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# A Review on Efficacy of Dietary Approaches in The Management of Hypertension

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**Abstract**

Hypertension (HTN), commonly known as the 'Silent Killer,' presents a significant worldwide health concern, with a prevalence of 24% in men and 21% among women in India. As lifestyle and food culture evolve, the prevalence of Non-Communicable Diseases (NCD) is increasing, thereby impacting overall health. The primary objective of this study is to conduct a comprehensive review of existing literature with a view towards exploring the recent advancements in diet and nutritional approaches for individuals with HTN.

This study aims to understand the importance of different diets such as the DASH diet, Mediterranean diet, potassium-rich diet, low salt diet and vegetarian diet which have been recommended globally owing to their varying ability to lower Blood Pressure (BP). Additionally, it emphasises the significance of protein in reducing BP, especially in India, where protein deficiency is highly prevalent. The study also investigates the role of simple and easily accessible functional foods that exhibit antihypertensive effects, with supporting evidence for their efficacy.

The study's findings indicate that adopting a consistent diet regime, such as a balanced diet with sufficient high-quality protein (at least 0.83g/kg/day), along with generous portions of fruits, vegetables and reduced salt intake, has proven to be highly effective in managing BP. Complementing non-pharmacological interventions with lifestyle modifications, such as healthy eating, regular physical activity, weight management, abstaining from smoking, limiting alcohol consumption and implementing stress management techniques, can collectively contribute to preventing and controlling HTN, thus reducing the disease burden. An effective change in the daily diet consistent with current protein recommendations is helpful in BP control.

**Keywords:** DASH (Dietary Approach to Stop Hypertension), Functional foods, Hypertension, Lifestyle modification, Non-Communicable Diseases (NCDs), Protein, Salt.

## 1. Introduction

Hypertension (HTN)- the ‘silent killer’[1] is a global health problem[2] and a leading lifestyle disorder in the Indian and South Asian populations[3] Lifestyle changes worldwide have been influenced by the rapid shifts in demographics, epidemiology, substantial economic growth and globalisation. This has brought changes in the choice of food, increased sedentary lifestyle, consumption of tobacco, alcohol and fluctuation of body weight. This transition can be seen as a notable factor preceding the increased prevalence of Non-Communicable Diseases (NCDs) and HTN in particular, among adults and older

individuals, which in turn creates a burden on healthcare systems[4]. It is said to affect an estimated 1.3 billion worldwide, killing approximately 10 million people yearly [5]. Amongst the developing countries, India has the highest prevalence of HTN [6]. In low- and middle-income countries, the prevalence of HTN is greater, as there is a lower level of awareness, treatment and control compared to high-income countries [7]. According to the World Health Organization (WHO), one in four individuals in India has HTN, and just 12% of them have their Blood Pressure (BP) under control[8]. HTN is the most important leading factor for coronary heart diseases (CHD), cerebrovascular disease, renal failure [9]. and many other metabolic diseases which is a cause of the increase in overall mortality [4]. Hence, early initiation and prolongation of non-pharmacological treatment like lifestyle modification, which includes a change in dietary habits, weight management, dietary salt restriction, increased physical activity and others along with medications can help in the effective management of HTN [10].
Thus, the aim of this study is to identify the latest developments in the field of diet, nutrition & HTN, with a view towards Summarising the diet for practising dietitians.

### 1.1 Definition:

The term "Blood Pressure"(BP) refers to the force exerted by the blood flow on the blood vessels [3]. HTN is defined as when the Systolic Blood Pressure (SBP) is ≥140 mmHg (millimetre of mercury) and Diastolic Blood Pressure (DBP) is ≥ 90 mmHg [11], [12]. Furthermore, Table 01 presents the classification and grading of HTN.

**Table01:Category of Blood Pressure and Hypertension grade**

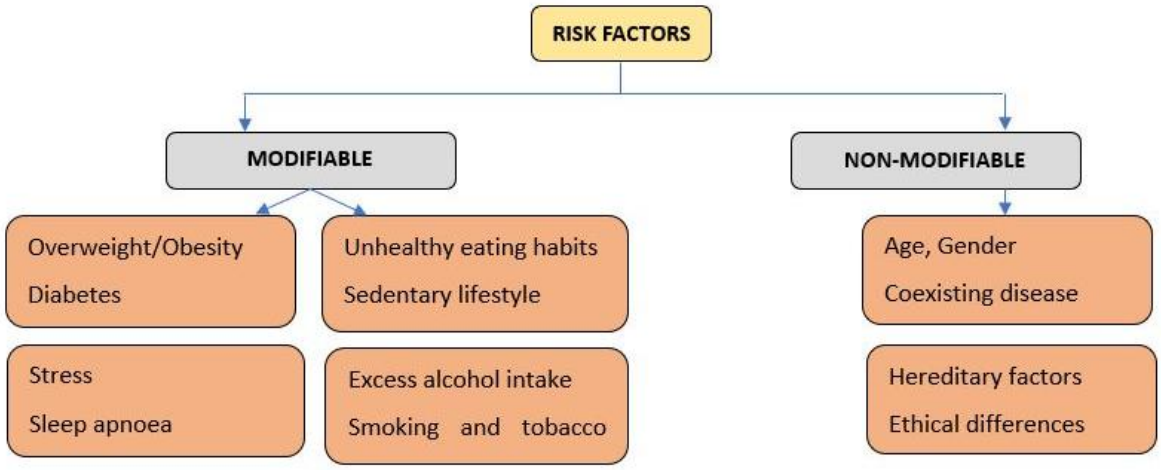
| Blood pressure category | Systolic (mmHg)-upper number | | Diastolic (mmHg)-lower number |
|---|---|---|---|
| Normal | <120 | and | <80 |
| Elevated | 120-129 | and | <80 |
| Hypertension stage 1 | 130-139 | Or | 80-89 |
| Hypertension stage 2 | ≥140 | Or | ≥90 |
| Hypertension stage 3/ Hypertensive crisis | >180 | and/or | >110 |

[3], [12],[13]

### 1.2 Aetiology and Symptoms

According to the American Heart Association (AHA), high BP is said to be mostly asymptomatic. A few symptoms such as facial flushing, blood spots in the eye and dizziness [14] are indirectly related, while the other symptoms experienced by the majority of the patients include nausea, vomiting, anxiety, confusion, chest pain, severe headache and palpitations [11]. The cause of HTN is multifactorial and can be classified as modifiable and nonmodifiable factors as shown in Figure 01

**Figure 01: modifiable and nonmodifiable risk factors of hypertension**




### 1.3 Criteria for predicting hypertension

The use of anthropometric indices like Body Mass Index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) has been used for a long time for the screening of HTN[15]. The revised BMI classification criteria for Asian Indians demonstrated greater sensitivity (67%) in predicting and diagnosing HTN compared to the WHO criteria (55%) [16]. A study showed that the BMI was higher in the hypertensive group (26.7 Kg/m2) compared to the non-hypertensive group (24.1 Kg/$m^2$) [17]. Table 02 highlights the BMI and WHR for predicting HTN [18].

**Table 02:BMI and Waist Hip ratio value for predicting hypertension**

| BMI | Waist to Hip ratio |
|---|---|
| ≥24.5 Kg/$m^2$ in men and ≥24.9 kg/$m^2$ in women | ≥83 cm in men and ≥78cm in women |

### 1.4 Prevalence and incidence of HTN

According to the data presented in Table No. 03, the prevalence of HTN among individuals aged 15 to 49 years as per NFHS-05 is 24% for males and 21% for females. The study observed that the occurrence of HTN in relation to BMI is 40% among men and 28% among women. Moreover, the study found that HTN is more prevalent among Sikhs, followed by Jains and Christians when compared to individuals belonging to other religious backgrounds [1].

**Table03:Prevalence of HTN based on age group and in relation to BMI as per NFHS-5 (2019-2021)**

| Gender | Prevalence | |
|---|---|---|
| | Age 15 to 49 years | In relation to BMI (overweight) |
| Male | 24% | 40% |

| | | |
|---|---|---|
| Female | 21% | 28% |

**2. Diet modalities in Hypertension**

Diet management plays a significant role in the initial phase as multiple dietary factors are involved in the prevalence of HTN. It is one of the major lifestyle modifications in preventing the occurrence of HTN at a cost that is often less than the current pharmacological intervention [10]. Health organisations such as the National Health, Lung, and Blood Institute (NHLBI), the American Heart Association (AHA), and the American College of Cardiology (ACC) have given their support to evidence-based diets that are recommended for patients[9].

**2.1 DASH Diet**

Dietary Approaches to Stop Hypertension (DASH), a programme by the National Institutes of Health, USA, is a lifelong approach to healthy eating that is designed to help, treat or prevent HTN without medication. This diet is rich in fruits, vegetables, whole grains, and low-fat dairy products, including poultry, fish and nuts, contains small amounts of red meat, sweets and sugar-containing beverages, and a sodium intake within normal limits[19]. The DASH plan is a first step for treating HTN when combined with calorie restriction [20]thereby providing superior BP-lowering effects[19]. In consideration of the taste preferences of Indian patients, the DASH diet is recommended for hypertensive control in diabetic patients[3].

**Mechanism of action:**

The DASH diet steepens the pressure-natriuresis curve, suggesting a natriuretic action [21]. The natriuretic effect has also been exemplified by its interaction with the renin-angiotensin system (RAS), resulting in increased plasma renin activity and aldosterone levels [22], [23]. While the recommended DASH diet reduces HTN by lowering the amount of sodium to 2300 mg/day, lowering it further to 1500 mg/day reduces HTN drastically[10].

**2.2 Mediterranean diet**

A Mediterranean diet is abundant in fruits, vegetables, legumes, whole grains, olives, nuts and seeds, contains extra-virgin olive oil, with frequent consumption of fish, moderate consumption of dairy products and red wine and low consumption of red meat and isolated sugars. However, a low sodium intake is not a feature of both the Mediterranean diet and the DASH diet. They are palatable, relatively easy to adhere to and are in accordance with dietary recommendations for cardiovascular health[19]. Moderate implementation of the Mediterranean diet showed a decrease of 2.4 mmHg for SBP and 1.3 mmHg for DBP; while more systematic application decreased SBP and DBP by 3.1 and 1.9 mmHg, respectively. Additionally, the adoption of the Mediterranean diet in 772 subjects (55-80 years), who were at high risk for cardiovascular disease, resulted in an SBP reduction of 7.1 mmHg[10].

**Mechanism of action:**

The fatty acid profile and high antioxidant content of the Mediterranean diet contribute to the improvement of endothelial function. Early endothelial inflammation is observed in hypertensive and vascular disease patients which leads to atherosclerosis. This diet which is rich in Monounsaturated fatty

acid (MUFA) reduces the susceptibility of cholesterol molecules to oxidation thereby exerting its antioxidant effect[24]. Dietary components of the Mediterranean diet, such as magnesium, fish-derived omega-3 fatty acids, and olive oil (with extra-virgin oil) improve endothelial function. Cocoa flavanols, anthocyanins, (berries, red grapes and red wine) & flavan-3-ols (apples, hops, tea, beer, wine, fruit juice and black tea) are associated with improvements in both vascular endothelial disease and BP[19].

### 2.3 The Vegetarian Diet

Vegetarians have lower BP compared to meat eaters. This is due to a higher intake of fruit, and vegetables, rich in fibre coupled with a low intake of saturated fats and sodium, thereby contributing to a lower BMI [25]. The glutamic acid component of a vegetarian diet has a BP-lowering effect due to its anti-oxidant and anti-inflammatory properties. There are several studies which have shown that a dietary pattern with a lower meat intake, like a vegetarian diet, is associated with a lesser rate of NCDs, particularly HTN thereby contributing to better health outcomes and a longer life expectancy [26].

**Mechanism of action involves:**

1. Improving blood viscosity, vasodilation and insulin sensitivity.
2. Altering the baroreceptors, renin-angiotensin system and Sympathetic Nervous System (SNS).
3. Changing the colony and strain of gut microflora.

### 2.4 Low sodium diets

High dietary sodium intake is associated with the development and progression of HTN [27], [28]. Meta-analysis has shown that every 100 mmol reduction in sodium (equivalent to 2.3 mg sodium/day) is associated with a fall in SBP of 5.8 mmHg [29]. Notably, the BP-lowering effect of salt restriction is on top of the healthy dietary pattern.

**Mechanisms of action:**

Excessive Sodium consumption >5 g/day, has been shown to produce a significant increase in BP and is linked with the onset of HTN. It also leads to fluid retention, enhanced sympathetic activity, increased vasoconstriction, vascular remodelling, myocardial remodelling and renal damage in the long run [30]. Both high and low sodium intake are associated with increased mortality. RCTs in Asian populations have proved the significant BP-lowering effect of sodium restriction owing to its ability to activate the sympathetic system with impairment of BP homeostasis in hypertensive patients [31], [32].

### 2.5 Potassium-rich diet

Potassium is an essential nutrient which along with sodium helps to regulate acid and electrolyte balance, total body volume and normal cell function, thereby preventing muscle cramps and arrhythmia by causing vasodilation [33](IDA, 2020). By and large, a diet high in processed foods is often lacking in potassium. Lower potassium consumption has been associated with elevated BP [34]and stroke,[35] and higher levels of consumption could be protective against these conditions [36]. An increased dietary potassium intake (3500–5000 mg/day) from fresh fruits, vegetables and pulses is preferred over pill supplementation which is potentially toxic [37].

**Physiological mechanism of action:**

1. Causes Natriuresis and prevents retention of sodium and thus lowers BP
2. Inhibit the formation of free radicals by inhibiting the proliferation of the smooth vascular muscle cells, and reducing the vascular resistance.

Moderate and high-quality evidence showed that a higher potassium intake of 90-120 mmol/day reduced BP and was associated with a lower risk of incident stroke. According to some studies, potassium supplementation had a clinically modest impact on essential HTN and thus may be used as an adjuvant anti-hypertensive agent[38]. Increasing potassium intake, especially from fruits and vegetables, is therefore recommended for the prevention and treatment of HTN [39].

**3. Role of proteins in hypertension**

Protein helps in building muscle mass, maintaining fluid balance, acid-base balance and in the formation of antibodies. Proteins also act as carriers of vitamins, oxygen and carbon dioxide[40]. Almost half the protein in our body is in the form of muscle and the rest of it is in bone, cartilage and skin. Protein requirements vary with age, physiological status, stress and disease condition. Foods such as pulses, legumes, milk, meat, fish and eggs are rich sources of proteins [41].

However, a 2017 survey shows that 73% of Indians are deficient in protein while above 90% are unaware of the daily requirement. Indian diets are predominantly cereal-based, and 60% of protein is derived from cereals. A study conducted across 8 Indian cities found that 71% of individuals, between the ages of 30 to 55 years suffer from poor muscle health with higher percentages observed in specific cities such as 81% in Lucknow and 64% in Delhi [42]. Figure 02: Shows the average daily protein intake among Asian countries

Recent evidence from RCTs, Systematic reviews and other epidemiological studies have indicated that increasing dietary protein intake from both plant and animal sources, lowers BP and thus potentially reduces the risk of CVD [43]– [47](figure 03). Higher intake of plant protein was associated with lower BP in individuals with pre-hypertension or stage 1 HTN [48], [49]. The DASH diet, Omni heart, INTERSALT and Japanese cross-sectional study showed an inverse relationship between total protein intake and BP. However, the INTERMAP study, PREMIER study and Isfahan Healthy Heart program emphasised plant proteins were associated with a reduction in BP. Data from an epidemiology study, Shanghai Women's Health and another RCT conducted by[50] revealed soya protein consumption reduced SBP and DBP in both hypertensive and normotensive subjects, but these reductions were markedly greater in hypertensive subjects. Another double-blind cross-over RCT concluded that dairy protein improves BP and vascular function in overweight and obese subjects [47].

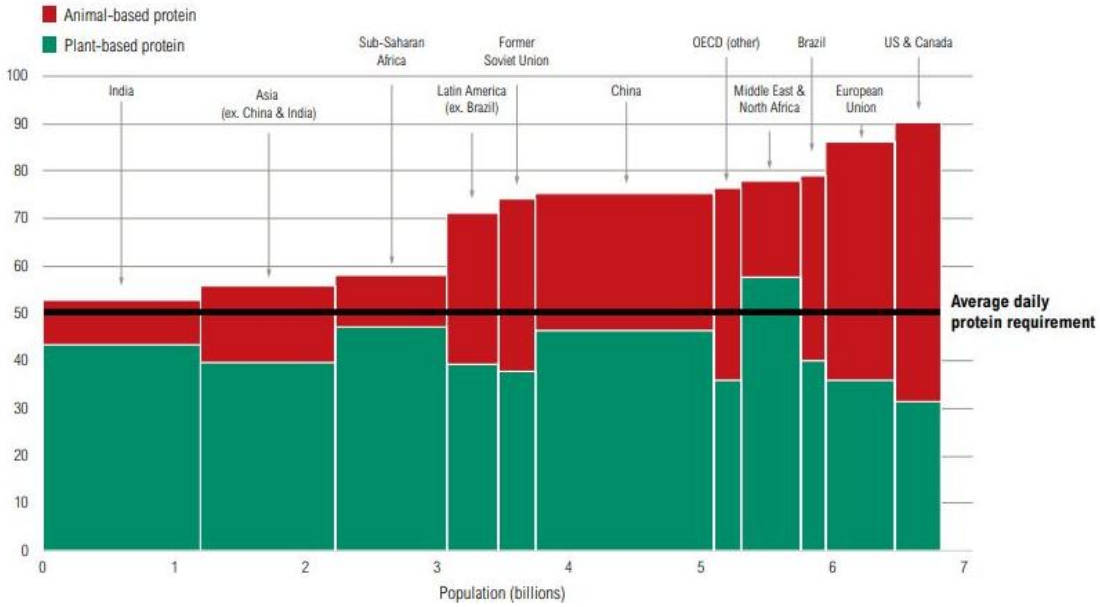
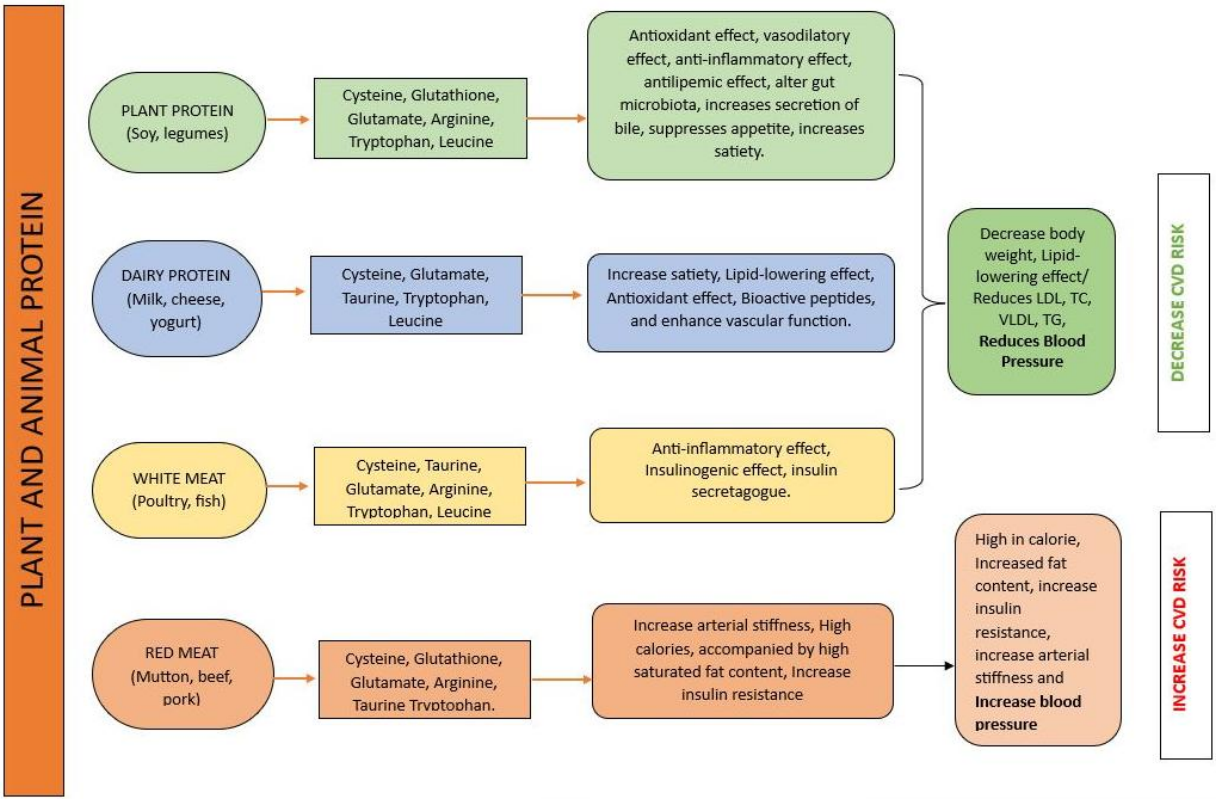



**Figure 02: The average daily protein intake among Asian countries**

Globally, there is a growing trend of increased protein consumption, with the average person consuming around 68g of protein daily. In comparison to several Asian countries and developed nations, India has the lowest average daily protein intake, with individuals consuming only 47g of protein per person on average.

Source: Ranganathan, J., Waite, R., Searchinger, T., Vennard, D., Dumas, P., & Lipinski, B. (2016). *Shifting Diets for a Sustainable Food Future*. https://doi.org/10.13140/RG.2.1.3808.2961 , (Suri, 2020).

**Figure 03: Plant and animal sources of protein, amino acids present and its effect on lowering Blood Pressure thereby preventing CVD risk**



In addition, it has been reported that protein has a higher satiation effect on hunger than glucose. In hypertensive individuals, a diet rich in protein and low in carbohydrates can lead to improved insulin sensitivity, which, in turn, facilitates weight loss by reducing body fat. This dietary approach helps preserve muscle mass and ultimately contributes to a decrease in BP [40].

The EAT Lancet-Commission report shows that Indians consume a greater proportion of simple carbohydrates and a lower quantity of complex carbohydrates, proteins, fruits and vegetables in their diets. The Indian Consumer Market 2020 shows high monthly expenditure on cereals and processed foods with only one-third being spent on protein-rich foods [42].Taking into consideration the data on protein intake, ICMR-NIN has suggested a recommended daily allowance of 0.83g/kg/day for a normal adult (IDA, 2020).

In summary, an extensive and generally consistent body of evidence from observational studies, and cross-sectional and longitudinal epidemiological studies, as well as controlled clinical trials, has documented significant inverse associations between protein intake and BP. Dietary changes that are consistent with current recommendations for protein are helpful in BP control.

## 4. Medical Nutrition Therapy

### 4.1 Weight management

Weight management is vital in preventing and controlling HTN as being overweight and obese is directly associated with an increased risk of HTN[19], [51]. Losing weight, approximately 10 kg, might decrease SBP by 5 to 20 mmHg [10]. Excess energy intake results in overweight and obesity which is directly associated with HTN. In several guidelines, a BMI of 25kg/m $^2$ is the upper limit for weight management [51], [52], and a WC of <94 cm for men and <80 cm for women[53] (IDA, 2020) is recommended.

### 4.2 Increase physical activity

Compared to resistance exercise (strength exercise), endurance exercise (aerobic exercise) has strong evidence for the prevention and management of HTN. Individuals who meet the minimum physical activity levels recommended by international guidelines have a 6% lower risk of HTN than individuals with inactive lifestyles [19]. Exercise such as brisk walking, 5–7 times/week (30–60 min/session), aiming for at least 150 min/week is known to reduce SBP by 5 mmHg in hypertensives and 3 mmHg in non-hypertensives. Also, dynamic resistance exercise like weight lifting or circuit training done 2–3 times/week under supervision is said to reduce SBP by 4 mmHg in hypertensives and 2 mmHg in non-hypertensives[37].

### 4.3 Smoking and tobacco intake

Cigarette smoking has an acute hypertensive effect, by damaging the walls of blood vessels and thus, is a risk factor for stroke and heart attack[54], [55]. Chronic cigarette smoking increases the risk of CVD through mechanisms like oxidative stress, impairment of endothelial function, arterial stiffness and inflammation. Hypertensives who smoke are at a higher risk of experiencing severe types of HTN, such as malignant and renovascular HTN [56]. In a study, cessation of smoking decreased overall SBP by 4.0±17.9 mmHg and DBP by 2.5±12.0 mmHg. Hypertensive participants showed a more prominent BP-lowering effect than non-hypertensive participants[57].

### 4.4 Moderate alcohol intake

Alcohol reduces sensitivity to hypertensive therapy and increases the risk of stroke[25]. Both the ACC/AHA and the ESC/ESH guidelines recommend reducing alcohol intake for the management of HTN. Substantial evidence supports the detrimental effects of excessive alcohol intake on BP. Even low alcohol intakes around one drink per day are associated with a higher prevalence of CVD including HTN and death. A meta-analysis of longitudinal studies including a total of 361,254 participants concluded that alcohol intake beyond two drinks/day, that is 12 g of pure ethanol per drink, was consistently associated with an increased incidence of HTN in both men and women. Reduction in alcohol consumption in adults to intake goal ≤2 standard drinks/day for men and ≤1 standard drink/day for women will reduce SBP by 4 mmHg in hypertensives and 3 mmHg in non-hypertensives [37].

### 4.5 Yoga and stress management in Hypertension

Practising Yoga helps to achieve harmony and integration of the body, mind, and spirit. Unhealthy choices, including an unbalanced diet, tobacco use and excessive alcohol consumption, often accompany stress and can contribute to the development of HTN. Poor management of stress contributes to the suboptimal control of HTN. Scientific studies show that yoga is linked to a reduction in SNS activity and an increase in parasympathetic (vagal) activity, which are both associated with diminishing stress-related responses. Yoga's positive impact on reducing stress and enhancing functional capacity, which is closely associated with HTN, makes it an effective approach to managing HTN. Research has shown that yoga is particularly effective in reducing SBP compared to DBP [58]. Out of the nine studies conducted, eight have shown that yoga can lower BP by influencing the physiological system of the body, particularly the heart rate [59]. A systematic review has provided evidence that incorporating three fundamental elements of yoga practice, namely postures, meditation, and breathing, has a modest yet significant effect on reducing BP, supporting the notion that yoga can be beneficial in managing HTN [60]. In a randomised controlled trial, patients with HTN experienced a noticeable decrease in BP and an improvement in their quality of life after engaging in home-based yogic exercises for a period of three months [61].

## 5. Functional foods

### 5.1 Ginger

6-shogaol and 9-gingerol are the compounds responsible for the antihypertensive effect of ginger [62]. A systematic review and meta- analysis of clinical trials showed a significant decrease in DBP in mean age ≤ 50 years with ginger doses of ≥3 g/day[63]. Studies have shown that a dosage of 2-6g/day of ginger significantly reduces BP and aids in preventing chronic conditions like hypercholesterolemia, constipation, and arthritis without causing any toxicity. Alongside high potassium content, ginger plays an important role in BP regulation [64].

### 5.2 Garlic

The antihypertensive effects of garlic have been attributed to its allicin content, a sulphur compound that can inhibit angiotensin II and promote vasodilation [65], [66]. A systematic review has indicated that there is moderate-quality evidence suggesting that standardised aged garlic extracts containing 1.2–2.4 mg of s-allyl cysteine or 600–2400 mg of garlic powder per day can be effective as an adjunct therapy in

the standard treatment of HTN, particularly in patient populations with SBP above 140 mmHg [67]. Furthermore, a meta-analysis involving 10 studies on garlic and HTN demonstrated a significant reduction in SBP of 8.4 ± 2.8 mmHg and a decrease in DBP of 7.3 ± 2.5 mmHg ($p < 0.001$) among hypertensive patients [65].

### 5.3 Spirulina

Spirulina and its derived compounds have demonstrated rich potential for the treatment and prevention of HTN and other cardiovascular-related disorders. The high protein content of Spirulina, along with the potential release of bioactive peptides that inhibit angiotensin-I-converting enzyme, is believed to contribute to its antihypertensive activity. A randomized double-blind placebo-controlled trial involving patients with HTN reported a significant reduction in SBP and stiffness index among patients who received a daily dose of 2 g of Spirulina for three months [68].

### 5.4 Omega-3 fatty acids

Omega-3 fatty acids exert their antihypertensive effects by regulating inflammatory signalling through modulation of the expression of cytokines and prostaglandins with vasoactive properties. In a longitudinal population study of 4508 American adults aged 18–30 without HTN at baseline, the incidence of HTN was monitored over a 20-year course. This study demonstrated that among those in the highest quartile of n−3FA consumption (>0.37 g/day), the incidence of HTN was significantly lower at follow-up when compared to those in the lowest quartile [65], [69].

### 5.5 Green tea

Green tea contains polyphenol-catechins- Epigallocatechin gallate (EGCG). EGCG has been shown to stimulate nitric oxide synthesis in endothelial cells, promoting vasodilation. It also inhibits fluid retention and vasoconstriction, further contributing to its positive effects on cardiovascular health [65]. In obese hypertensive patients, 1 capsule of Green Tea Extract (GTE) containing 379 mg of GTE (including 208 mg of EGCG) taken with their morning meal for 3 months showed significant improvement in BP [70].

### 5.6 Fenugreek

Fenugreek Seed (FS) exhibits a significant antihypertensive effect. Supplementation with FS, especially in dosages ≥ 15 g/day and durations ≤ 12 weeks, might play a role in reducing SBP, but not DBP [71]. Consumption of FS through oral administration pre-prandially causes a significant decrease in SBP. A study where 5g FS was given twice a day for two months before food showed a significant reduction in SBP and DBP [72].

### 5.7 Turmeric

Curcumin and its analogues, such as hexahydro curcumin and tetrahydro curcumin, have been found to possess anti-hypertensive effects through various signalling pathways[73]. In a systematic review and meta-analysis of RCTs, supplementation of curcumin showed significant improvement in DBP by 2.96 mmHg [64].

### 5.8 Cinnamon

Cinnamon is said to be an effective treatment of HTN along with other conditions like diabetes, hyperlipidaemia and heart disease. A systematic review and meta-analysis showed an association between cinnamon consumption and a decrease in SBP by 5.39 mmHg and DBP by 2.6 mmHg[64].

**6. Principles of Diet for Hypertension**

A diet rich in complex carbohydrates, normal protein, moderate fat, low sodium, and high fibre is recommended.

**6.1Carbohydrate**

In India consumption of carbohydrates is high, and data from recent studies show that high carbohydrate intake, i.e., more than 60% of the total energy is associated with harmful effects on total mortality [25]. Evidence suggests that both the amount and type of carbohydrate consumed affect BP. The daily carbohydrate allowance must be within 55% of the total calorie intake with a greater proportion of complex carbohydrates like legumes, whole grains, unprocessed cereals and starchy vegetables (IDA, 2020).

**6.2 Protein**

RDA for healthy Indian adults is 0.83g/kg/day [74]an allowance of 18% of the total calorie is advised for managing BP (IDA, 2020). As per studies, increased protein intake, especially plant protein may reduce the risk of HTN and CVD. Plant protein includes beans, peas, lentils, soya and its product, nuts and seeds, broccoli, and greens. Sources of animal protein include milk and its product, eggs, chicken and fish.

**6.3 Dietary fat**

RDA for total fat intake is 30ml/person/day[74]. Total dietary fat includes saturated fat, omega-3 and omega-6 polyunsaturated fat and monounsaturated fat. Saturated fat should be restricted to 6% of the total calorie, and dietary cholesterol to 150mg/day.Limit daily intake of saturated fat from fatty meats and full-fat dairy.Substitute saturated fat with unsaturated fats from nuts, seeds, fatty fish and avocado (IDA, 2020).Consumption of saturated fats should be decreased since hypertensives frequently have concurrent hyperlipidaemia [25]. Avoid trans fats which are used in processed and fast foods (IDA, 2020).

**6.4 Dietary Fibre**

RDA is 40g/person/day (both soluble and insoluble fibre) [74]. Foods rich in soluble fibre include nuts, beans, lentils, apples, oatmeal, and insoluble fibres include whole wheat products, brown rice, legumes, leafy greens, almonds, walnuts, seeds, and fruits with edible skins like apples[75].

**6.5**

**6.6 Potassium**

In adults with normal kidney function, the RDA for Indians is 3500mg/day [74]. High intake of potassium is associated with the reduction of BP[76]. Table 04 below contains foods rich in potassium.

**Table 04: Foods rich in potassium**

| Fruits | Vegetables |
|---|---|
| Amla, sapota, peaches, orange, papaya, | Drumstick, broccoli, tomato, Cabbage, bitter gourd, ladies |

| | |
|---|---|
| banana, plums, lemons, sweet lime, pineapple, apple, watermelon | finger, cauliflower, spinach, potato, drumstick, radish white, brinjal, pumpkin, French beans, Colocasia, tapioca |

### 6.6 Calcium

The RDA is 1000mg/person /day [74]. An increased intake of calcium may have a BP-lowering effect [77], [78]mainly if achieved through a DASH diet pattern. Calcium tightens and relaxes blood vessels as and when required [79]. Foods with >50mg of calcium are considered a high source (IDA, 2020) Dairy products, vegetables like drumstick leaves, spinach, amaranth, fenugreek, ragi, broccoli,soya chunk, almond, flax seeds, figs and fishes like sardines are good sources of calcium.

### 6.7 Magnesium

The RDA is 440mg/person /day [74]. Magnesium helps to regulate BP, blood glucose levels, relax blood vessels, in production of energy and in improving muscle and nerve functioning [80], [81] (IDA, 2020). Whole grains, dark green leafy vegetables, nuts and seeds, pumpkin seeds, almonds, cashews, groundnut, beans, spinach, and brown rice are good sources of magnesium [82].

### 6.8 Salt intake

Table salt is a mineral and chemically consists of two elements known as sodium (Na- 40%) and chloride (Cl- 60%). Salt is used as a taste enhancer, binder, stabilizer and food preservative. According to the AHA (2021) and Harvard (2023), it is suggested that the human body requires a minimum of 500 mg of sodium/day for optimal functioning. The global average salt intake exceeds the recommended levels by more than twice, with the average person consuming approximately two teaspoons (equivalent to 10.8 grams) of salt/ day. This amount is significantly higher than the WHO recommendation of 5 g/day [83]. The most common methods used to measure salt intake are 24-hour dietary recall, food frequency questionnaire (FFQ), or food record. There is evidence of a link between high dietary salt intake and risk for overweight, obesity, CVD, gastric cancer, and kidney disease [84].

#### 6.8.1 Recommended Daily Allowance

The RDA for salt is 5g/person/day or 2000 mg of sodium [74]. For an adult hypertensive, 1500mg sodium or 3.7g of salt is the ideal limit. The main source of sodium in our diet is table salt. High sodium consumption and insufficient potassium intake (<3.5 grams/day) contribute to high BP and increase the risk of heart disease and stroke[85]. Refer to Table 05 for sodium content in foods and Table 06 for foods to be avoided to reduce salt intake.

**Table 05: Food groups and their sodium content classified as high, moderately high, moderate and low**

| Food Group | <25mg low | 25-50 mg moderate | 50-100 mg moderately high | >100 mg high |
|---|---|---|---|---|
| **Cereals** | Ragi, vermicelli, wheat, maida, semolina, rice, bajra, maize, barley | | | |
| **Pulses** | Peas, cow pea, | Black gram, green | Bengal gram dhal | |

| | | | | |
|---|---|---|---|---|
| | Black gram dal, rajma, soya | gram dal and whole, red gram dal and whole, lentil whole, Bengal gram whole, | | |
| **Fruits** | Amla, sweet lime, papaya, orange, sapota, grapes, banana, guava, mango, muskmelon, | Pineapple, apple | Watermelon, | |
| **Milk and its product** | milk(cow), paneer | Milk(buffalo), khoa | | Milk powder |
| **Meat, chicken, fish, eggs** | | Mutton, pork | Tender liver, prawns, beef, chicken, fish | Bacon, lobster, egg, crab, |
| **Vegetables** | Bitter gourd, bottle gourd, snake gourd, ridge gourd, brinjal, cabbage, ladies finger, Colocasia, cucumber, French beans, onion, potato, tomato ripe, yam, capsicum, field beans, kovai, mushroom | radish white, Cauliflower, knol-knol, raw mango, sweet potato, | beetroot, Carrot | |
| **Green leafy vegetables** | Amaranth, drumstick leaves, mint, gongura leaves, radish greens, mustard leaves | Fenugreek leaves, coriander leaves, spinach | lettuce | |
| **Dry fruits and nuts** | Almond, cashew, dry coconut, sesame seeds (white & black), ground nut, walnut, sunflower seed | Raisins | | |
| **Sugar and jaggery** | | Jaggery | | |
| **Miscellaneous** | | Coconut water | | |

**Table 06: Foods to be avoided to control excess salt intake**

| |
|---|
| • Table salt<br>• Ajinomoto (monosodium glutamate)<br>• Baking powder<br>• Fried foods<br>• Alcohol<br>• Bakery products<br>• Biscuits, cakes, bread and pastries<br>• Foods preserved in salt<br>• Pickles<br>• Canned foods<br>• Ketchup, mayo, sauces<br>• Prepared mixes<br>• Potato chips, peanut butter, salted butter and papads<br>• Processed cheese, noodles<br>• Red meat, cured and processed meats |

### 6.8.2 Practical applications to reduce salt intake

- Refrain from adding table salt to cooked meals.
- Avoid having a salt shaker readily available on the table and restrict consumption of high-salt products.
- Educate food handlers on minimising salt usage.
- Restaurants can enhance salt reduction efforts by eliminating salt shakers and soy sauce from tables.
- Introducing a shelf labelling system (high sodium foods) and clear labels indicating the sodium content of foods and meals.
- Specific tailor-made dietary guidance for individuals who visit health facilities, emphasizing sodium reduction.
- Educating children about the benefits of low-salt diets and fostering a supportive environment that facilitates early adoption of good dietary habits.
- Gradually decrease of salt over a period of time allows consumers to acclimate to the adjusted taste without seeking alternative products.
- Raising consumer awareness by conducting promotional activities in food establishments.

### 6.8.3 Misperceptions about salt reduction

- "On a hot and humid day when you sweat, you need more salt in the diet"
  The amount of salt lost through sweat is minimal, so there is no requirement for additional salt. However, staying hydrated is crucial.
- "Salt added during cooking is not the main source of salt intake"
  Processed foods contribute to approximately 80% of the salt intake in the diet in many countries.
- "Food does not need salt to have an appealing flavour"
  It may require some time for an individual's taste buds to adapt to less salt but other flavours from herbs can enhance the taste too.
- "Food has no flavour without salt"

While initially true, taste buds quickly adapt to lower salt levels, resulting in an increased likelihood of enjoying food with reduced salt and enhanced flavours.

- "Foods high in salt taste salty"
  Certain foods that contain high amounts of salt consist of other ingredients like sugars, which can mask the saltiness. Therefore, it is crucial to read food labels to analyse salt content.
- "Only old people need to worry about how much salt they eat"
  Eating too much salt can raise BP at any age [85].


Figure 04: Sample of food label with sodium

### 6.8.4 The sodium content on a food label

Read the food label before purchasing any packed foods and look for hidden salt. Figure 04 is an example of a food label and parameters to be mentioned as per food regulatory guidelines.

- Look for food with low sodium % daily value.
- 5% daily value or less per serving of sodium is considered as low.
- 20% Daily Value (DV) or more per serving of sodium is considered as high[86].

## Conclusion

With the ever-growing burden of NCD, HTN is the third most important mc
a substantial public health menace on healthcare systems in India contributing to 57% of all stroke deaths and 24% of all coronary heart disease (CHD) deaths. HTN develops due to an interaction of genetic and lifestyle factors, such as diet, sedentary lifestyle, being overweight etc. The DASH diet is one of the most prominent diets used across the world for its palatability and its easy adaptability among various cultures. A diet rich in complex carbohydrates, normal protein, moderate fat, low sodium, high fibre and a is recommended for lowering BP. A positive lifestyle pattern, which includes engaging in regular physical activity, practising stress management techniques, reducing alcohol consumption, and quitting smoking, was also involved in the management of BP. Overall, our findings underscore the need for maintaining a balanced diet containing adequate amounts and proportions of total protein, which may be more beneficial in preventing and treating BP and chronic disease risk reduction.

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**Abbreviations:**

| Abbreviations and Acronym | |
|---|---|
| BP | Blood Pressure |
| HTN | Hypertension |
| AHA | American Heart Association |
| SBP | Systolic Blood Pressure |
| DBP | Diastolic Blood Pressure |
| WHO | World Health Organisation |
| BMI | Body Mass Index |
| WHR | Waist-to-Hip Ratio |
| WC | Waist Circumference |
| IDA | Indian Dietetic Association |
| ACC | American College of Cardiology |
| ICMR | Indian Council of Medical Research |
| NIN | National Institute of Nutrition |
| NFHS | National Family Health Survey |
| ESC | European Society of Cardiology |
| NHLBI | National Health, Lung, and Blood Institute |
| DASH | Dietary Approaches to Stop Hypertension |
| ESH | European Society of Hypertension |
| CVD | Cardiovascular Disease |
| RDA | Recommended Dietary Allowance |
| NCD | NON-Communicable disease |
| MUFA | Mono-unsaturated fatty acid |
| EGCG | Epigallocatechin gallate |
| GTE | Green Tea Extract |
| FS | Fenugreek Seed |

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