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Effects of Exercise and Diet on Chronic Disease Part III
Hypertension
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Hypertension which is defined a systolic blood pressure greater than 140 mmHg and/or diastolic pressure greater than 90 mmHg is one of the principle contributors to:

- CAD,
- stroke,
- congestive heart failure, and
- end-stage renal disease.

Presently, it has been estimated that hypertension affects as many as 56 million adults in the United States, and an additional 23 million have high-normal blood pressure (130–139 mmHg systolic or 85–89 mmHg diastolic), accounting for approximately one-third of all US adults.

Additionally, one-half of all individuals over the age of 60 have hypertension in the United States and only 47% of all adults have optimal blood pressure (<120/80). The National High Blood Pressure Education Program includes in its recommendations for primary prevention of hypertension to engage in moderate physical activity and consume a diet rich in fruits, vegetables, and low-fat dairy products and reduced in saturated and total fat.

Several studies document that both physical activity and diet have blood pressure-lowering effects. For example, studies of migrants suggest that diet can affect blood pressure. In the Yi People Study in China, blood pressure rose very little with age after puberty in Yi farmers living in remote villages but increased in Yi migrants and Han (local residents). The proportion of energy from fat ranged from <10% among Yi farmers to almost 40% among Yi migrants and Han, and, compared with Yi farmers, Yi migrants consumed less potassium, calcium, and magnesium.

Population studies and clinical trials have suggested that vegetarian diets are associated with lower blood pressure. For example, the association between blood pressure and a vegetarian diet was studied in Seventh-Day Adventist vegetarians and omnivores (meat eaters) and in Mormon omnivores. Mean blood pressures adjusted for age, height, and weight were significantly lower in vegetarians than in Mormon omnivores.

The prevalence of hypertension was 10 and 8.5% in Mormon and Seventh-Day Adventist omnivores, respectively, and <2% in Seventh-Day Adventist vegetarians. Analysis of diet records showed that vegetarians consumed significantly more dietary fiber, polyunsaturated fat, magnesium, and potassium and significantly less total fat, saturated fat, and cholesterol than did Mormon omnivores.

Ascherio examined prospectively the relation between nutritional factors and blood pressure among 30,681 predominantly US male health professionals, without hypertension. During 4 yr of follow-up, 1,248 men were diagnosed with hypertension, and, in men with a fiber intake of less than 12 g/day, the relative risk of hypertension was 1.57 compared with an intake of more than 24 g/day. This group subsequently looked at the effects of dietary factors on blood pressure levels among 41,541 female nurses, and after a 4-yr follow-up, 2,526 women reported a diagnosis of hypertension, and intakes of fiber, fruits, and vegetables were inversely associated with systolic and diastolic pressures, .e., the higher the fiber, fruits and vegetable intact the lower the blood pressure..

For physical activity, Blair measured physical fitness in over 6,000 men and women with no history of cardiovascular disease and who were normotensive at baseline. After an average 4-yr follow-up, those with low levels of physical fitness (72% of the group) had a relative risk of 1.52 for the development of hypertension when compared with highly fit persons, and the risk of developing hypertension also increased substantially with increased baseline blood pressure.

In the Coronary Artery Risk Development in Young Adults (CARDIA) study, individuals with low fitness had a relative risk of 2.59 for hypertension compared with those with high fitness, as determined by duration on a maximal treadmill test. Additionally, Harvard alumni who did not engage in vigorous sports play were at 35% greater risk of hypertension, and vigorous sports participation was inversely related to hypertension. Hypertension is also less frequent in master's athletes. Previous meta-analyses have estimated that regular physical activity decreases blood pressure by an average of 7.4 /5.8 mmHg, and both aerobic and resistance exercise training have the ability to lower blood pressure, effects of which are largely independent of weight loss.

Intervention Studies and Mechanisms

The ***DASH*** (**D**ietary **A**pproach to **S**top **H**ypertension) clinical trial tested a diet:

- high in fruits and vegetables (~10 servings/day),
- low-fat dairy (2 servings/day), and
- reduced red meat, sugar, and refined carbohydrates

on blood pressure. Significant reductions in blood pressure were noted within 2 wk, and by 8 wk diet reduced blood pressure by 5.5/3.0 mmHg in individuals with normal blood

pressure and by 11.4/5.5 mmHg in patients with hypertension, **with 70% of hypertensive patients exhibiting normal blood pressure after 8 wk**. Such reductions are similar to that achieved with single-drug therapy in individuals with mild hypertension. The blood pressure-lowering effects of ***DASH*** were correlated with blood pressure at randomization, occurred independent of body weight changes, and were enhanced with sodium reduction. Subsequently, the ***DASH*** diet reduced systolic blood pressure in patients with stage 1 isolated systolic hypertension (defined as a systolic blood pressure 140 to 159 mmHg, diastolic blood pressure <90 mmHg).

The effect of the Pritikin combined lifestyle modification on blood pressure was measured in 268 hypertensive patients. Of 216 who entered the program on medication, blood pressure was reduced from 134 ± 2/77 ± 1 (blood pressure measured on drug therapy) to 130 ± 2/73 ± 1 mmHg (measured off in 83% and on in 17%), with 83% taken off medication and the majority of others having their dosages reduced.

Barnard studied hypertensive, diabetic patients going through the 26-day intervention and noted reductions in blood pressure of 141 to 127 mmHg, with 37 of the 61 patients taking antihypertensive medications having discounted their medications. In a study of 652 diabetics, lifestyle modification reduced both systolic and diastolic blood pressure. Overall, the combined effect of lifestyle modification on blood pressure over seven studies and 1,117 subjects is displayed in.

Gordon compared the effects of single vs. combined physical activity and diet (kcal restriction) intervention and found no significant additive effect of both interventions; however, the combined intervention induced an average of 12.5 /7.9 reductions in blood pressure. The Diet, Exercise, and Weight Loss Intervention Trial investigated the effects of lifestyle on blood pressure and other cardiovascular disease risk factors. For 9 wk, 44 hypertensive, overweight adults on a single blood pressure medication were fed a hypocaloric version of the ***DASH*** diet and participated in a supervised, moderate-intensity exercise program 3 times/wk. Noted were significant reductions in daytime systolic (12.1 mmHg) and diastolic (6.6 mmHg) blood pressures as well as Total-C (–25 mg/dl), LDL-C (–18 mg/dl), and HDL-C (–5 mg/dl).

In the PREMIER trial, a comprehensive lifestyle intervention, including implementation of the DASH diet, a minimum of 180 min/wk of physical activity, and weight loss resulted in a 53% risk reduction in hypertension after 6 mo. Additionally, Dengel noted decreases in systolic (14 ± 3 mmHg) and diastolic (10 ± 2 mmHg) blood pressure after a combined aerobic exercise and weight loss intervention.

Exercise interventions have also been documented to reduce blood pressure. Ishikawa noted significant reductions in blood pressure in both young (~15/12 mmHg) and older (~ 10/5 mmHg) hypertensive subjects after a multifaceted physical activity intervention. Seals found similar reductions after 12 wk of training in both resting (10/7 mmHg) and submaximal exercise (21/8 mmHg) systolic and diastolic blood pressure in postmenopausal women with high-normal blood pressure or hypertension. **Walking only 3–4 days/wk has been shown to reduce blood pressure, increase forearm blood flow**

measured by venous occlusion plethysmography, and increase peak limb vascular conductance (a measure of arterial structure) in hypertensive patients.

Several mechanisms may explain the blood pressure-lowering effect of physical activity and diet, including:

- reduction of oxidative stress and
- amelioration of insulin resistance/hyperinsulinemia

Increased intake of unrefined (whole grain), high-fiber carbohydrates, antioxidants, and other phytochemicals (plant chemicals) as well as reduced fat consumption most likely contribute to diet-induced reductions in blood pressure. Katz documented that oatmeal consumption reversed the negative effect of a high-fat meal in healthy subjects. Soluble fiber decreases after meal elevations of glucose, insulin, and trglycerides, which may contribute to its beneficial effects.

Vogel demonstrated that a single high-fat meal impairs endothelial function (the ability of arteries to relax and expand) in healthy individuals, and this response was blocked by pretreatment with antioxidant vitamins C and E, suggesting an oxidative mechanism. Ingesting diets high in fruits and vegetables, offering an array of photochemicals, may be more effective in mitigating oxidative stress, as opposed to consuming supplements, which have not been shown to be effective in some studies. Other dietary components may also be important, such as potassium, magnesium, calcium, and protein.

Summary

Hypertension is the most common cardiovascular disease in the United States and is a hallmark risk factor for CAD and stroke. Both physical activity and diet have been shown to affect the development of hypertension and can lower blood pressure even in those without clinically defined hypertension. The ***DASH*** trial documented that blood pressure reductions with dietary intervention may be comparable to single-drug therapy in the absence of weight loss. Exercise training has been shown in numerous studies to lower resting blood pressure, associated with improvements in endothelial function.