 25 studies, Neter et al. [8] concluded that

a 1 kg loss of body weight is associated with an approximate 1 mm drop in BP. This was achieved without the necessity of also attaining normal weight status. The Trial of Hypertension Prevention, one of the largest of these studies, included a weight-loss intervention arm. In this trial, a 2 kg loss in weight over a 6-month period resulted in a decline of 3.7 mm in SBP and 2.7 mm in DBP. There was also a 42% decline in the prevalence of hypertension [9].

The SPRINT (Systolic Blood Pressure Intervention Trial) study is the most recent randomized clinical trial comparing an intensive-treatment goal of SBP <120 versus usual care with a goal of SBP <140. The primary end-point was a composite of myocardial infarction, non-myocardial infarction, acute coronary syndrome, stroke, acute decompensated heart failure, and death from cardiovascular disease. Antihypertensive medications, including thiazide-type diuretics, calcium channel blockers, and angiotensin-converting enzyme inhibitors or angiotensin receptor blocks, were used with an average of 2.8 medications in the intensive group versus 1.8 in the usual care group. The SBP in the intensively treated group was 122 versus 135 mm and resulted in a 25% reduction in numbers of participants reaching the primary outcome measure relative to the standard treatment group [10, 11]. A meta-analysis by Xie et al. [12] also showed the benefits of more intensive treatment of hypertension.

Increased physical activity (PA) has also been proposed as a means for BP reduction. Recent research indicates BP reductions of between 1 and 5 mm systolic among adults engaging in regular bouts of PA [13]. These impacts appear to require fairly intense PA sessions several times per week, with less rigorous approaches yielding more modest reductions in BP.

Diet and BP

Dietary Sodium

The jury of scientific opinion is still out on the degree to which weight loss or sodium restriction make independent contributions to BP reduction. An early study found that sodium restriction in low-calorie diets was thought to be the primary cause of BP reduction. Several more recent studies have sided with weight loss as having an independent effect on BP reduction [9].

Chief among perceived dietary influences on BP is sodium consumption. A large body of literature supports the notion that decreasing sodium consumption below that typical in Western society will result in a decline in BP [14]. Numerous epidemiological studies have demonstrated this relationship [9]. Reductions in sodium intake to around 75 mmol/day (0.18 g/day) are associated with a decline in BP of about 1.9 mm SBP and 1.1 mm DBP. The previously described Trial of Hypertension Prevention (TOHP) found that a decrease of 44 mmol/day (0.10 g/day) of sodium leads to a 38% reduction in the prevalence of hypertension in one of its treatment arms. The Dietary Alterations to Stop Hypertension Study-Sodium Study (DASH-Na) observed in persons with elevated BP who were eating a typical American diet that an approximate 100 mmol/day (0.23 g/day) reduction in sodium intake leads to a maximum reduction in SBP and DBP of about 6.7 and 3.5 mm, respectively. When the reduction in sodium consumption was only half as much (approximately 50 mmol/day or 0.12 g/day), there was much less decline in SBP and DBP (2.1 and 1.1 mm, respectively) [15]. These findings were produced in the absence of weight loss.

The results of the various studies looked at above support the recommendations of the Dietary Guidelines for Americans and the American Heart Association for a heart-healthy diet. Both recommend that people choose and prepare foods with little salt (less than 2300 mg of sodium per day or approximately one teaspoon of salt). It is important to note that reductions can be accomplished both through individual alterations in voluntary intake and through alterations in sodium content of processed foods [16].

Potassium and BP

Potassium has the opposite effect to sodium and meta-analysis shows that adding potassium to the diet and lowering the urinary sodium-to-potassium ratio generally has a mild impact on BP reduction [17, 18].

Dietary Patterns and BP

Manipulation of dietary patterns can have an important effect on lowering BP [7, 19]. The motivation for this line of research was the recognition of the inconsistent effects of micronutrient supplementation. In the DASH (Dietary Approaches to Stop Hypertension) Trial, a diet high in fruit, vegetables, and low-fat dairy servings reduced SBP and DBP by 5.3 and 3.0 mm, respectively, in the absence of either weight loss or sodium restriction [20]. A meta-analysis of 20 studies showed that the DASH diet significantly reduced SBP by 6.7 mm (95% CI: −8.2, −5.2) and DBP by 3.5 mm (95% CI: −4.3, −2.8) [19]. Similar reductions are seen when lean pork is substituted for chicken and fish [21] and when whole fat dairy products are used instead of low-fat dairy products [22].

The Mediterranean Diet [17] and vegetarian diets are widely associated with lower BP levels.

In contrast to the beneficial effect of fruits and vegetables, the opposite is seen with sugar. Increased consumption of sugar and the fructose which it contains can increase both weight and fat mass and increase BP [23].

Dietary Fat

Increased BP and dyslipidemia are both risk factors for cardiovascular disease. Whether dietary fat modifies BP in subjects with higher BP in the metabolic syndrome is unknown. This was investigated in a randomized European multicenter clinical trial lasting 12 weeks. A total of 486 subjects were assigned to one of four diets with different quantities and types of dietary fat. There were two high-fat diets, one of which was rich in saturated fat and the other in monounsaturated fat. There were two low-fat, high-complex carbohydrate diets; one was supplemented with 1.2 g/day of very long-chain n-3 PUFA while the other had no supplementation. Overall, there were no differences in SBP, DBP, or pulse pressure (PP) between the dietary groups after the intervention. The high-fat diet rich in saturated fat had minor unfavorable effects on SBP and PP in males [24].

Dietary Protein

A number of short-term controlled and randomized clinical trials have shown a BP lowering effect of increased dietary protein intake, but longer term trials show inconsistent results. Because carbohydrates were exchanged for proteins, the question remains whether there is a potential benefit from high-protein diets or whether the effect is due to decreased carbohydrate intake. There are no clear differences between plant and animal sources of protein in observational studies, and clinical trials comparing plant versus animal protein are lacking [25, 26].

Alcohol Intake

Alcohol intake is positively associated with BP in most studies in men, and a recent study has shown that this applies to women as well [27]. (Viewing the data in the larger perspective, it is recommended that alcohol consumption be limited to two drinks per day for men and one drink per day for women.)

Summary

Numerous dietary manipulations have a significant impact on BP. The array of dietary patterns and of macro- and micronutrients implicated in control of BP and hypertension is impressive and growing over time. Much further research is still necessary, particularly in the areas of micronutrient interactions and in elucidating the roles of dietary fat and protein in BP management. Findings resulting from such investigations will ultimately help fine-tune dietary approaches to the management of BP and the control hypertension.

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Suggested Further Reading

http://www.nhlbi.nih.gov/hbp The National Heart Lung and Blood Institute provides information for preventing and controlling high blood pressure.

http://www.nhlbi.nih.gov/health/public/heart/hbp/dash Access the DASH Eating Plan—"Lowering Your Blood Pressure with DASH." Click on the brochure for the full report.