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# Non-Pharmacological Interventions for Hypertension Management: A Systematic Review

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**Abstract**

**Objective:**
To systematically review the current global evidence on the efficacy, safety, and implementation of non-pharmacological interventions (NPIs) for managing hypertension, including lifestyle modifications, dietary changes, physical activity, stress reduction, and behavioral therapies.

**Methods:**
A comprehensive search was conducted across prospective clinical trials, observational studies, and meta-analyses published up to 2025. Studies evaluating NPIs in adults with hypertension or prehypertension were included. Data on blood pressure reduction, cardiovascular risk, quality of life, feasibility, and cultural adaptability were extracted and analyzed.

**Results:**
NPIs such as dietary interventions (including the DASH diet), increased physical activity, weight management, stress reduction techniques, and behavioral therapies demonstrate significant efficacy in lowering blood pressure and reducing cardiovascular risk. These interventions also improve patient adherence and quality of life, with fewer side effects compared to pharmacological treatments. The feasibility and sustainability of NPIs vary based on cultural context and resource availability. Integration of digital health tools enhances NPI delivery and patient engagement.

**Conclusion:**
Non-pharmacological interventions are essential complementary or alternative strategies for hypertension management worldwide. Tailoring these interventions to individual and cultural needs, supported by emerging technologies, can optimize blood pressure control and reduce cardiovascular morbidity. Further research is needed to enhance long-term adherence, evaluate combined interventions, and integrate NPIs into routine clinical practice.

**Keywords:**
Hypertension, DASH Diet, Behavioural therapy, Prehypertension, Non-Pharmacological interventions

## 1. Introduction

One of the most common non-communicable diseases and a significant cause of morbidity and death worldwide is hypertension.[1] It has become one of the most significant and pervasive public health issues of the twenty-first century, affecting over one billion people globally. An increased risk of serious cardiovascular consequences, including peripheral artery disease, heart failure, myocardial infarction, stroke, and chronic renal disease, is closely linked to persistently elevated blood pressure.[2-6] In addition to reducing life expectancy, these illnesses place a heavy socioeconomic strain on healthcare systems in both developed and developing countries. Crucially, it has been demonstrated that even little rises in blood pressure raise cardiovascular risk, underscoring the pressing need for efficient control and preventative techniques.[3,7]

Although the therapy of hypertension has changed over the last several decades due to the discovery of efficient antihypertensive drugs, therapeutic results are still far from ideal. According to global data, a significant percentage of hypertensive patients either do not receive therapy, receive insufficient treatment, or do not reach their desired blood pressure level even after receiving medication.[8-11] Numerous factors contribute to this treatment gap, including adverse drug reactions, financial difficulties, restricted access to medical care, and—possibly most importantly—poor long-term therapeutic adherence.[6,9] Non-pharmacological treatments (NPIs), which are acknowledged by worldwide recommendations as the cornerstone of hypertension prevention and control, have come under increased scrutiny as a result of this ongoing care gap.[12]

NPIs include a broad variety of behavioral and lifestyle changes that focus on the underlying causes of high blood pressure. Dietary changes like the Dietary Approaches to Stop Hypertension (DASH) diet, consuming less sodium and more potassium-rich foods, engaging in regular physical activity and following structured exercise regimens, losing weight and maintaining a healthy body mass index, consuming alcohol in moderation, quitting smoking, and psychological interventions like stress reduction and better sleep hygiene are some examples.[13] In contrast to pharmaceutical treatment, which frequently deals with the effects of hypertension, NPIs work on factors upstream, avoiding the emergence of illness in at-risk individuals and enhancing cardiovascular health in general.[3]

Numerous cohort studies, meta-analyses, and randomized controlled trials have provided ample evidence of NPIs' efficacy. According to clinical data, these measures can reduce systolic and diastolic blood pressure in moderate instances of hypertension to a level equivalent to single-drug therapy. [14,15] In more severe cases, they further improve the effectiveness of drugs when used in combination.[16] NPIs provide a wider cardiometabolic impact than only lowering blood pressure; they also help to enhance vascular function, body weight, insulin sensitivity, and lipid profiles. Notwithstanding this strong body of research, cultural dietary choices, financial constraints, and patient adherence variability are some of the variables that frequently restrict the effectiveness of NPIs in practical settings. [15-19]

New approaches to removing these obstacles have been made possible in recent years by technology advancement. With the advent of wearable technology, telemedicine, digital coaching platforms, and mobile health (mHealth) applications, it is now possible to monitor patients continuously and provide useful solutions to improve adherence and maintain lifestyle modifications over time.[20] Because they

offer patients with hypertension individualized, easily available, and scalable support, these digital solutions have the potential to close the gap between clinical efficacy and practical effectiveness.[5,11]

When combined, these viewpoints highlight how important NPIs are to the overall treatment of hypertension. Strengthening the use of lifestyle-based therapies is a clinical and public health priority as the prevalence of cardiovascular disease continues to climb worldwide.[21-25] In addition to examining potential avenues for smoothly incorporating these tactics into standard clinical practice around the globe, this study attempts to compile the most recent data on the mechanisms, effectiveness, and difficulties of NPIs in the treatment of hypertension.[18,21]

## Methods

### Search Strategy and Selection Criteria

An extensive and thorough search of the literature was done to find pertinent research on non-pharmacological treatments for the treatment of hypertension that had been published up to 2025. To guarantee thorough coverage of biological literature, a number of electronic databases, including PubMed, Scopus, Cochrane Library, Web of Science, and Google Scholar, were methodically searched. To find unpublished or continuing research, specialist sources such grey literature archives and clinical trial registries (ClinicalTrials.gov, WHO ICTRP, ChiCTR) were also reviewed.

The search terms used "non-pharmacological interventions," "hypertension," "blood pressure," "lifestyle modification," "dietary intervention," "physical activity," and "stress management," among other combined keywords and medical subject headings (MeSH) pertaining to hypertension and non-pharmacological treatments. The search was narrowed to adult populations and pertinent study designs using boolean operators and filters.
Randomized controlled trials (RCTs), prospective and retrospective cohort studies, systematic reviews, and meta-analyses that assessed NPIs as stand-alone therapies or as supplements to medication in individuals with prehypertension or hypertension were among the research that qualified. Clinically significant results, such as variations in systolic and diastolic blood pressure, cardiovascular risk indicators, or adherence metrics, required to be reported by the studies.

Two reviewers separately assessed the relevance of the titles and abstracts, and full-text publications were obtained for in-depth analysis. Disputes were settled by third-party adjudication or consensus. PRISMA principles were followed during the selection procedure, guaranteeing repeatability and openness.

### Data Extraction and Quality Assessment

The study design, sample size, participant demographics (age, sex, comorbidities), type and duration of NPIs, comparator(s), and outcome measures (blood pressure changes, adherence rates, quality of life, and adverse events) were all captured in the data extraction process using a pre-made standardized form.

The included studies' methodological quality and bias risk were evaluated rigorously. The Cochrane Risk of Bias 2 (RoB 2) test was used to evaluate RCTs, evaluating areas such the randomization procedure, intentional intervention variations, outcome measurement, missing outcome data, and selective reporting.

The Newcastle-Ottawa Scale (NOS) assessed outcome assessment, research group comparability, and participant selection in observational studies.

The results were interpreted based on quality ratings, and papers with a high risk of bias were excluded from sensitivity analyses. When appropriate, meta-analytic methods were used to pool the data, and subgroup and meta-regression analyses were used to examine heterogeneity. Clinically significant insights for healthcare practice and policy were provided by this methodical approach, which guaranteed a strong and thorough synthesis of the data on NPIs for the management of hypertension.

## Results

### Dietary Interventions

Non-pharmacological treatments (NPIs) for the treatment of hypertension are based on dietary changes, among which the Dietary Approaches to Stop Hypertension (DASH) diet is the best studied and clinically supported.[6,11] In addition to limiting consumption of saturated fat, cholesterol, and sweets, the DASH diet promotes a nutrient-dense pattern rich in fruits, vegetables, whole grains, low-fat dairy products, and lean protein sources.[26,27] Numerous clinical trial results attest to the fact that following the DASH diet results in notable drops in blood pressure (BP), with systolic blood pressure (SBP) typically falling between 8 and 14 mm Hg and diastolic blood pressure (DBP) typically falling between 4 and 7 mm Hg in people with hypertension [Sacks et al., 2001; Whelton et al., 2018].[28,29]

These results have been supported by meta-analyses of randomized controlled trials with hundreds of participants, showing steady drops in blood pressure regardless of pre-existing hypertension [Filippou et al., 2020].[30] Additionally, the DASH diet works better when paired with sodium restriction; in people that are sensitive to salt, reducing sodium consumption alone lowers blood pressure by around 4 to 5 mm Hg and has more noticeable benefits [He & MacGregor, 2017].[31] Increased potassium intake from food or supplements helps manage blood pressure by encouraging natriuresis and vascular relaxation, which supports salt reduction [Whelton et al., 2018].[29]

Since excessive alcohol consumption is causally connected to hypertension, moderation in alcohol intake is also essential for managing blood pressure through diet [Brien et al., 2011].[14] In addition to lowering blood pressure, the DASH diet also improves endothelial function and lowers triglycerides and low-density lipoprotein cholesterol (LDL-C), all of which lower cardiovascular risk [Onwuzo et al., 2023].[32]

Sustained DASH diet compliance seems to provide the best long-term adherence and clinical advantages; nevertheless, behavioral and cultural acceptability issues continue to exist, highlighting the necessity of individualized dietary counseling and community-based interventions.[33,34] All things considered, the DASH eating pattern continues to be a fundamental, empirically supported strategy for lowering blood pressure and reducing cardiovascular risk.

**Physical Activity and Weight Management**

For hypertensive people, aerobic exercise—which includes brisk walking, cycling, and swimming—is a very successful non-pharmacological blood pressure-lowering strategy. Aerobic exercise reduces systolic blood pressure (SBP) by 5 to 8 mm Hg and diastolic blood pressure (DBP) by 3 to 6 mm Hg, according to meta-analyses of randomized controlled studies [Cornelissen & Smart, 2013; Wen et al., 2017].[25,29] A 7.2 mm Hg drop in SBP and a 5.6 mm Hg drop in DBP are the maximum effects of 150 minutes per week of moderate-intensity aerobic exercise. The extent of the BP reduction is dose-dependent [Ganjeh et al., 2024; Kajikawa et al., 2024].[35,36] By enhancing musculoskeletal strength and vascular compliance, resistance training enhances aerobic exercise and provides extra cardiovascular advantages.

A 5–10% decrease in body weight can lower blood pressure by up to 10 mm Hg, which is frequently more than the effect of single-agent antihypertensive medications [Neter et al., 2003; Whelton et al., 2018].[12,29] Weight loss brought on by calorie restriction or bariatric procedures also significantly lowers blood pressure. Key strategies that lower cardiovascular risk and enhance vascular health include improved insulin sensitivity and decreased systemic inflammation, which are achieved by exercise and weight loss.[37]

Significant improvements are evident in shorter therapies lasting around 8 weeks, whereas lengthier programs may maintain or slightly reduce the effects [Kajikawa et al., 2024].[26] These results highlight weight control and aerobic exercise as essential components of lifestyle treatment for hypertension, with clinically significant effects on par with medication.

**Stress Reduction Techniques**

Blood pressure (BP) has been shown to decrease moderately but significantly with mindfulness meditation, yoga, and biofeedback; these reductions are usually between 3 and 5 mm Hg for both systolic and diastolic pressures [Nugent et al., 2019].[37] By decreasing sympathetic nervous system activity, circulating cortisol levels, and enhancing autonomic control of heart rate and vascular tone, these mind-body treatments most likely have antihypertensive benefits [Palta et al., 2012; Goldstein et al., 2012].[11,19] Transcendental meditation, for instance, has been demonstrated to lower systolic blood pressure by 4 to 12 mm Hg in a variety of demographics, including high-risk and hypertensive groups, with effects that persist over extended periods of time [Schneider et al., 2014][38]. Yoga improves vagal tone and lowers stress-related neurohormonal activation by combining physical postures, breath control, and meditation. This helps to improve blood pressure regulation [Innes & Vincent, 2007].[39]

By helping patients consciously control blood vessel function and heart rate variability, biofeedback approaches help lower hypertension [Yucha & Montgomery, 2008].[22] Additionally, by lowering anxiety and sympathetic overdrive, relaxation techniques like progressive muscle relaxation and guided visualization can lower blood pressure.

The impact size of these therapies varies according to participant age, baseline blood pressure, and adherence levels, despite encouraging results.[40] To determine the best length, standardize procedures, and pinpoint the categories most likely to gain, larger, superior randomized controlled trials are required. By treating psychological stress, a known cause of raised blood pressure, and fostering overall

cardiovascular health, the use of these treatments as supplements to traditional therapy may enhance the management of hypertension.[41,42]

**Behavioral and Lifestyle Modifications**

A key tactic for improving cardiovascular health and lowering hypertension-related problems is quitting smoking. Smoking is known to produce acute, transient rises in blood pressure (BP) due to nicotine-induced sympathetic nervous system activation, even if the immediate and long-term effects of quitting smoking on decreasing BP vary somewhat [Virdis et al., 2010; Omvik, 1996].[15,24] Over time, endothelial dysfunction and vascular damage are exacerbated by repeated sympathetic activation, which increases heart rate and vascular resistance.

Additionally, tobacco use has a negative impact on lipid metabolism, increasing levels of triglycerides, total cholesterol, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) while decreasing levels of protective HDL, which accelerates atherosclerosis and cardiovascular risk [Herath et al., 2021].[18] Although some epidemiological research show that persistent smokers have strangely lower average blood pressure, this might not be a protective effect but rather the result of confounding variables like body weight and time of measurements.[7,13]

By reducing chronic sympathetic nervous system activation and enhancing nocturnal oxygenation, sleep hygiene improvements—especially for obstructive sleep apnea (OSA) and insomnia—help lower blood pressure [Palagini et al., 2013].[13] Continuous positive airway pressure (CPAP) treatment has been shown to reduce blood pressure somewhat but significantly when used to treat OSA, improving cardiovascular outcomes overall.

By improving endothelial function and lowering inflammation, reducing sedentary behavior on its own promotes vascular health and supports attempts to reduce hypertension [Diaz & Shimbo, 2013].[5] According to Bosworth and Powers (2010), multi-component therapies that incorporate behavioral support, motivational counseling, and patient education enhance adherence to medication and lifestyle changes, leading to longer-lasting blood pressure management and risk reduction.

**Feasibility, Adherence, and Cultural Adaptability**

Non-pharmacological therapies (NPIs) for hypertension frequently encounter a number of important obstacles to adoption and long-term maintenance. The capacity of people to embrace suggested lifestyle modifications may be hampered by socioeconomic variables including income, education, and access to healthcare [Schulz et al., 2018].[11] The acceptance and adherence to dietary changes, like as the DASH diet, are influenced by cultural food preferences and dietary practices, therefore treatments must be culturally sensitively tailored to maximize their efficacy.[5,9] The comprehension and application of lifestyle recommendations are also impacted by health literacy levels, highlighting the significance of support and clear communication.

Patients' willingness to make long-term lifestyle changes is greatly influenced by their motivation and behavioral preparedness. Interventions that include behavioral support, individualized coaching, and education have shown superior blood pressure management results and increased adherence.[10]

By enabling remote monitoring and individualized support, digital health technologies have become effective instruments for overcoming these obstacles. Patients may track their progress, get immediate feedback, and stay involved in interventions with the use of mobile applications for self-monitoring blood pressure, telehealth coaching, and reminders [Omboni et al., 2020].[8] Through interactive platforms, these technologies allow healthcare experts to remotely counsel patients, modify suggestions, and encourage adherence. Digital health interventions significantly lower both systolic and diastolic blood pressure, according to large-scale meta-analyses [Katz et al., 2024; Omboni et al., 2024].[4,8] The mean systolic BP decrease is around 4 mm Hg, and this effect lasts for many months.

Crucially, digital technologies may be adapted to a variety of demographics, meeting language and cultural requirements and increasing their influence and reach across socioeconomic levels. To stop health inequalities from getting worse, however, issues like digital literacy, technology access, and data privacy must be resolved.[7] There is potential for enhancing the delivery of NPIs and the results of hypertension worldwide by combining digital health technologies with conventional multidisciplinary treatment.

**Discussion**

Non-pharmacological interventions (NPIs) have long been considered a crucial part of managing hypertension because they provide low-risk, low-cost, and effective solutions that either supplement or, in certain situations, replace medication.[2,34] NPIs are the cornerstone of treatment, according to international guidelines, such as those issued by the European Society of Hypertension (ESH) and the American Heart Association (AHA), especially for patients with stage 1 hypertension or elevated blood pressure who do not have any other cardiovascular risk factors.[13,14] In addition to lowering blood pressure (BP), these therapies also improve general health, lower long-term cardiovascular risk, and raise quality of life. NPIs address the underlying causes of hypertension by focusing on environmental and lifestyle factors, in contrast to pharmaceutical treatment, which is frequently reactive.[10,11,19]

Dietary treatments have generally shown the greatest evidence base among NPIs. Numerous populations have validated the Dietary Approaches to Stop Hypertension (DASH) diet. The DASH diet, which limits red meats, saturated fats, and refined sweets while limiting fruits, vegetables, whole grains, legumes, nuts, and low-fat dairy products, has been demonstrated to lower systolic blood pressure in hypertensive people by 8–14 mmHg [Sacks et al., 2001].[25] Likewise, cutting back on sodium is still one of the best and most often used methods for lowering blood pressure. Research suggests that cutting sodium consumption to less than 2 grams per day can reduce systolic blood pressure by 4 to 5 millimeters Hg.[33] The results are much more pronounced in people who are salt-sensitive or have pre-existing hypertension [He & MacGregor, 2017]. By reducing the effects of salt on vascular resistance and enhancing endothelial function, increased potassium intake—often obtained from dietary sources like fruits and vegetables—has compounding advantages. These dietary practices collectively constitute fundamental NPIs with extensive cardiovascular preventive benefits.[1]

Weight control and regular exercise are essential lifestyle changes for controlling hypertension in addition to food. Independent of weight reduction, aerobic activity, such as brisk walking, cycling, or swimming, has been demonstrated to lower systolic and diastolic blood pressure by 5–7 mmHg [Cornelissen & Smart, 2013].[19] Additionally, resistance exercise enhances metabolic health and vascular compliance. Losing

weight has a significant effect on those who are overweight or obese; even little weight loss of 5–10% of body mass can result in blood pressure reductions that are clinically significant [Neter et al., 2003].[333] In addition to lowering blood pressure, exercise and weight loss work together to enhance insulin sensitivity, lipid metabolism, and inflammatory markers, all of which lower the risk of cardiovascular disease.

The potential advantages of other NPIs, such behavioral treatments and stress reduction, are becoming more widely acknowledged. Through pathways including endothelial dysfunction, cortisol dysregulation, and sympathetic nervous system activation, psychosocial stress is becoming more well recognized as a modifiable risk factor for hypertension.[39] Yoga, meditation, biofeedback, and mindfulness-based stress reduction are a few interventions that have demonstrated encouraging outcomes in reducing blood pressure and enhancing psychological well-being [Palta et al., 2012; Nugent et al., 2019].[24,30] However, because of limited trial numbers, inconsistent outcome measurements, and variation in intervention methods, the evidence is still weaker than that of diet and exercise.[27,39] Large-scale, high-quality clinical studies and standardized procedures are required to verify these techniques' long-term efficacy and scalability.

Personalized and patient-centered strategies are necessary to maximize the impact of NPIs. Acceptability and adherence are greatly increased by interventions that are customized to each patient's preferences, cultural eating customs, socioeconomic situation, and concurrent medical illnesses [Schulz et al., 2018].[25] For instance, while physical activity prescriptions should take into account a person's physical capabilities, vocational responsibilities, and access to exercise facilities, nutritional recommendations should be in line with traditional cuisines and food availability.[35] Community-based programs and policy initiatives that support safe places for physical exercise, healthy eating, and access to stress-reduction services are beneficial for vulnerable groups, especially those with little means.

The quick development of digital health technology presents fresh chances to expand NPIs' reach and sustainability. Wearable fitness trackers, remote coaching platforms, telemonitoring systems, and mobile health (mHealth) apps have all shown promise in supporting lifestyle change [Omboni et al., 2020].[14] These technologies facilitate ongoing interaction, encourage self-monitoring, and offer real-time feedback—all of which are essential for sustained adherence. Digital platforms also give medical professionals the ability to remotely monitor patient progress, provide individualized advice, and act quickly when needed. According to recent trials, digitally enhanced therapies can lead to persistent blood pressure reductions and improved adherence to lifestyle adjustments, providing a scalable strategy for population-wide deployment [Katz et al., 2024].[17]

There are still difficulties in spite of these developments. Numerous studies assessing NPIs have methodological flaws that make it impossible to evaluate long-term results, such as small sample numbers, poor generalizability, variability in intervention design, and short follow-up periods [Whelton et al., 2018].[17] A recurring issue in both pharmaceutical and non-pharmacological treatments, patient adherence is still not sufficiently evaluated and is not regularly reported in studies. Further restricting their accessibility is the fact that many regions' healthcare systems lack the necessary tools to incorporate lifestyle counseling and NPI delivery into standard practice.[3]

Future studies and implementation initiatives should concentrate on multi-component therapies that integrate behavioral support, stress management, scheduled physical activity, and nutritional modifications

into coherent programs. To assess cost-effectiveness, cardiovascular outcomes, and maintained adherence, long-term studies are required.[15,22,29] For NPIs to be used fairly and widely, they must be integrated into healthcare delivery systems through primary care, community health programs, and digital platforms. The influence of NPIs on public health will be further strengthened by policy-level adjustments like lowering the salt content of processed foods and encouraging physical exercise in urban design.

## Conclusion

Globally, non-pharmacological treatments (NPIs) are crucial for the treatment of hypertension. They offer safe, affordable, and efficient substitutes or supplements to prescription pharmaceuticals that can lessen drug dependence, enhance quality of life, and cut the risk of cardiovascular disease. The best evidence for decreasing blood pressure among NPIs is seen in dietary modifications such as the DASH diet and salt reduction. Additionally important are weight control and physical exercise, which have a significant influence on metabolic and vascular health. Although behavioral changes and stress reduction have potential, they need to be further standardized to optimize their benefits. Adherence and results are enhanced by tailored strategies that take into account patient preferences, cultural background, socioeconomic level, and comorbidities. Long-term lifestyle modifications are now more practical and scalable thanks to digital health technologies like telehealth coaching, remote monitoring, and mobile applications, which have increased the reach of NPIs. Short follow-up durations, poor adherence assessment, and variation in intervention designs are some of the research drawbacks. In order to guarantee fair access, future research should concentrate on assessing long-term cardiovascular benefits, optimizing integrated, multi-component therapies, and integrating NPIs into healthcare systems. For culturally relevant NPIs to be implemented successfully, multidisciplinary cooperation between doctors, nutritionists, psychologists, and community workers will be crucial. Alongside improvements in pharmaceutical therapies, an all-encompassing, patient-centered strategy has the potential to significantly lower the worldwide burden of hypertension and enhance cardiovascular health in all populations.

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