Hypertension and the Role of Dietary Fiber

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Abstract: Hypertension (HTN) is a leading modifiable risk factor for multiple diseases. It has reached epidemic proportions, affecting nearly a third of the world's population. With such a high prevalence and an exhaustive list of potential complications, antihypertensive therapy has been a subject of focus for the scientific community for a long time. Recently, Dietary fiber is emerging as yet another promising candidate addressing this issue. It is a well-known fact that dietary modification alone can significantly impact a patient's health, with a noticeable effect on BP as well. But simply switching to healthy alternatives is not enough and must happen in tandem with dietary supplementation. The consumption of ultra-processed food has only increased in recent times. Hence, we feel the need to focus on dietary interventions in managing hypertension. This review aims to bring to light the current literature on the pathophysiology, risk factors, and treatment protocols of hypertension, focusing on dietary fibers and their role in hypertension management. (Curr Probl Cardiol 2022;47:101203.)

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Introduction

Various modifiable risk factors lead to cerebrovascular, cardiovascular, and renal morbidity and mortality; Obesity, physical activity, smoking, hypertension, etc. being a few of them. Hypertension (HTN) is a leading modifiable risk factor for multiple diseases.[1] A study by Lewington S et al. concluded that with an elevation of every 20 mm Hg systolic BP and a 10 mm Hg diastolic BP, the incidence of cardiovascular and cerebrovascular doubles.[2]

According to a study by Mills KT et al., around 31.1% of the overall world population are suffering from hypertension, thus making it one of the most prevalent diseases in modern medicine.[3] In western countries, there is an increased incidence of hypertension. This may be due to the reduced fiber content in the general population's diet as per 1 hypothesis. While the American Heart Association recommends a daily fiber intake of 25-30 g/day, an average person's average dietary fiber intake in western countries is around 15 g/day.[4] Lack of nutritional fibers is being hypothesized as the factor accelerating incidents of not only cardiovascular events but also many gastrointestinal and other metabolic anomalies.[5]

With such a high prevalence, a lot of research has been done to manage increased blood pressure to prevent various complications like chronic kidney disease, stroke, heart failure, myocardial infarction, and retinopathy. Multiple interventions like lifestyle changes, aerobic & strength training, medications, dietary modifications, and mindfulness have been suggested, and their effect on hypertension has been extensively studied.[6] Many of those studies throw light on how a combination of a balanced diet, nutritional supplements, mindful approach, and physical activity can successfully keep blood pressure in check.[7]

Interestingly, the idea of a correlation between gut microbiota and hypertension is gaining momentum. HTN is a mildly inflammatory condition. Healthy gut flora can reduce inflammation and hence is suspected of having a blood pressure-lowering effect.[8] All these evidence points toward the significance of dietary modification in the management of hypertension. A few experiments have been with vegetarian diets, low-calorie diets, low-fat diets, and low carbohydrate diets and their impact on blood pressure. Among these, dietary fiber is emerging as a promising candidate due to its gut flora-promoting properties.

Dietary fibers are constituents of plants resistant to digestion and absorption in the human small intestine with complete or partial

fermentation in the large intestine. They can be broadly classified into water-insoluble (less fermented such as cellulose, hemicellulose, lignin) and water-soluble (well- fermented such as pectin, gum, mucilage).[9]

Insoluble fibers, which are poorly fermented by gut microbes, increase gut transit rate, therefore, decreasing the amount of time available for the colonic bacteria to ferment nondigested food.[10] On the other hand, some fibers contain polysaccharides which are acted upon by the gastrointestinal tract microbiome to produce fermentative end products such as short-chain fatty acids (SCFA), which are beneficial to the host.[11] Such fibers may also be termed "prebiotics," defined as a group of nutrients degraded by gut microbiota and whose degradation products (SCFA) are released into the bloodstream to affect not only the gastrointestinal tract but also distant organs.[12] It is to be noted here that these prebiotics is different from probiotics (which are live microorganisms administered in adequate amounts to provide health benefits to the host).[13] Butyrate, one of the SCFA byproducts of fermentation, is used by enterocytes as an energy source to maintain gastrointestinal cell integrity.[14,15] Some of these SCFA may indirectly stimulate the growth of other microbes, thus modulating the human gastrointestinal microbiota.[16] A decrease in levels of SCFA producing bacteria and a drop in butyrate levels in gastrointestinal microbiota leads to gut dysbiosis, which in turn is associated with hypertension. Therefore, dietary modifications that modulate gut microbiota could play an essential role in the treatment of hypertension.[17]

A recent study showed dietary fiber supplements, when used with conventional hypocaloric diets, were more effective in controlling blood pressure than the latter used alone.[18] Even in lean HTN patients, dietary fiber supplements have shown effectiveness. Although the mechanism is not entirely clear, a few hypotheses regarding changes in sodium-potassium turnover and glucose-insulin metabolism have been put forward.[19]

Hypertension Is regarded as a silent killer, leading to significant morbidity and mortality. This Literature Review aims to investigate the effects of dietary fibers on blood pressure while providing a comprehensive review of the current literature on the pathophysiology, risk factors, and prevention of hypertension.

Pathophysiology of Hypertension

Hypertension is the dysregulation of the vascular system in the body. A variety of factors and mechanisms independently influence blood pressure (BP), the roots of which can be traced back to the findings initially proposed by Irvine Page in the 1900s.[20] Some of these factors and

mechanisms involved in the regulation of BP are cardiac output and peripheral resistance, endothelial dysfunction, autonomic nervous system, vasoactive substances, and renin-angiotensin-aldosterone system.[21]

Blood pressure is determined by the product of cardiac output and Total Peripheral Resistance (TPR). Any increase in cardiac output or peripheral resistance increases the blood pressure. It has been postulated that due to sympathetic overactivity in the very early stages of hypertension, there is increased cardiac output which ultimately raises the blood pressure. This raised blood pressure is due to the cascading effect of increased TPR, which acts as a compensatory mechanism to reduce the stress of high flow on the capillary beds.[21] A study done among young adults cements this theory of imbalance between sympathetic and parasympathetic nervous systems. It showed reduced parasympathetic nervous system effect causes increased heart rate which has been associated with increased diastolic blood pressure.[22]

Vessel endothelium and vasoactive mediators work in tandem to regulate blood pressure. Endothelin is one such agent. Novel anti endothelin agents are being used therapeutically to reduce blood pressure which further consolidates the role of endothelin in the maintenance of blood pressure.[23] Nitric oxide is another mediator that has been heavily studied for its role in BP regulation. Genetic mutations in eNOs genes are more common in hypertensive patients.[24] Bioactivity impairment of nitric oxide also has a significant role in endothelial dysfunction.[25]

Goldblatt put forward a hypothesis that focuses on Renal microvascular injury.[26] Authors proposed that renal injury proceeds through 3 phases in which initially the kidney is exposed to stimuli causing vasoconstriction, and later it tries to compensate which ultimately increases the systemic blood pressure. This theory explains various factors and mechanisms altering blood pressure.[27]

Even though a variety of mechanisms are being actively investigated to determine the pathophysiology of hypertension, it is tough to pinpoint a single mechanism that is responsible for it.

Furthermore, hypertension can be classified into primary and secondary. Primary Hypertension generally accounts for 95% of cases.[28] Although various genetic predispositions are being studied extensively, the actual cause of primary hypertension is still unknown. The major causes of secondary hypertension are chronic kidney disease, renal artery stenosis, excessive aldosterone secretion, pheochromocytoma, and sleep apnea.[28]

Elevated blood pressure can ultimately cause end-organ damage by affecting the brain, heart, kidney, and peripheral arteries. Hypertension is

an independent risk factor for heart failure, coronary artery disease, stroke, and renal peripheral artery disease. Understanding the pathophysiology is of paramount importance so that an efficient targeted therapeutic approach can be deployed.[29]

Risk Factors and Prevention of Hypertension

Hypertension is generally accepted as a multifactorial condition and refers to the interaction of modifiable and non−modifiable risk factors.

Modifiable Risk Factors for Hypertension

Obesity and hypertension are well known to be associated with each other. Hypertension affects an estimated 15%, 25%, and 40% of normal-weight, overweight, and obese people, respectively.[30] It is well documented that a lack of regular physical activity negatively impacts blood pressure, regardless of whether the individual is normotensive or hypertensive. A systematic review of 27 randomized controlled trials (RCTs) in hypertensive individuals found that regular medium-to-high intensity aerobic activity was associated with lower 11 mm Hg systolic BP and 5 mm Hg diastolic BP.[31]

Although the evidence on the effect of smoking on blood pressure is controversial, most studies identify smoking as an essential determinant of hypertension.[32,33] Although active smoking is associated with an increased risk of incident hypertension, passive smoking can also negatively impact blood pressure.[33]

Alcohol consumption also impacts blood pressure. A recent meta-analysis of 36 intervention trials with a total of 2865 participants found that a 7-day reduction in alcohol consumption in normotensive or hypertensive individuals who drank more than 2 drinks per day was associated with a 5.5- and 4.0-mm Hg reduction in systolic and diastolic blood pressure, respectively.[34]

Non−Modifiable Risk Factors for Hypertension

Increasing age causes structural changes and considerable arterial stiffness, leading to changes in blood pressure over time.[35] The third National Health and Nutrition Examination Survey (NHANES) in the United States revealed that 3 of every 4 hypertensive adults are over 50, and advancing age is an essential element of hypertension.[36]

Sex differences in blood pressure and hypertension risk are also observed. Up to the age of 65, males have a higher prevalence of hypertension, whereas females appear to have an increased risk of hypertension after that age.[37] This may be due to a protective effect of sex hormones against hypertension development in women of reproductive age, which is altered after menopause.[38]

In epidemiologic studies, racial and ethnic differences have also influenced Hypertension.[37] Individuals with a family history of hypertension have a markedly higher prevalence of hypertension than those without family history.[39]

Pazoki and colleagues created a genetic risk score for high blood pressure to see if lifestyle factors could offset the BP effect of an adverse genetic profile. Regardless of the underlying BP genetic risk, the healthy lifestyle score was strongly inversely associated with systolic and diastolic blood pressure.[40]

Preventive Measures

Physical activity has been shown to improve blood pressure.[41] According to AHA and/or ACC (American Heart Association and/or American College of Cardiology) guidelines, aerobic exercise for 90-150 minutes/week at 65%-75% of maximum heart rate reserve is necessary to prevent hypertension.[42]

Similarly, ESC and/or ESH (European Society of Cardiology and/or European Society of Hypertension) stated to aim for 300 minutes of moderate-intensity aerobic physical activity per week or 150 minutes of vigorous-intensity aerobic physical exercise per week to prevent hypertension.[43]

Dietary changes, such as following the Dietary Approaches to Stop Hypertension (DASH) diet, are equally effective in lowering blood pressure in people with and without hypertension and patients with or without antihypertensive medication.[44] Similarly, reducing sodium intake is an effective strategy for lowering blood pressure in hypertensive patients, and the effects may be additive to those of pharmacologic interventions.[45]

According to ACC and/or AHA guidelines, a diet high in fruits, vegetables, whole grains, and low-fat dairy product with a low saturated and total fat content (DASH dietary pattern) and reduction in sodium intake to 1500 mg per day and increase in potassium intake to 3500-5000 mg per day is adequate for prevention of hypertension.[42] Similarly, it has been reported that losing excess body weight is a highly effective method

in patients with hypertension, both those who are not on medication and, especially, those who are on medication.[46]

The ACC and/or AHA and the ESC and/or ESH guidelines recommend reducing alcohol intake to manage hypertension.[42,43] ESC and/or ESH provides smoking cessation, supportive care, and referral to smoking cessation programs to prevent HTN.[43]

Low-dose pharmacologic therapy has also been demonstrated to lower blood pressure and prevent hypertension. Treatment with a low-dose chlorthalidone and amiloride combination resulted in both a reduction in blood pressure and hypertension prevention. A drug intervention is easier to implement and maintain than a lifestyle change intervention; however, it is natural to be hesitant to recommend a lifetime of pharmaceutical therapy for hypertension prevention. Low-dose pharmacotherapy should be considered only for those at high risk of developing hypertension despite vigorous efforts to lower blood pressure with 1 or more non−pharmacologic interventions.[47]

Current Treatment Protocols for Hypertension

People with hypertension generally consider lowering their blood pressure by engaging in physical activities or taking anti−hypertensive medications. There are guidelines prepared by organizations such as the National Institute for Health and Care Excellence (NICE), American Heart Association (AHA), European Society of Hypertension (ESH), International Society of Hypertension (ISH), and Joint National Committee (JNC 8) with standard set treatment protocol for lowering blood pressure in hypertensive patients.[48]

The physical activity intervention started on hypertensive patients focuses on spending energy performing tasks above resting levels.[49,50] Physical activity interventions can include aerobic exercise, resistance training, a combination of aerobic and resistance activities, high-intensity interval type training, yoga, accumulated exercises, and walking-based interventions.[49,51-53] A comprehensive approach involving physical activity and medications is needed.[54] For managing hypertension more efficiently and effectively, there is a need to adapt, and use standardized, evidence- based protocols.[55]

The AHA updated the guidelines in 2017, which is consistent with the latest 2018 European Society of Cardiology and/or European Society of Hypertension guidelines and as per the latest updated guidelines of AHA, the Blood pressure (BP) category and their treatment protocol are as follows[56]:

BloodPressure categories and their treatment protocol[56]:

BP	BP category	Treatment protocol
• <120/80 mm Hg	Normal	Encouraged to have optimal lifestyle habits Reassessed in 1 y
• 120-129/<80 mm Hg	Elevated	Non−pharmacologic therapy Reassessed in 3-6 mo
• 130-139/80-89 mm Hg without ASCVD and estimated 10 y CVD risk </=10%	Stage 1 hypertension without ASCVD and estimated 10 y CVD risk	Non−pharmacologic therapy Reassessed in 3-6 mo
• 130-139/80-89 mm Hg with Clinical ASCVD or Estimated 10 y CVD risk >/=10%	Stage 1 hypertension with clinical ASCVD or estimated 10 y CVD risk	Antihypertensive along with non−pharmacologic therapy Reassessed in 1 mo. If the target BP is obtained, the patient is reassessed in 3-6 mo. If not, adherence to therapy is optimized and intensification of therapy is considered
• BP >/=140/90 mm Hg	Stage 2 hypertension	Treatment strategies are similar to stage 1 hypertension with ASCVD or estimated 10 y CVD risk >/= 10%

Comparison of Guidelines[57,58]

	AHA	ESH and/or ISH
Definition of Hypertension	Office and/or clinic mean of ≥130/80 mm Hg Daytime mean and Home BP mean of ≥130/80 mm Hg. Nighttime mean of ≥110/65 mm Hg. 24 h mean of ≥125/75 mm Hg is defined as hypertension	Office and/or clinic BP of ≥140/90 mm Hg, Daytime mean and Home BP mean of ≥135/85 mm Hg, Nighttime mean of ≥120/70 mm Hg, the 24-h mean of ≥130/80 mm Hg, is defined as hypertension
Intervention	BP ≥130/80 mm Hg, Initially- Single-pill combination therapy Target BP <130/80 mm Hg	PB ≥140/90 mm Hg Initially- Single-pill combination therapy Target- systolic <140 mm Hg and close to 130 mm Hg
Similarities	- Monitoring of home BP twice (morning and evening) in the week before clinic; - Checking BP machine annually for validation, - Initiating single-pill combination as initial therapy, - Restricting beta-blockers in patients with comorbidities or other indications, -Detecting poor adherence and focusing on improvement -BP telemonitoring and digital health solutions are recommended	

Non−Pharmacologic Treatment:

Non−Pharmacologic treatment	Process	Reduction in BP
Weight loss	Aim to reduce at least 1 kg for adults who are overweight. Results in 1 mm Hg BP reduction for every kg lost	Reduction of SBP by 5 mm Hg in hypertensive patients and 2-3 mm Hg in normotensive patients.
Dietary Approaches to Stop Hypertension (DASH)dietary pattern	**Consume a diet rich in fruits, vegetables, whole grains, and low-fat dairy products with reduced content of saturated and total fat**	**Reduction of SBP by 11 mm Hg in hypertensive patients and3 mm Hg in normotensive patients.**
Dietary sodium	Consume sodium < 1500 mg/d	Reduction of SBP by 5-6 mm Hg in hypertensive and 2-3 mm Hg in normotensive patients
Dietary Potassium	Consume potassium 3500-5000 mg/d through a potassium-rich diet	Reduction of SBP by 4-5 mm Hg in hypertensive and 2 mm Hg in normotensive patients.
Physical activity	Doing aerobics or dynamic resistance exercises 90-150 min/week and isometric resistance exercises 3 sessions/week (8-10 weeks)	Reduction of SBP by 5-8 mm Hg in hypertensive and 2-4 mm Hg in normotensive patients
Moderation in alcohol consumption	Alcohol consumption for men </=2 drinks/d and women</=1 drink/d	Reduction of SBP by 4 mm Hg in hypertensive and 3 mm Hg in normotensive patients

The effective non−pharmacologic intervention for prevention and treatment of hypertension includes[57]:

Pharmacologic Treatment

According to the JNC 8 guideline, adults aged 18 or more with hypertension need to modify their lifestyle, set BP goals, and initiate BP-lowering medication.[59] ACE inhibitors or ARBs, CCBs, and Thiazides are the first-line medications for the commencement of antihypertensive pharmacologic therapy.[60] It is not recommended to treat people with hypertension with an ACE inhibitor, an ARB, and/or a renin inhibitor simultaneously.[61-63]

Choice of starting monotherapy vs combination therapy[64]:

- In adults with stage 1 hypertension and target BP <130/80 mm Hg, a single antihypertensive drug is initiated with titrating the dose or adding other drugs sequentially to meet the target BP.

- For adults with stage 2 hypertension and an average BP more than 20/10 mm Hg above their target BP, antihypertensive drug treatment is started with 2 different first-line medicines either separately or in a fixed-dose combination.

If the BP goals are achieved, the treatment is continued and monitored. If the BP goal is still not met with first line drugs, medication like beta-blockers aldosterone antagonists is used and titrated to the maximum. Otherwise, another medication is added, and the patient is referred to a hypertension specialist.[59]

The threshold of blood pressure to start antihypertensive medication and their target control blood level per clinical conditions[64,65]:

The patients having clinical CVD or 10-year ASCVD risk ≥10% have threshold BP is ≥130/80 mm Hg and the ones with no clinical CVD or 10-year ASCVD risk <10% have threshold BP is ≥140/90 mm Hg to start antihypertensive medication. The goal of antihypertensive in both conditions is less than 130/80 mm Hg.

The patients who are the older people of age ≥65 years, noninstitutionalized, ambulatory, and living in community, have threshold SBP of ≥130 mm Hg and the goal SBP for such patients is <130 mm Hg.

The patients with specific comorbidities like Diabetes mellitus, CKD, CKD post-renal transplantation, heart failure, stable ischemic heart disease, and peripheral artery disease, have the threshold BP of ≥130/80 mm Hg however, for the secondary troke prevention BP of ≥140/90 mm Hg is the threshold. The goal of antihypertensive in all comorbid conditions is ≤130/80 mm Hg.

Treatment of Choice in Different Comorbidities[58]:

Comorbidities	Treatment Of Choice
Heart Failure	Angiotensin-converting enzyme inhibitors (ACEI) and/or Angiotensin II receptor blocker (ARB) +Beta blocker + diuretic + spironolactone
Post Myocardial Infarction and/or Clinical Coronary artery disease (CAD)	ACEI and/or ARB and beta-blockers
CAD	ACEI, Beta-blockers, diuretics, calcium channel blockers
Diabetes	ACEI and/or ARB, Calcium channel blockers, diuretics
Chronic Kidney Diseases	ACEI and/or ARB
Recurrent stroke prevention	ACEI, diuretics
Pregnancy	labetalol is the first drug of choice, nifedipine, and methyldopa can also be used

Follow-up After Commencing the Antihypertensive Medication

Adults starting a new or modified medication regimen for hypertension should have their adherence and responsiveness to therapy evaluated at monthly intervals until they attain control.[66-68]

A large fraction of people today follows unhealthy lifestyles, which lead to a high risk of stroke, myocardial infarction, heart failure, and chronic kidney disease. This is the main challenge in tackling hypertension, the fact that in so many cases, it is a disease we bring upon ourselves by our own choices.[69] Adopting a healthy lifestyle is a good solution, but the dissemination, proper acceptance, and full implementation of standard treatment guidelines will ultimately improve public health.[70] Decreasing barriers to accurate diagnosis and management of hypertension, gradually moving toward team-based care, proper implementation of techniques for improving therapeutic adherence, and maximum involvement of patients in their care are all possible solutions to follow standard treatment protocols, and these could potentially relieve the burden on primary care clinicians.[71]

Role of Dietary Fibre Supplementation (In General)

According to Food and Drug Administration (FDA), a minimum of one among the following physiological effects that are beneficial to human health must be demonstrated before the FDA would propose to allow the carbohydrate eligible to be incorporated in the definition of "dietary fiber"[72]:

Lowering blood glucose Lowering cholesterol levels Lowering blood pressure Increase in frequency of bowel movements Increased mineral absorption in the intestinal tract Reduced energy intake.

Lowering Blood Glucose

To support anabolism, blood glucose levels must be kept within a physiological range of fasting 70-80 mg/dL and postprandial 140-160 mg/dL. Postprandial blood sugar level depends on numerous elements like the composition of feeds, the frequency of gastric emptying, and the absorption of glucose from the intestinal wall.[73] Enriching consumption of soluble fiber is a sensible strategy to enhance postprandial.

Lowering Cholesterol Levels

Mechanisms for fiber-mediated cholesterol-lowering are a.) increased bile acid-binding and excretion, b.) viscosity induced delayed absorption,

c.) inhibition of lipase and amylase, and d.) short-chain fatty acids (SCFAs) causing decreased lipogenesis and enhanced lipolysis.[74] A study among reproductive age group women demonstrated the direct lipid-lowering and indirect lipid increasing effect (mediated by estradiol).[75] However, the different studies generally support increasing the intake of fiber-rich food for the primary prevention of cardiovascular diseases among women.[76-78] Increased dietary fiber intake complements statin therapy to lower total and LDL cholesterol levels and decrease statin dose.[79] A recently published study (population-based prospective cohort analysis) with a median follow-up of approximately 21 years revealed a lowered risk of acute cardiovascular disease with improved diet quality and increased fiber intake like fruits, vegetables, and beans.[80,81]

Increase in Frequency of Bowel Movements

Carbohydrate breakdown by the colonic microbiota leads to improved laxation and anticancer effects.[82,83] Bacterial cell mass is raised by increased intake of carbohydrates, which facilitates increased laxative effects and a briefer colonic transit period.[84] The diminished transit periods reduce the collection of putrefactive substances, whereas fermentation of dietary fiber leads to the production of 3 major colonic short-chain fatty acids (SCFAs), namely acetate, propionate, and butyrate.[82]

SCFAs influence gut motility by modulating physiological processes like the ileocolonic brake or the defense against colo-ileal reflux.[85]

Increased Mineral Absorption in the Intestinal Tract

The capability of the diet to present enough minerals as cations and anions (ionized forms) primarily determines the transcellular absorption of minerals.[86] SCFAs in the colon acidify the intestinal, thereby preventing the formation of complexes between minerals and negatively charged metabolites and improving the extent of mineral absorption.[87] However, an investigation, by Shah M et al., among patients with T2D following an increased soluble fiber intake noticed mildly reduced serum calcium along with lowered urinary calcium and phosphorus levels.[88] The study indicates the increased need to provide adequate amounts of dietary minerals among patients pursuing a long-term consumption of a high-fiber diet.[88]

Reduced Energy Intake

As the dietary fibers (both soluble and insoluble) have no caloric value, a diet rich in whole grain proteins, vegetables, and fruits is beneficial for

reducing cardiovascular disease.[79] Dietary fiber defies digestion and may undergo microbial fermentation in the large intestine—the digestive and viscosity characteristics of dietary fiber drop overall nutrient absorption.[89] The viscosity of soluble fiber β-glucan explains satiety enhancement by oatmeal.[90,91] Consumption of fiber (natural food and/or supplemental) reduces fat, and protein absorption decreases digestible energy intake and promotes long-term weight management.[92]

Role of Dietary Fiber in the Management of Hypertension

The North American diet is rich in saturated fats.[93] The National Institute of Health came up with DASH (Dietary Approaches to Stop hypertension) in 1992 when they found that dietary modifications alone could decrease systolic blood pressure by 6 to 11 mm Hg. Over the past 2 decades, the consumption of ultra-processed foods in the US has only increased.[94] Hence, we strongly feel the need to focus on dietary interventions in the treatment protocol of hypertension.

A typical serving guide for a patient following the DASH diet would include vegetables, fruits, carbohydrates, low-fat dairy products, lean meat products, nuts, and seeds.[93] Fruits and vegetables in their raw form may provide fiber and nutrients, however once cooked or fried, they may also substantially contribute fat and sodium to the diet.[16] On the other hand, psyllium (a fiber) increases the viscosity of the digesta, thus delaying the absorption of glucose and nutrients in the gastrointestinal tract. This phenomenon helps modulate glucose release into the circulation and improves systemic insulin resistance.[95] Insulin resistance, if not controlled, plays a role in endothelial dysfunction, leading to hypertension.[96] However, simply switching to healthy alternatives in the diet was not enough, and external dietary supplements would be required to yield maximum health benefits.[97]

It has been observed that individuals with a high intake of dietary fiber are less likely to develop hypertension and its associated consequences, such as coronary artery disease and stroke.[98] Dietary modifications should be considered before starting them on lifetime medications, especially in first- time hypertensives. Psyllium fiber, which is available in pharmacies, is an excellent source of dietary fiber found to decrease systolic and diastolic blood pressure in hypertensive individuals.[99] Fibers provide an array of benefits such as reduction in blood pressure, improvement in insulin resistance, lowering of low-density lipoproteins, and have the advantage of having zero to minimal side effects.[100-102] It was noticed

that people with elevated blood pressure often had diets deficient in dietary fiber.[103] Americans, who do not follow an adequate fiber intake in their diet would most benefit from this dietary intervention.[79] Apart from the benefits mentioned above, nutritional fibers were also found to reduce depression by reducing inflammation in the body.[104] They have been demonstrated to be effective in the prevention of colorectal carcinoma.[97]

The U.S. Food and Drug Administration (FDA) will be adding gum acacia (gum arabic) to the FDAs definition of dietary fiber.[105] Gum arabic, a soluble and fermentable dietary fiber, is known to reduce blood glucose levels and increase lipid metabolism. It has also been shown to prevent obesity amongst healthy adults.[106,107] Body mass index (BMI) is a risk factor for hypertension; thus, gum arabic could play an essential role in preventing hypertension.[108] The other mechanisms or gum arabic and other dietary fibers have already been described in this article.

The most common side effects of dietary fibers are flatus, bloating, and stomach cramps, especially with gum arabic, which is highly fermented by colonic bacteria.[109] It was also noted that adherence to dietary changes in the treatment of hypertension always varied among individuals.

People who took pharmacologic medications would notice the consequence of missing some doses instantly; however, the impact of modulating lifestyle changes was very gradual. Thus, some individuals prefer taking pharmacologic medicines rather than making daily changes in their lifestyle and dietary patterns.[110,111]

Conclusion

The main challenge in HT is that, in so many cases, it is a disease we bring upon ourselves by our own choices. Despite developing detailed secondary prevention protocols and nearly unlimited options for treating HT, many challenges remain. The authors aim with this review was to reiterate the role of diet in the management of HT, especially when the consumption of ultra-processed food is at an all-time high. With well-documented benefits beyond blood pressure reduction combined with minimal side effects, dietary fiber supplementation and careful dietary interventions can go a long way in managing the blood pressure of individuals.

Authors' Contribution

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