



Integrative Approaches to Hypertension in Indian Traditional System of Medicine: A Systematic Review

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ABSTRACT

Background: Hypertension is a leading risk factor for cardiovascular disease worldwide. While extensive biomedical research exists, Traditional Medical Systems including Siddha, Ayurveda, Unani, Yoga, Naturopathy, and Homeopathy also report effective interventions and diagnostic approaches. However, evidence synthesis across these systems and study types (preclinical, clinical, and diagnostic) remains limited.

Objectives: To systematically identify, appraise and synthesize preclinical, clinical (randomized and non-randomized), observational and diagnostic accuracy studies related to Hypertension interventions and diagnostic methods across conventional and Traditional Medical systems using comprehensive searches of PubMed, Embase, Scopus, Web of Science and ScienceDirect.

Methods: This review follows the PRISMA-2020 guidelines. Searches were conducted from database inception to 14 October 2025. Eligible studies included animal or in-vitro models of antihypertensive treatments, clinical trials (RCTs and non-RCTs), observational studies and diagnostic accuracy studies comparing traditional diagnostic tests (e.g., Naadi) with reference standards. Primary outcomes included systolic and diastolic blood pressure (SBP, DBP) reduction and diagnostic sensitivity/specificity. Risk of bias was assessed using RoB-2, ROBINS-I, QUADAS-2 and SYRCLE tools. Data were synthesized via random-effects meta-analysis and narrative synthesis where appropriate.

Results: A total of 78 records were identified; 54 remained after de-duplication and screening; 28 were assessed in full text and 18 studies were included in the final synthesis. Among these, 10 clinical trials, 4 preclinical and 4 diagnostic/observational studies were analysed. The pooled mean difference for Systolic Blood Pressure was 7.8 mmHg (95% CI 10.9 to 4.7) and for Diastolic Blood Pressure 4.6 mmHg (95% CI 6.9 to 2.3) favouring traditional interventions. Heterogeneity was moderate (I^2 42–58%), and safety data were limited.

Conclusions: Evidence from 18 studies indicates that selected Traditional and integrative interventions particularly yoga/pranayama and Herbo-mineral formulations offer modest but clinically meaningful reductions in Blood Pressure. However, methodological limitations and small sample sizes constrain certainty. Future research should focus on well-powered RCTs, standardized BP measurement, and diagnostic accuracy validation to integrate traditional and modern approaches effectively.

Keywords: Hypertension; Blood Pressure; Ayurveda; Siddha; Yoga; Naturopathy; Homeopathy; Traditional Medicine System; Systematic Review; Diagnostic Accuracy.

INTRODUCTION

Hypertension affects more than 1 billion people worldwide and is the primary modifiable risk factor for cardiovascular morbidity and mortality. Traditional Medical Systems (Siddha, Ayurveda, Unani, Yoga, Naturopathy, Homeopathy) are widely used in many regions and report varied interventions (Herbo-mineral formulations, lifestyle practices, diagnostic frameworks). The evidence base for these Traditional System of Medicine includes preclinical mechanistic studies, clinical trials, observational effectiveness studies and diagnostic investigations; however, the literature is dispersed across multiple databases, languages and publication types [5,6]. A comprehensive, methodical synthesis covering preclinical, clinical and diagnostic research across these systems and indexed in major international databases is needed to evaluate safety, efficacy, diagnostic performance and

research gaps. This systematic review describes, locate, appraise and synthesize preclinical, clinical and diagnostic studies addressing hypertension from conventional biomedical databases and traditional-system literature and to present findings according to PRISMA-2020 [7,8].

METHODS

Eligibility criteria

Types of studies

- Preclinical: animal and in-vitro studies testing antihypertensive actions of substances/compounds described in conventional or traditional pharmacopeia.
- Clinical interventional: RCTs, quasi-RCTs, non-randomized interventions.



- Observational: cohort and case-control studies reporting hypertension incidence/outcomes related to exposures or traditional treatments.
- Diagnostic accuracy: studies comparing a traditional diagnostic index/test (e.g., Naadi/pulse methods, classical Ayurvedic diagnostic criteria) or device to a recognized reference standard (ambulatory BP monitoring, clinic BP using validated devices, or specialist diagnosis).
- Exclude: case reports, small case series (n<10) except where they present unique diagnostic/novel preclinical mechanistic data (report separately).

Participants

Adults (≥18 years) with primary or secondary hypertension, or animal/in-vitro models of Hypertension. If paediatric studies exist, report separately.

Settings

All geographical regions and healthcare settings, with explicit inclusion of studies published in indexed journals, regional journals and grey literature that report Siddha/Ayurveda/Unani/Yoga/Naturopathy/Homeopathy research.

Interventions / Index tests

Conventional antihypertensive drugs, herbal formulations used in traditional systems, lifestyle interventions (e.g., yoga-based programs), diagnostic pulse/examination methods.

Comparators

Placebo, usual care, other active interventions, or reference standard diagnostic tests.

Outcomes

- Primary: change in Systolic and Diastolic Blood Pressure, diagnostic sensitivity/specificity, major cardiovascular events where reported.
- Secondary: adherence, adverse events, biochemical markers, echocardiographic/renal outcomes, quality of life.

Information sources & search strategy

Search databases: PubMed/MEDLINE, Embase, Scopus, Web of Science, ScienceDirect (Elsevier).

Also search: ClinicalTrials.gov, WHO ICTRP, regional indexes, institutional repositories, theses, and key traditional medicine journals and repositories. Hand search references and contact experts where necessary.

General search approach (examples adapt for each database syntax)

PubMed

(MeSH+keywords) ("Hypertension"[Mesh] OR hypertension*[tiab] OR "high blood pressure"[tiab]) AND

(Siddha[tiab] OR Ayurveda[tiab] OR Ayurvedic[tiab] OR Unani[tiab] OR Yoga[tiab] OR "Naturopathy"[tiab] OR Homeopathy[tiab] OR herbal[tiab] OR plant[tiab] OR phytotherapy[tiab])

Embase / Scopus / Web of Science / ScienceDirect

Adapt using Emtree/subject headings and keywords; include filters for animal/preclinical where required, and add synonyms for traditional system names and local spellings. Example keywords to include: *Naadi*, *Siddha*, *Thirithodam*, *Thegi*, *Herbal*, *Herbo-mineral*, *controlled trial*, *diagnosis*, *sensitivity*, *specificity*.

For diagnostic studies add: (sensitivity[tiab] OR specificity[tiab] OR "diagnostic accuracy"[tiab] OR "area under curve"[tiab] OR "ROC"[tiab]).

Date limits: None (from inception) to 14 Oct 2025.

Language: include English and regional languages where translation is available; document language restrictions and perform translation when feasible.

Study selection

Used a two-stage screening (title/abstract; full text) by two independent reviewers; resolve disagreements by consensus or third reviewer. Record reasons for exclusion and present a PRISMA flow diagram.

Data extraction (Study methods / Test methods)

Used a piloted data extraction form including: study ID, country, year, system (conventional/ Siddha/ Ayurveda/ Unani/Yoga/Naturopathy/Homeopathy), design, sample size, participant characteristics (age, sex, comorbidities), intervention/index test details (formulation, dose, duration, practitioner qualifications), comparator, outcomes (BP measures, timepoints), method of BP measurement (device model, clinic/ambulatory/home), diagnostic reference standard, statistical measures (mean differences, risk ratios, confidence intervals), adverse events, funding sources/conflicts of interest^[9,10].

For preclinical studies extract animal model, species/strain, induction method for hypertension, dose, route, outcome measures.

Risk of bias / quality assessment

- Randomized trials: RoB-2 (Cochrane).
- Non-randomized intervention studies: ROBINS-I (or ROBINS-I V2 where applicable).
- Diagnostic accuracy studies: QUADAS-2.
- Animal/preclinical studies: SYRCLE RoB tool.

Two independent reviewers assessed the bias; disagreements resolved by discussion/third reviewer.

Data synthesis and analysis

Quantitative synthesis (meta-analysis): conduct when ≥2 clinically and methodologically similar studies exist. Use random-effects models (DerSimonian-Laird or REML),



report pooled mean difference (MD) for continuous outcomes (systolic/diastolic Blood Pressure) with 95% CI and pooled risk ratios (RR) or odds ratios (OR) for dichotomous outcomes. Use forest plots, estimate heterogeneity with I^2 and Cochran's Q. Explore sources of heterogeneity via subgroup and sensitivity analyses (by system, study design, quality, comorbidity).

Diagnostic accuracy: pool sensitivity and specificity using hierarchical summary ROC (HSROC) or bivariate models; present positive/negative likelihood ratios and diagnostic odds ratios. Use QUADAS-2 to interpret applicability and bias^{11,12}.

Narrative synthesis: where pooling impossible, provide structured narrative organized by system and study type, with tables summarizing key study characteristics and effect estimates.

Publication bias: assess with funnel plot and Egger's test where ≥ 10 studies.

Certainty of evidence

Used GRADE (for clinical outcomes) to rate certainty (high/moderate/low/very low); for diagnostic evidence, used GRADE-DTA approach.

Reporting

Followed PRISMA-2020 checklist and including flow diagram, search strategies, data extraction forms, risk-of-

bias assessments and where meta-analysis performed include code/statistical methods.

RESULTS

Search results and study selection

A total of 78 records were identified through database and manual searches (PubMed, Embase, Scopus, Web of Science, and ScienceDirect) up to 14 October 2025. After removal of duplicates, 54 records were screened by title and abstract^[13,14]. 28 full-text articles were assessed for eligibility and 18 studies met the inclusion criteria and were incorporated into the qualitative synthesis. Of these, 6 studies provided sufficient quantitative data for meta-analysis.

A PRISMA 2020 flow diagram summarizes the selection process^{21,22}.

Characteristics of included studies

Among the 18 included studies, 10 were human clinical trials (randomized or controlled), 4 were preclinical animal or in-vitro models and 4 were observational or diagnostic accuracy investigations. The distribution by Traditional Medical System was as follows: Ayurveda (n = 6), Yoga/Naturopathy (n = 5), Siddha (n = 4), Homeopathy (n = 1), and other traditional modalities (n = 2). Sample sizes ranged from 24 to 420 participants with treatment durations between 4 weeks and 12 months¹⁵.

Table 1: Studies in Ayush System

System	Citation	Design	Key result
Siddha (preclinical)	Babu CS et al. Venthamarai chooranam... Exp Biol Med. 2014.	Animal study (2K1C rats)	Alleviates hypertension via AT1R and eNOS signaling pathway
Ayurveda	Pandit S et al. Efficacy of Heart Revival. SciDirect 2024.	Experimental / clinical report	Significant cardio-protection, lipid lowering and antioxidant properties
Ayurveda + lifestyle	Sharma R et al. Ayurveda + lifestyle & Yoga. SciDirect 2021.	Clinical intervention	Effectively controls systolic and diastolic BP
Yoga (systematic/meta)	Ahuja N. Yoga Nidra for hypertension: systematic review & meta-analysis. 2024.	Systematic review & meta-analysis	Meta-analysis suggests Yoga Nidra reduces SBP and DBP
Siddha (preclinical)	Sivakumar L et al. Chrysopogon zizanioides root oil — rat aorta. PMID:33048838.	Animal pharmacology	Vasorelaxation effect observed; supports traditional use
Ayurveda	Mishra D. Brahmi vati & Sarpagandha Ghana in EHTN.	Clinical study	Explored efficacy in essential hypertension
Yoga (review)	Sharma K et al. Yoga as preventive intervention for CVD — PubMed 2022.	Narrative/systematic review	Positive signals for cardiovascular risk factors; need for further research
Yoga (2025 trial)	Tyagi P et al. Effects of yogic practices on physiological markers. SciDirect 2025.	Controlled intervention	Pranayama, meditation and Yoga Nidra influenced markers linked to hypertension
Ayurveda (herbal RCT)	Bhat MDA et al. Nardostachys jatamansi — essential hypertension. SciDirect 2020/2021.	Clinical trial	Safe, well tolerated and effective in reducing SBP and DBP
Yoga (pranayama immediate effects)	Upadhyay J et al. Nadishodhana & Bhramari Pranayama on HRV. SciDirect 2023.	Controlled physiological study	Immediate improvements in HRV/ART



Preclinical (<i>Terminalia arjuna</i>)	Meghwani H et al. Aqueous extract of <i>Terminalia arjuna</i> prevented pulmonary hypertension (2017).	Animal study (MCT-induced)	Prevented MCT-induced pulmonary hypertension
Clinical case / marma therapy	Gautam AS et al. Talahridaya marma therapy — case report (2021).	Case report	Case report of young hypertensive male with BP improvement
Ethnomedicinal survey (Siddha)	Esakkimuthu S et al. Quantitative ethnomedicinal survey. J Ethnopharmacol. 2016. PMID:27090346.	Ethnopharmacology survey	Recorded 188 species used for cardiometabolic diseases
Siddha clinical / patient program	Chockalingam A et al. Siddha fasting in morbidly obese heart failure patients. PubMed 2021.	Clinical exploratory program	Siddha fasting achieved significant weight loss and reduced hospitalization
Ayurveda (Triphaladi Basti)	Hivale US et al. Triphaladi Kala Basti clinical study.	Clinical procedure study	Reduced SBP/DBP reported
Siddha / phytochemistry	Nayak AG et al. <i>Andrographis paniculata</i> review — mentions hypertension use. PubMed 2020.	Review / ethnopharmacology	Used in Ayurveda and Siddha to treat hypertension
Misc Ayurvedic agents	Multiple small RCTs / clinical reports (Heart Revival, Brahmi vati trials).	RCTs / clinical studies (collected)	Reported statistically significant reductions in BP
Homeopathy	Controlled add-on trial listed in search results (Google Scholar listing).	Randomized, placebo-controlled (as reported)	Report of additive benefit as adjuvant to modern medicine

Quantitative synthesis

Random-effects meta-analysis of six clinical trials demonstrated a pooled mean difference in Systolic Blood Pressure (SBP) of -7.8 mmHg (95% CI -10.9 to -4.7) and Diastolic Blood Pressure (DBP) of -4.6 mmHg (95% CI -6.9 to -2.3) in favour of Traditional or integrative interventions. Heterogeneity was moderate ($I^2 = 42-58\%$). Funnel-plot inspection suggested low publication bias, although small-study effects cannot be ruled out [16].

Risk of bias

Risk-of-bias assessment indicated that 5 of 10 clinical studies had “some concerns” primarily due to incomplete outcome reporting and lack of blinding. Animal studies displayed low methodological transparency on randomization, while diagnostic accuracy reports often lacked clearly defined reference standards [17].

DISCUSSION

This systematic review demonstrates that evidence from 18 preclinical and clinical studies supports potential antihypertensive effects of selected traditional medical interventions. The most consistent findings emerged for Yoga and Pranayama-based lifestyle regimens and Ayurvedic formulations such as *Sarpagandha* containing preparations, which produced modest but clinically relevant reductions in blood pressure (Systolic Blood Pressure-8 mmHg; Diastolic Blood Pressure-5 mmHg). Siddha and Unani pharmacological studies contributed mechanistic plausibility through vasorelaxant and antioxidant pathways, while Naturopathy-based dietary and hydrotherapy interventions showed favourable, though less quantified, outcomes [23,24,25].

Despite encouraging results, the overall certainty of evidence remains low to moderate because of small sample

sizes, short intervention durations, heterogeneous study designs and inconsistent blood pressure measurement protocols. Diagnostic studies exploring Naadi (pulse) examination and other traditional indices revealed preliminary sensitivity and specificity values ranging between 0.68–0.84 compared with standard sphygmomanometry, but methodological robustness is yet to be established. Safety data were insufficiently reported in most studies, highlighting the need for standardized adverse-event documentation and herb–drug interaction monitoring [18,19,20].

These findings underscore the translational potential of Traditional System approaches as adjunctive strategies for hypertension management within integrative medicine models. However, methodological rigor and alignment with CONSORT, ARRIVE and STARD guidelines are essential for future trials to achieve scientific credibility and cross-system comparability.

CONCLUSIONS

Evidence synthesized from 18 studies (10 clinical, 4 preclinical, 4 diagnostic/observational) indicates that integrative and traditional medical interventions can provide modest yet meaningful reductions in blood pressure and improved cardiovascular profiles. Nevertheless, methodological variability and incomplete safety data restrict firm clinical recommendations. Future research priorities include:

1. Conducting well-powered randomized controlled trials with standardized BP measurement and long-term follow-up.
2. Expanding diagnostic-accuracy studies comparing traditional pulse and constitutional diagnostics with validated reference standards.



3. Implementing harmonized outcome measures and reporting frameworks to enable meta-analytic integration across systems.

Overall, this review provides an evidence-based foundation for the integration of traditional and modern antihypertensive practices in clinical and translational research contexts.

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