



HERBAL MEDICINES AS ALTERNATIVE AND COMPLEMENTARY THERAPIES
FOR HYPERTENSION: A REVIEW

Vivek Lodhi*, Tarun Jat, Jagdish Verma, Shelly Gupta
KNP College of Pharmacy, Bhopal (M.P.)

***Correspondence Info:**

Vivek Lodhi

**KNP College of Pharmacy,
Bhopal (M.P.)**

Email: vlodhi1898@gmail.com

***Article History:**

Received: 20/07/2026

Revised: 02/08/2026

Accepted: 17/08/2026

ABSTRACT

Hypertension is a major global public health concern and a leading risk factor for cardiovascular diseases, stroke, chronic kidney disease, and premature mortality. Despite the availability of effective antihypertensive medications, challenges such as adverse effects, high treatment costs, poor adherence, and inadequate blood pressure control have prompted growing interest in alternative and complementary therapies. Medicinal plants have been extensively utilized in traditional healthcare systems for the prevention and management of hypertension due to their therapeutic efficacy, accessibility, and favorable safety profiles. This review aims to provide a comprehensive overview of medicinal plants with antihypertensive potential, their bioactive constituents, mechanisms of action, and available preclinical and clinical evidence. Several medicinal plants, have demonstrated significant blood pressure-lowering effects through diverse mechanisms such as vasodilation, angiotensin-converting enzyme inhibition, calcium channel blockade, diuretic activity, antioxidant effects, and modulation of endothelial function. Phytochemicals including flavonoids, alkaloids, phenolic acids, terpenoids, saponins, and organosulfur compounds contribute substantially to these pharmacological actions. Although existing evidence supports the potential role of medicinal plants as adjunctive therapies for hypertension management, further well-designed clinical trials, standardization of herbal formulations, and comprehensive safety assessments are required to establish their efficacy and long-term safety. Medicinal plants represent a promising source of novel antihypertensive agents and may offer cost-effective, accessible, and complementary strategies for improving cardiovascular health.

Keywords: Hypertension, medicinal plants, antihypertensive activity, herbal medicine, complementary therapy, phytochemicals, cardiovascular diseases.

INTRODUCTION

Systemic arterial hypertension (hereafter referred to as hypertension) is characterized by persistently high blood pressure (BP) in the systemic arteries. BP is commonly expressed as the ratio of the systolic BP (that is, the pressure that the blood exerts on the arterial walls when the heart contracts) and the

diastolic BP (the pressure when the heart relaxes). The BP thresholds that define hypertension depend on the measurement method. Several aetiologies can underlie hypertension (Surendran *et al.*, 2016; Ehret *et al.*, 2016). The majority (90–95%) of patients have a highly heterogeneous ‘essential’ or primary hypertension with a multifactorial

gene-environment aetiology (Liu *et al.*, 2016; Dominiczak *et al.*, 2017). A positive family history is a frequent occurrence in patients with hypertension, with the heritability (a measure of how much of the variation in a trait is due to variation in genetic factors) estimated between 35% and 50% in the majority of studies. Genome-wide association studies (GWAS) have identified ~120 loci that are associated with BP regulation and together explain 3.5% of the trait variance. These findings are becoming increasingly important as we search for new pathways and new biomarkers to develop more-modern 'omics'-driven diagnostic and therapeutic modalities for hypertension in the era of precision medicine (Lifton *et al.*, 2001; Ehret and Caulfield, 2013).

Hypertension is the most common preventable risk factor for cardiovascular disease (CVD; including coronary heart disease, heart failure, stroke, myocardial infarction, atrial fibrillation and peripheral artery disease), chronic kidney disease (CKD) and cognitive impairment, and is the leading single contributor to all-cause death and disability worldwide. The relationship between BP and the increased risk of CVD is graded and continuous, starting as low as 115/75 mmHg, well within what is considered to be the normotensive range (Maass *et al.*, 2015). Successful prevention and treatment of hypertension are key in reducing disease burden and promoting longevity in the world's population. In treating hypertension, it is important to consider a person's predicted atherosclerotic CVD (ASCVD) risk more than the level of BP alone, as persons with high CVD risk derive the greatest benefit from BP lowering treatment (Forouzanfar *et al.*, 2016).

Classification of hypertension

Category	Systolic BP (mm Hg)	Diastolic BP (mm Hg)
Normal	120-129	80-84
High normal	130-139	85-89

Hypertension

Stage 1 (mild)	140-159	90-99
Stage 2 (moderate)	160-179	100-109
Stage 3 (severe)	180-209	110-119

The dispersion of hypertension across populations

Hypertension in the Elderly

Particularly in the elderly, hypertension poses a serious risk for cardiovascular morbidity and mortality. Numerous studies have demonstrated that treating hypertension in older persons is safe and reduces their risk of heart attack, stroke, myocardial infarction, and overall mortality. Treatment for hypertension in elderly adults also decreases dementia and cognitive decline. One of the most important aspects of managing hypertension is living a healthy lifestyle. Although the data points to the potential benefits of several antihypertensive drug classes in reducing cardiovascular events, older adults with hypertension require more than one therapy to keep their blood pressure stable (Lionakis *et al.*, 2012; Kintiraki *et al.*, 2015).

Hypertension during pregnancy

The use of antihypertensive drugs is fraught with controversy, especially when moderate hypertension is involved. PIH is a common health issue that can be detrimental to the foetus or baby as well as the mother. It is believed to be a complex health issue with a poorly known pathogenetic pathway (Mittal and Singh, 2010; Jiang *et al.*, 2016).

Hypertension in Developing Countries

As one of the main causes of death and disability in developing nations, hypertension is a serious public health concern. By 2025, it is expected that 29% of adults worldwide would have hypertension, an increase from the current quarter. By 2025, it is anticipated that 1.15 billion individuals worldwide would suffer from hypertension in emerging nations. There have been many factors linked to this diversity, such as racial and ethnic disparities, urbanisation and related lifestyle changes, nutritional status, and birth weight. Lack of awareness and insufficient care for people who have it exacerbate the disease's substantial burden (Drukeinis *et al.*, 2007).

Hypertension in the obese

Obesity is a major risk factor for important hypertension, diabetes, and other morbidities that contribute to the development of kidney disease because it primarily promotes tubular resorption to aggravate pressure natriuresis and promote volume expansion via the activation of the SNS and the RAS. Consuming foods rich in omega-3 fatty acids, fibre, antioxidants, plant and animal proteins, low in fat and sugar, vitamins, and fibre on a regular basis aids in the body's nutritional signalling pathways' adaptation to reference levels (McNiece *et al.*, 2007; Tolwinska *et al.*, 2005).

Hypertension in teenagers

Childhood hypertension has been related to cardiovascular disease risk factors, such as LVH and thicker arterial walls (Sorof *et al.*, 2003; Sorof *et al.*, 2002). With a prevalence of 14% to 26%, LVH is the most commonly described kind of end organ damage in children and adolescents with hypertension. Even after accounting for age, sex, and BMI,

children with hypertension still have an elevated left ventricular mass index, which is linked to a higher risk of cardiovascular death. Mass index, which is linked to a higher risk of cardiovascular death (Tracy *et al.*, 1995; Chamontin *et al.*, 1994).

Diagnosis of Hypertension

First line treatment

Establishing baseline blood pressure, assessing the degree of target organ damage and concurrent CVD, looking for specific causes of secondary hypertension that may be treated, identifying hypertensinogenic factors and other CVD risk factors, and characterising the patient will help with treatment decisions (particularly drug selection) and prognostic determination (Carretero and Oparil, 2000).

BP measurement

The most important part of the patient's diagnostic evaluation and follow-up is taking their blood pressure using the cuff technique, which is an effective and precise technique that should be done in a uniform manner using equipment that has been approved and calibrated.

Every visit ought to incorporate a couple of measures, with a minimum of two minutes separated among each measurement. An alternative to a mercury sphygmomanometer is a freshly calibrated aneroid manometer or an authorised electronic instrument coupled to an arm cuff. The systolic reading is collected at the level when sounds stop. Each excursion should involve two or three measures, with a minimum of two minutes elapsed between each measurement. The mercury sphygmomanometer can be substituted with a newly calibrated aneroid manometer or an approved electronic device fastened to an arm cuff. The systolic reading is obtained at the

point at which sounds cease (Perloff *et al.*, 1993; Prisant *et al.*, 1995).

Laboratory tests and other diagnostic procedures

The only tests that are regarded as routine are urinalysis, a 12-lead ECG, a complete blood count, blood chemistry (potassium, salt, creatinine, fasting glucose, total and high-density lipoprotein, or HDL cholesterol), and a blood sample. Optional tests for the diagnosis of secondary hypertension and/or comorbid conditions are recommended in some patients. These tests include creatinine clearance, 24-hour urine protein, and measurement of microalbuminuria, uric acid, calcium, glycosylated haemoglobin, fasting triglycerides, limited echocardiography, 34, and plasma renin activity and aldosterone measurement (Black *et al.*, 1991).

Etiology

Most cases of hypertension are idiopathic, which is also known as essential hypertension. It has long been suggested that an increase in salt intake increases the risk of developing hypertension (Guyton *et al.*, 1972). One of the described factors for the development of essential hypertension is the patient's genetic ability to salt response (Fagard *et al.*, 1995; Warren *et al.*, 2017). About 50% to 60% of the patients are salt sensitive and therefore tend to develop hypertension.

Epidemiology

More than one billion adults worldwide have hypertension, with up to 45% of the adult populace being affected by the disease. The high prevalence of hypertension is consistent across all socio-economic and income strata, and the prevalence rises with age, accounting for up to 60% of the population above 60

years of age (NCD Risk Factor Collaboration, 2017).

- In the year 2010, the global health survey report published in Lancet, which was comprised of patient data from 67 countries, reported Hypertension as the leading cause of death and disability-adjusted life years worldwide since the year 1990 (Danaei *et al.*, 2009).
- In the United States, HTN alone accounts for more cardiovascular disease-related deaths than any other modifiable risk factor and is second only to cigarette smoking as a preventable cause of death for any reason (Kearney *et al.*, 2005).
- Recent estimates have suggested the number of patients with hypertension could increase as much as 15% to 20%, which could reach close to 1.5 billion by 2025.

Pathophysiology

There are various mechanisms described for the development of hypertension, which include increased salt absorption resulting in volume expansion, an impaired response of the renin-angiotensin-aldosterone system (RAAS), and increased activation of the sympathetic nervous system. These changes lead to the development of increased total peripheral resistance and increased afterload, which in turn leads to the development of hypertension.

Primary prevention of hypertension

In order to accomplish the main goal of treating all blood pressure-related illnesses in society at large, preventative strategies must be implemented in alongside the identification

and management of hypertension (Macmohan *et al.*, 1987).

Weight loss

Cross-sectional and longitudinal research has repeatedly found a link between obesity and hypertension, regardless of age (Appel *et al.*, 1993). Furthermore, several scientific trials have shown that losing weight may lower blood pressure. Men and women with high normal blood pressure participated in the Trials of Hypertension Prevention (TOHP), Phase I, and were given weight loss counseling (Schotte and Stunkard, 1990; Whelton *et al.*, 1997). Their blood pressure dropped by -2.3 mm Hg in the diastolic phase and -2.9 mm Hg in the systolic phase (all K.01). As a result, people shed an average of -3.9 kg. Furthermore, weight loss treatments reduced the prevalence of hypertension by 34% (95% CI, 6% to 54%).

Dietary sodium

Numerous research have demonstrated a connection between dietary sodium and blood pressure, including animal tests, observational epidemiological studies, migration studies, and randomised controlled trials. Results from observational epidemiologic studies as well as randomised controlled trials have shown a dose-response relationship between dietary sodium and blood pressure in humanity. Within-population analyses in the cross-sectional INTERSALT study, which included 10,074 participants from 52 populations in 32 countries after correcting for regression dilution bias and adjusting for age and sex, revealed a relationship between a 100 mmol higher 24-hour urinary sodium and a 4.3 mm Hg increase in systolic and 1.8 mm Hg increase in diastolic blood pressure (Whelton *et al.*, 1996; Elliott *et al.*, 1996).

Potassium supplementation

Randomized controlled trials that were published between 1981 and 1995 were the subject of a meta-analysis by Whelton and colleagues. The average systolic blood pressure decreased by 3.1 (95% CI, -1.9 to -4.3) mm Hg, while the average diastolic blood pressure decreased by 2.0 (95% CI, -0.5 to -3.4) mm Hg with potassium supplementation (Whelton *et al.*, 1997).

Stress management

According to research from the Framingham Heart Study, anxiety levels among middle-aged men were a strong predictor of the later incidence of hypertension (Markovitz *et al.*, 1993).

Moderation in consumption of caffeine

A meta-analysis of 23 controlled clinical trials looking at the impact of coffee drinking on blood pressure was done by Jee and colleagues. Most of the trials were brief, and the majority of the subjects were normotensive. The average daily consumption of 3.3 cups of coffee was linked to a 2.4 (95% CI, 1.0 to 3.7) mm Hg rise in systolic blood pressure and a 1.2 (95% CI, 0.4 to 2.1) mm Hg rise in diastolic blood pressure among the 11 trials that lasted longer than two weeks (Jee *et al.*, 2001).

Fish oil supplementation

Clinical trials account for the majority of the data indicating that adding omega-3 polyunsaturated fatty acids, also known as fish oils, to the diet may lower blood pressure. Appel and colleagues observed an average decrease in systolic blood pressure of 1.5 (95% CI, -0.6 to -2.4) mm Hg and in diastolic blood pressure of 1.0 (95% CI, -0.4 to -1.6) mm Hg in a meta-analysis of 17 controlled

trials (n = 1019) of fish oil intake (Appel *et al.*, 1993).

Magnesium supplementation

Observational studies on the relationship between dietary magnesium consumption and blood pressure were examined by Mizushima and colleagues⁶⁰. Twenty-seven of the 88 published observational studies on magnesium supplementation have been shown to have a negligible effect on hypertension patients' blood pressure in randomised controlled trials. In TOHP-I, oral magnesium supplementation (340 mg/day) only slightly lowered systolic and diastolic blood pressure by -0.2 and -0.1 mm Hg, respectively (Whelton *et al.*, 1997; Mizushima, 1996).

Exercise in hypertension

By increasing physical activity, cardiovascular illnesses caused by hypertension may be averted. Vigorous activities, such as long-distance running, may have an even stronger preventive or pressure-lowering effect than less vigorous ones; however, this has not always been observed (COX *et al.*, 2001). Arroll and Beaglehole examined 22 published clinical trials that looked at the impact of exercise on blood pressure (Arroll and Beaglehole, 1992).

Pharmacological Treatments for HTN

ACE inhibitors

Operate in two distinct ways. They lessen the metabolism of the active RAAS vasoconstrictor angiotensin II and increase the availability of the RAAS vasodilator bradykinin. These medications can be taken alone or in conjunction with calcium channel blockers (CCB) and diuretics, with the former being more advantageous in Caucasians, perhaps because the RAAS is less apparent in the black population. In patients with heart

failure, chronic renal disease, left ventricular systolic dysfunction, and postmyocardial infarction, these medications have been shown to improve clinical outcomes, according to several studies (Hollenberg, 2003; Dahlof *et al.*, 1997).

Angiotensin receptor blockers (ARB's)

Similar to ACE inhibitors, angiotensin receptor blockers (ARBs) work by inhibiting the AT1 receptor, which is in charge of the angiotensin II receptor's downstream actions, to target the RAAS? Due to comparable methods of action, patients using these medications enjoy the same advantages as those receiving the ACE inhibitors discussed before. As an added bonus, these medications do not result in an unwanted cough (Sanoski *et al.*, 2009).

Direct renin inhibitors

Which, in contrast to ACE inhibitors and ARBs, target a different portion of the RAAS, are another treatment option for individuals who are resistant to first-line antihypertensive medications as an add-on or monotherapy.

Calcium channel blockers

In order to stop the contraction of smooth muscle cells and cardiac myocytes, calcium channel blockers (CCBs) attach to the L channels of vascular smooth muscle cells. Dihydropyridine Non-dihydropyridines work by reducing both heart rate and the force of myocardial contraction, unlike CCBs, which lower blood pressure primarily through direct vasodilation and lowering systemic vascular resistance. There is ample proof that CCBs lower the risk of stroke and improve overall mortality in people with HTN (Costanzo *et al.*, 2009).

Beta-blockers

When treating hypertensive patients with a history of myocardial infarction and heart failure, betablockers are the medication of choice. When starting therapy in the setting of heart failure, it is important to anticipate that heart failure will initially get worse as a result of these medications' reductions in cardiac output and renal renin secretion.

Diuretics

Increased renal salt and water excretion is how diuretics work. Diuretics have a proven track record of enhancing cardiovascular health and lowering stroke risk (Psaty *et al.*, 2003). Studies have shown that the use of spironolactone reduces the risk of morbidity and mortality in hypertensive individuals with heart failure, which is a longterm consequence of HTN (Wing *et al.*, 2003; Remme *et al.*, 2003).

Aldosterone antagonist

Spironolactone, an aldosterone antagonist that is a member of the mineralocorticoid receptor antagonist family, merits special attention because of the benefits it provides when used with ACE inhibitors, ARBs, CCBs, and diuretics, particularly in patients with heart failure. However, in patients who can tolerate it, it has been demonstrated that its use as an

antihypertensive is excellent (Pitt *et al.*, 1999).

Alpha blockers

Since its inception more than ten years ago, the use of alpha-blockers in the treatment of HTN has developed further. In patients with uncontrolled HTN or those who have poor tolerance to other first-line treatments, this drug, which reduces vascular sympathetic tone by blocking postganglionic 1-receptors, is typically used as an add-on therapy (Ezekowitz and McAlister, 2009).

Herbal medicines used for the treatment of hypertension

Many antihypertensive agents used in the treatment of HTN have some side effects. Therefore, scientific studies recommend diverse lifestyle alterations and the use of suitable medicinal plants in its treatment. Secondary metabolites of some herbs and spices display antihypertensive properties. Most herbal medicines control and reduce HTN by exerting antioxidant, anti-inflammatory, and anti-apoptosis properties, stimulating the eNOS-NO signaling pathway, suppressing endothelial permeability, and activating angiogenesis (Pourjabali *et al.*, 2017; Huang and Liu, 2016).

Table 1: Herbal medicines used for the treatment of hypertension

S. No.	Names of plants	Part used	Mechanism of action	References
1.	<i>Achillea millefolium</i>	Flower	Calcium channel blockers and ACE inhibitors	Duran <i>et al.</i> , (2021)
2.	<i>Allium sativum</i>	Rhizome	Enhance nitric oxide production	Nwokocha <i>et al.</i> , (2011)
3.	<i>Andrographis paniculata</i>	Herbs	Increases NO, Inhibit ACE, Block calcium channels	Cahyawati, (2021)
4.	<i>Annona muricata</i>	Leaves, fruits	Reduce peripheral vascular resistance	Sokpe <i>et al.</i> , (2020)

5.	<i>Apium graveolens</i>	Seeds	Calcium channels blocker	Makarova et al., (2022)
6.	<i>Aristolochia manshuriensis</i>	Leaves	Diuretic	Tabassum and Ahmad, (2011)
7.	<i>Artocarpus altilis</i>	Leaves	ACE Inhibitors	Siddesha et al., (2011)
8.	<i>Blond psyllium</i>	Roots/ leaves	Lower systolic blood pressure	Sharma et al., (2012)
9.	<i>Camellia sinensis</i>	Leaves	Inhibits ACE (AT1 receptor)	Xingfei et al., (2020)
10.	<i>Capparis cartilaginea</i>	Shrub	Calcium channels blocker	Upadhyay, (2011)
11.	<i>Carum copticum</i>	Seeds	Increase NO production, Calcium channels blocker	Gilani et al., (2005)
12.	<i>Cassia absus</i>	Seeds	HR reduction through increased NO synthesis	Ahmad et al., (2018)
13.	<i>Cassia occidentalis</i>	Leaves	An active diuretic. preventing Ca ²⁺ influx via voltagesensitive	Ntchapda et al., (2015)
14.	<i>Commelina virginica</i>	Leaves	Calcium channels blockers	Khatoon et al., (2022)
15.	<i>Coptis chinensis</i>	Leaves/ roots/ stem	Calcium channels blockers	Verma and Sinha, (2021)
16.	<i>Coriandrum sativum</i>	Leaves	Diuretic action. By stimulating Badrenoceptors, ROS generation is inhibited	Mahleyuddin et al., (2021)
17.	<i>Crataegus pinnatifida</i>	Leaves/ roots	Activates eNOS and inhibits platelet aggregation and thrombosis	Wang et al., (2011)
18.	<i>Crinum glaucum</i>	Leaves	Boost NO production. Reduce systolic and diastolic pressure	Ndjenda et al., (2021)
19.	<i>Crocus sativus</i>	Roots/ leaves	Blocks Ca ²⁺ Channels	Hosseini et al., (2018)

CONCLUSION

Medicinal plants have gained considerable attention as alternative and complementary approaches for the prevention and

management of hypertension due to their therapeutic potential, accessibility, and long-standing use in traditional medicine systems. A growing body of evidence indicates that

numerous plant species possess antihypertensive properties mediated through diverse mechanisms, including vasodilation, inhibition of the renin–angiotensin–aldosterone system, calcium channel blockade, diuretic effects, antioxidant activity, anti-inflammatory actions, and improvement of endothelial function. Bioactive phytoconstituents such as flavonoids, alkaloids, phenolic compounds, terpenoids, saponins, and organosulfur compounds play crucial roles in these beneficial effects. Although preclinical studies and emerging clinical evidence support the efficacy of medicinal plants in lowering blood pressure and reducing cardiovascular risk, limitations related to variability in plant composition, lack of standardization, insufficient high-quality clinical trials, and potential herb–drug interactions remain significant challenges. Therefore, rigorous scientific validation, comprehensive safety assessments, dosage optimization, and the development of standardized herbal formulations are essential to facilitate their integration into evidence-based healthcare. In conclusion, medicinal plants represent a valuable source of novel antihypertensive agents and may serve as effective adjuncts to conventional therapies. Their incorporation into hypertension management strategies has the potential to improve patient outcomes, enhance treatment accessibility, and contribute to the development of safer and more affordable therapeutic options.

DECLARATION OF INTEREST

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

REFERENCES

- Ahmad, S., Hassan, A., Abbasi, W. M., & Rehman, T. (2018). Phytochemistry and pharmacological potential of *Cassia absus*—A review. *Journal of Pharmacy and Pharmacology*, 70(1), 27–41.
- Appel, L. J., Miller, E. R., Seidler, A. J., & Whelton, P. K. (1993). Does supplementation of diet with “fish oil” reduce blood pressure? A meta-analysis of controlled clinical trials. *Archives of Internal Medicine*, 153, 1429–1438.
- Arias-Duran, L., Estrada-Soto, S., Hernandez-Morales, M., Millan-Pacheco, C., Navarrete-Vazquez, G., Villalobos-Molina, R., & others. (2021). Antihypertensive and vasorelaxant effect of leucodin and achillin isolated from *Achillea millefolium* through calcium channel blockade and NO production: In vivo, functional ex vivo and in silico studies. *Journal of Ethnopharmacology*, 273, 113948.
- Arroll, B., & Beaglehole, R. (1992). Does physical activity lower blood pressure: A critical review of the clinical trials. *Journal of Clinical Epidemiology*, 45(5), 439–447.
- Black, H. R., Weltin, G., & Jaffe, C. (1991). The limited echocardiogram: A modification of standard echocardiography for use in the routine evaluation of patients with systemic hypertension. *The American Journal of Cardiology*, 67(11), 1027–1030.

- Cahyawati, P. N. (2021). A mini review: Efek farmakologi *Andrographis paniculata* (Sambiloto). *WICAKSANA: Jurnal Lingkungan dan Pembangunan*, 5(1), 19–24.
- Carretero, O. A., & Oparil, S. (2000). Essential hypertension: Part I: Definition and etiology. *Circulation*, 101(3), 329–335.
- Chamontin, B., Amar, J., Barthe, P., & Salvador, M. (1994). Blood pressure measurements and left ventricular mass in young adults with arterial hypertension screened at high school check-up. *Journal of Human Hypertension*, 8(5), 357–361.
- Costanzo, P., Perrone-Filardi, P., Petretta, M., Marciano, C., Vassallo, E., Gargiulo, P., Paolillo, S., Petretta, A., & Chiariello, M. (2009). Calcium channel blockers and cardiovascular outcomes: A meta-analysis of 175,634 patients. *Journal of Hypertension*, 27(6), 1136–1151.
- Dahlof, B., Devereux, R., de Faire, U., Fyhrquist, F., Hedner, T., Ibsen, H., Julius, S., Kjeldsen, S., Kristiansson, K., Lederballe-Pedersen, O., & Lindholm, L. H. (1997). The Losartan Intervention for Endpoint reduction (LIFE) in hypertension study: Rationale, design, and methods. *American Journal of Hypertension*, 10(7), 705–713.
- Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J. L., & Ezzati, M. (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Medicine*, 6(4), e1000058.
- Dominiczak, A. F., Delles, C., & Padmanabhan, S. (2017). Genomics and precision medicine for clinicians and scientists in hypertension. *Hypertension*, 69, 10–13.
- Drukteinis, J. S., Roman, M. J., Fabsitz, R. R., Lee, E. T., Best, L. G., Russell, M., & Devereux, R. B. (2007). Cardiac and systemic hemodynamic characteristics of hypertension and prehypertension in adolescents and young adults: The Strong Heart Study. *Circulation*, 115(2), 221–227.
- Ehret, G. B., & Caulfield, M. J. (2013). Genes for blood pressure: An opportunity to understand hypertension. *European Heart Journal*, 34, 951–961.
- Ehret, G. B., Ferreira, T., Chasman, D. I., Jackson, A. U., Schmidt, E. M., Johnson, T., Newton-Cheh, C. (2016). The genetics of blood pressure regulation and its target organs from association studies in 342,415 individuals. *Nature Genetics*, 48, 1171–1184.
- Elliott, P., Stamler, J., Nichols, R., Dyer, A. R., Stamler, R., Kesteloot, H., & Marmot, M. (1996). Intersalt revisited: Further analyses of 24-hour sodium excretion and blood pressure within and across populations. *BMJ*, 312(7041), 1249–1253.
- Ezekowitz, J. A., & McAlister, F. A. (2009). Aldosterone blockade and left ventricular dysfunction: A systematic review of randomized clinical trials.

- European Heart Journal*, 30(4), 469–477.
- Fagard, R., Brguljan, J., Staessen, J., Thijs, L., Derom, C., Thomis, M., & Vlietinck, R. (1995). Heritability of conventional and ambulatory blood pressures: A study in twins. *Hypertension*, 26(6, Pt. 1), 919–924.
 - Forouzanfar, M. H., Afshin, A., Alexander, L. T., Anderson, H. R., Bhutta, Z. A., Biryukov, S., Murray, C. J. L. (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, 388, 1659–1724.
 - Gilani, A. H., Jabeen, Q., Ghayur, M. N., Janbaz, K. H., & Akhtar, M. S. (2005). Studies on the antihypertensive, antispasmodic, bronchodilator and hepatoprotective activities of the *Carum copticum* seed extract. *Journal of Ethnopharmacology*, 98(1–2), 127–135.
 - Guyton, A. C., Coleman, T. G., Cowley, A. V., Scheel, K. W., Manning, R. D., & Norman, R. A. (1972). Arterial pressure regulation: Overriding dominance of the kidneys in long-term regulation and in hypertension. *The American Journal of Medicine*, 52(5), 584–594.
 - He, J., Whelton, P. K., & Klag, M. J. (1996). Dietary fiber supplementation and blood pressure reduction: A meta-analysis of controlled clinical trials. *American Journal of Hypertension*, 9, L21.
 - Hollenberg, N. K. (2003). The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT): Major outcomes in high-risk hypertensive patients randomized to angiotensin-converting enzyme inhibitor or calcium channel blocker vs diuretic. *Current Hypertension Reports*, 5(3), 183–185.
 - Hosseini, A., Razavi, B. M., & Hosseinzadeh, H. (2018). Saffron (*Crocus sativus*) petal as a new pharmacological target: A review. *Iranian Journal of Basic Medical Sciences*, 21(11), 1091–1099.
 - Jee, S. H., He, J., Appel, L. J., Whelton, P. K., Suh, I. I., & Klag, M. J. (2001). Coffee consumption and serum lipids: A meta-analysis of randomized controlled clinical trials. *American Journal of Epidemiology*, 153(4), 353–362.
 - Jiang, S. Z., Lu, W., Zong, X. F., Ruan, H. Y., & Liu, Y. (2016). Obesity and hypertension. *Experimental and Therapeutic Medicine*, 12(4), 2395–2399.
 - Kearney, P. M., Whelton, M., Reynolds, K., Muntner, P., Whelton, P. K., & He, J. (2005). Global burden of hypertension: Analysis of worldwide data. *The Lancet*, 365(9455), 217–223.
 - Khatoon, T., Naskar, A., Datta, K., Kumar, D., Kaur, G., Karmakar, P., & others. (2022). A short review on role of some natural herbs in the treatment of hypertension. *Asian Journal of*

- Pharmaceutical Research and Development*, 10(3), 88–93.
- Kintiraki, E., Papakatsika, S., Kotronis, G., Goulis, D. G., & Kotsis, V. (2015). Pregnancy-induced hypertension. *Hormones*, 14(2), 211–223.
 - Lifton, R. P., Gharavi, A. G., & Geller, D. S. (2001). Molecular mechanisms of human hypertension. *Cell*, 104, 545–556.
 - Lionakis, N., Mendrinou, D., Sanidas, E., Favatas, G., & Georgopoulou, M. (2012). Hypertension in the elderly. *World Journal of Cardiology*, 4(5), 135–147.
 - Liu, C., & Huang, Y. (2016). Chinese herbal medicine on cardiovascular diseases and the mechanisms of action. *Frontiers in Pharmacology*, 7, 469.
 - Liu, C., Kraja, A. T., Smith, J. A., Brody, J. A., Franceschini, N., Bis, J. C., Morrison, A. C. (2016). Meta-analysis identifies common and rare variants influencing blood pressure and overlapping with metabolic trait loci. *Nature Genetics*, 48, 1162–1170.
 - Maass, P. G., Aydin, A., Luft, F. C., Schächterle, C., Weise, A., Stricker, S., Hecht, J. (2015). PDE3A mutations cause autosomal dominant hypertension with brachydactyly. *Nature Genetics*, 47, 647–653.
 - MacMahon, S., Cutler, J., Brittain, E., & Higgins, M. (1987). Obesity and hypertension: Epidemiological and clinical issues. *European Heart Journal*, 8(Suppl. B), 57–70.
 - Mahleyuddin, N. N., Moshawih, S., Ming, L. C., Zulkifly, H. H., Kifli, N., Loy, M. J., & others. (2021). *Coriandrum sativum* L.: A review on ethnopharmacology, phytochemistry, and cardiovascular benefits. *Molecules*, 27(1), 209.
 - Makarova, E. I., Bokov, D. O., Sergunova, E. V., Chevidae, V. V., Kakhramanova, S. D., Bessonov, V. V., & others. (2022). *Apium graveolens* L.: A phytochemical and pharmacological review. *Research Journal of Pharmacy and Technology*, 15(2), 927–934.
 - Markovitz, J. H., Matthews, K. A., Kannel, W. B., Cobb, J. L., & D'Agostino, R. B. (1993). Psychological predictors of hypertension in the Framingham study: Is there tension in hypertension. *JAMA*, 270(20), 2439–2443.
 - McNiece, K. L., Gupta-Malhotra, M., Samuels, J., Bell, C., Garcia, K., Poffenbarger, T., Sorof, J. M., & Portman, R. J. (2007). Left ventricular hypertrophy in hypertensive adolescents: Analysis of risk by 2004 National High Blood Pressure Education Program Working Group staging criteria. *Hypertension*, 50(2), 392–395.
 - Mittal, B. V., & Singh, A. K. (2010). Hypertension in the developing world: Challenges and opportunities. *American Journal of Kidney Diseases*, 55(3), 590–598.
 - Mizushima, S. (1996). Dietary magnesium intake and blood pressure:

- A review of the observational studies. *Journal of Hypertension*, 14(1), S239.
- NCD Risk Factor Collaboration (NCD-RisC). (2017). Worldwide trends in blood pressure from 1975 to 2015: A pooled analysis of 1479 population-based measurement studies with 19.1 million participants. *The Lancet*, 389(10064), 37–55.
 - Ndjenda II, M. K., Nguelefack-Mbuyo, E. P., Atsamo, A. D., Fofie, C. K., Fodem, C., Nguemo, F., & others. (2021). Antihypertensive effects of the methanol extract and the ethyl acetate fraction from *Crinum zeylanicum* (Amaryllidaceae) leaves in L-NAME-treated rat. *Evidence-Based Complementary and Alternative Medicine*, 2021, 1–9.
 - Ntchapda, F., Barama, J., Azambou, D. R. K., Etet, P. F. S., & Dimo, T. (2015). Diuretic and antioxidant activities of the aqueous extract of leaves of *Cassia occidentalis* (Linn.) in rats. *Asian Pacific Journal of Tropical Medicine*, 8(9), 685–693.
 - Nwokocha, C. R., Ozolua, R. I., Owu, D. U., Nwokocha, M. I., & Ugwu, A. C. (2011). Antihypertensive properties of *Allium sativum* (garlic) on normotensive and two kidney one clip hypertensive rats. *Nigerian Journal of Physiological Sciences*, 26(2), 213–218.
 - Perloff, D., Grim, C., Flack, J., Frohlich, E. D., Hill, M., McDonald, M., & Morgenstern, B. Z. (1993). Human blood pressure determination by sphygmomanometry. *Circulation*, 88(5), 2460–2470.
 - Pitt, B., Remme, W., Zannad, F., Neaton, J., Martinez, F., Roniker, B., Bittman, R., Hurley, S., Kleiman, J., & Gatlin, M. (2003). Eplerenone, a selective aldosterone blocker, in patients with left ventricular dysfunction after myocardial infarction. *New England Journal of Medicine*, 348(14), 1309–1321.
 - Pitt, B., Zannad, F., Remme, W. J., Cody, R., Castaigne, A., Perez, A., Palensky, J., & Wittes, J. (1999). The effect of spironolactone on morbidity and mortality in patients with severe heart failure. *New England Journal of Medicine*, 341(10), 709–717.
 - Pourjabali, M., Mohammadrezaei-Khorramabadi, R., Abbaszadeh, S., Naghdi, N., Naji-Haddadi, S., & Bahmani, F. (2017). Medicinal plants used for hypertension. *Journal of Pharmaceutical Sciences and Research*, 9(5), 537–541.
 - Prisant, L. M., Alpert, B. S., Robbins, C. B., Berson, A. S., Hayes, M., Cohen, M. L., & Sheps, S. G. (1995). American national standard for nonautomated sphygmomanometers: Summary report. *American Journal of Hypertension*, 8(2), 210–213.
 - Psaty, B. M., Lumley, T., Furberg, C. D., Schellenbaum, G., Pahor, M., Alderman, M. H., & Weiss, N. S. (2003). Health outcomes associated with various antihypertensive therapies used as first-line agents: A network meta-analysis. *JAMA*, 289(19), 2534–2544.
 - Sanoski, C. A. (2009). Aliskiren: An oral direct renin inhibitor for the

- treatment of hypertension. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, 29(2), 193–212.
- Schotte, D. E., & Stunkard, A. J. (1990). The effects of weight reduction on blood pressure in 301 obese patients. *Archives of Internal Medicine*, 150(8), 1701–1704.
 - Sharma, I., Parashar, B., Dhamija, H. K., & Sharma, R. (2012). An Ayurvedic arena for hypertension treatment. *Asian Journal of Pharmaceutical Research*, 2(2), 54–58.
 - Siddesha, J. M., Angaswamy, N., & Vishwanath, B. S. (2011). Phytochemical screening and evaluation of in vitro angiotensin-converting enzyme inhibitory activity of *Artocarpus altilis* leaf. *Natural Product Research*, 25(20), 1931–1940.
 - Sokpe, A., Mensah, M. L. K., Koffuor, G. A., Thomford, K. P., Arthur, R., Jibira, Y., & others. (2020). Hypotensive and antihypertensive properties and safety for use of *Annona muricata* and *Persea americana* and their combination products. *Evidence-Based Complementary and Alternative Medicine*, 2020, 1–13.
 - Sorof, J. M., Alexandrov, A. V., Garami, Z., Turner, J. L., Grafe, R. E., Lai, D., & Portman, R. J. (2003). Carotid ultrasonography for detection of vascular abnormalities in hypertensive children. *Pediatric Nephrology*, 18, 1020–1024.
 - Sorof, J. M., Cardwell, G., Franco, K., & Portman, R. J. (2002). Ambulatory blood pressure and left ventricular mass index in hypertensive children. *Hypertension*, 39(4), 903–908.
 - Surendran, P., Drenos, F., Young, R., Warren, H., Cook, J. P., Manning, A. K., Danesh, J. (2016). Trans-ancestry meta-analyses identify rare and common variants associated with blood pressure and hypertension. *Nature Genetics*, 48, 1151–1161.
 - Tabassum, N., & Ahmad, F. (2011). Role of natural herbs in the treatment of hypertension. *Pharmacognosy Reviews*, 5(9), 30–40.
 - Tolwinska, J., Głowinska, B., Urban, M., & Pieciukiewicz, B. (2005). Ultrasonographic evaluation of atherosclerotic changes in carotid and brachial arteries in obese and hypertensive children. *Przegląd Lekarski*, 62(12), 1346–1351.
 - Tracy, R. E., Newman, W. P., III, Wattigney, W. A., Srinivasan, S. R., Strong, J. P., & Berenson, G. S. (1995). Histologic features of atherosclerosis and hypertension from autopsies of young individuals in a defined geographic population: The Bogalusa Heart Study. *Atherosclerosis*, 116(2), 163–179.
 - Upadhyay, R. K. (2011). Kareel plant: A natural source of medicines and nutrients. *International Journal of Green Pharmacy*, 5(4).
 - Verma, T., Sinha, M., Bansal, N., Yadav, S. R., Shah, K., & Chauhan, N. S. (2021). Plants used as

antihypertensive. *Natural Products and Bioprospecting*, 11, 155–184.

- Wang, T., Zhang, P., Zhao, C., Zhang, Y., Liu, H., Hu, L., & others. (2011). Prevention effect in selenite-induced cataract in vivo and antioxidative effects in vitro of *Crataegus pinnatifida* leaves. *Biological Trace Element Research*, 142, 106–116.
- Warren, H. R., Evangelou, E., Cabrera, C. P., Gao, H., Ren, M., Mifsud, B., Munroe, P. B. (2017). Genome-wide association analysis identifies novel blood pressure loci and offers biological insights into cardiovascular risk. *Nature Genetics*, 49(3), 403–415.
- Whelton, P. K., He, J., Cutler, J. A., Brancati, F. L., Appel, L. J., Follmann, D., & Klag, M. J. (1997). Effects of oral potassium on blood pressure: Meta-analysis of randomized controlled clinical trials. *JAMA*, 277(20), 1624–1632.
- Whelton, P. K., Kumanyika, S. K., Cook, N. R., Cutler, J. A., Borhani, N. O., Hennekens, C. H., Kuller, L. H., Langford, H., Jones, D. W., Satterfield, S., & Lasser, N. L. (1997). Efficacy of nonpharmacologic interventions in adults with high-normal blood pressure: Results from phase 1 of the Trials of Hypertension Prevention. *The American Journal of Clinical Nutrition*, 65(2), 652S–659S.
- Wing, L. M. H., Reid, C. M., Ryan, P., Beilin, L. J., Brown, M. A., Jennings, G. L., Johnston, C. I., McNeil, J. J., Macdonald, G. J., Marley, J. E., & Morgan, T. O. (2003). A comparison of outcomes with angiotensin-converting-enzyme inhibitors and diuretics for hypertension in the elderly. *New England Journal of Medicine*, 348(7), 583–592.
- Xingfei, L., Shunshun, P., Wenji, Z., Lingli, S., Qiuhua, L., Ruohong, C., & others. (2020). Properties of ACE inhibitory peptide prepared from protein in green tea residue and evaluation of its anti-hypertensive activity. *Process Biochemistry*, 92, 277–287.