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Integrative Approaches in Cardiovascular Disease Management: A Systematic Review of Siddha Medicine, Herbal Interventions, and Lifestyle Modifications

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Abstract

This review seeks to critically assess Siddha and herbal products, Siddha-based lifestyle interventions, and cardiovascular disease (CVD) phytochemicals derived from traditional therapeutic systems. Additionally, the review contrasts traditional dietary recommendations with contemporary dietary concepts and practices, examining their respective therapeutic mechanisms. To evaluate therapeutic efficacy and adherence to lifestyle modifications, we

systematically reviewed experimental, clinical, integrated, and computational studies from both Indian and global literature, with a focus on their combined mechanistic actions. Results indicate that, despite methodological limitations in the included studies, certain compounds within classical polyherbal and herbo-mineral formulations, identified as antihypertensive agents, demonstrate efficacy in managing hypertension and dyslipidemia, comparable to modern pharmaceuticals. Phytochemical profiling has revealed biologically active compounds with antioxidants, anti-inflammatory, vasodilatory, and lipid-lowering properties, supported by molecular docking studies and in vitro assays. The study also highlights similarities between the calendar-based fasting rules, diet, and dietary practices of the Siddha system and those in modern cardiology, although further experimental, evidence-based scientific validation is required. The integration of Siddha therapeutics with lifestyle modifications appears promising in clinical practice, although current evidence is limited by methodological constraints and a lack of extensive trials. These findings underscore the need for scientific integrative strategies for the primary and secondary prevention of cardiovascular diseases, thereby reinforcing traditional knowledge within the Siddha system in comparison to modern cardiology.

Introduction

Research on cardiovascular disease (CVD) has emerged as a critical area of inquiry because it is the leading cause of mortality worldwide, accounting for approximately 17.9 million deaths annually and projected to rise further by 2030 (Kaur & Kumar, 2024; Skowronek et al., 2024). Over recent decades, the field has evolved from focusing solely on pharmacological interventions to incorporating lifestyle modifications and alternative therapies, including traditional medicine systems such as Siddha and Ayurveda (Bhukan et al., 2024). The social and practical significance of this research is underscored by the increasing global burden of non-communicable diseases (NCDs), with CVDs constituting 27% of deaths in India (Saxena et al., 2024; Lal et al., 2024). This growing prevalence demands integrative approaches that address both prevention and management, emphasizing holistic health and cost-effective strategies (Sreedevi & Mavilavalappil, 2024; “Nutraceuticals: The Potential Agents to...”, 2022).

Despite significant advancements, the management of cardiovascular disease (CVD) continues to present challenges owing to the limitations inherent in conventional therapies, such as side effects and incomplete efficacy (Bianchi, 2017; Kaur and Kumar, 2024). Siddha medicine, a traditional Tamil system characterized by its rich herbal formulations and lifestyle guidance, offers promising alternatives; however, it remains underexplored in rigorous scientific contexts (Chitra 2024; Susila et al. 2013; Rajalakshmi et al. 2020). The current literature reveals a fragmented understanding of the role of Siddha in conjunction with herbal medicine and lifestyle modification in CVD care, with ongoing controversies regarding standardization, clinical validation, and integration with modern medicine (Rajalakshmi et al.; Kalra et al., 2024; Yue et al., 2024). This knowledge gap results in missed opportunities to develop comprehensive care models that could potentially reduce morbidity and healthcare costs (Saxena et al., 2024). Balanced perspectives emphasize both the potential benefits of herbal and lifestyle interventions and the necessity for robust evidence to support their widespread adoption (Gavagan; Pawar et al., 2024). The principles of Siddha medicine, which focus on dosha balance and herbal pharmacology, intersect with contemporary understanding of oxidative stress, inflammation, and metabolic regulation (Kshirsagara et al., 2023; Zarenezhad

et al., 2024). This framework advocates a holistic approach that links herbal medicine and lifestyle modifications as complementary strategies for the prevention and management of CVD (Chockalingam et al., 2022).

This systematic review aimed to critically evaluate the evidence on Siddha medicine, herbal interventions, and lifestyle modifications in the management of cardiovascular diseases. It aims to synthesize traditional knowledge with contemporary research to address existing gaps and inform integrative health care practices. This review adds value by providing a comprehensive, evidence-based assessment that aligns with the global health priorities for NCD control (Singh, 2024; Bankar et al., 2023).

The review methodology involved a comprehensive literature search and critical analysis of peer-reviewed studies, clinical trials, and traditional texts. The inclusion criteria focused on studies addressing Siddha medicine, herbal therapies, and lifestyle interventions for CVD, with findings organized thematically to elucidate therapeutic mechanisms and clinical outcomes (Rayadurgam et al., 2023; Rajalakshmi et al., 2020).

Purpose and Scope of the Review

Statement of Purpose

- This report aims to examine the existing research on "cardiovascular disease, Siddha medicine, herbal medicine, lifestyle modification" to elucidate the integrative potential of traditional Siddha practices and herbal interventions alongside lifestyle modifications for the prevention and management of cardiovascular diseases. This review is important because cardiovascular diseases remain a leading cause of morbidity and mortality globally, and there is growing interest in complementary and alternative therapies that offer holistic, cost-effective, and culturally relevant approaches. By synthesizing current evidence, this report aims to identify effective strategies, underlying mechanisms, and gaps in knowledge to inform future research and clinical applications that harmonize traditional wisdom with modern healthcare paradigms.

Results

Descriptive Summary of the Studies

This section maps the research landscape of the literature on cardiovascular disease, Siddha medicine, herbal medicine, lifestyle modification, encompassing a diverse range of studies that explore traditional herbal formulations, lifestyle interventions, and integrative approaches for cardiovascular health. The reviewed studies span experimental, clinical, and computational methodologies, with a notable focus on Siddha and Ayurvedic herbal remedies, phytochemical analyses, and lifestyle adherence in both Indian and global contexts. This comparative synthesis is relevant to the research questions as it highlights therapeutic efficacy, integration outcomes, and mechanistic insights, thereby informing the potential harmonization of traditional and modern cardiovascular care.

The comprehensive analysis of the reviewed studies reveals distinct patterns across multiple dimensions of cardiovascular disease management through Siddha and herbal medicine. Their research emphasized anti-inflammatory and antioxidant effects, showing that lifestyle plus alternative therapies improve cardiovascular outcomes. Similarly, the review on "Herbal Remedies for Lifestyle Diseases" (2022) found that herbal remedies effectively lower blood pressure and cholesterol, identifying garlic, hawthorn, and turmeric as key herbs with

cardioprotective properties through lipid lowering and vasodilation mechanisms, though noting limited data on adherence rates and the need for more trials when combining herbal and lifestyle approaches.

Cheng *et al*. (2024) provided evidence that traditional and natural medicines improve cardiovascular health markers, with lifestyle modifications being integral to treatment success. Their work characterized botanical extracts for cardioprotective compounds and demonstrated that integration with conventional medicine enhances outcomes through modulation of oxidative stress and inflammation pathways. Chitra (2024) specifically examined the Siddha formulation *Kurudhiazhal choornam*, which showed ACE inhibition properties reducing hypertension. Through molecular docking studies, phytoconstituents were identified with ACE receptor binding capabilities, and the Siddha herbal action was compared favorably to the allopathic drug captopril, revealing the ACE inhibition mechanism at the molecular level.

Veppampoo Mathirai polyherbal tablet was examined for its effectiveness in lowering blood pressure, reviewing its antihypertensive properties, and demonstrating how herbal ingredients regulate blood pressure pathways to position the Siddha formulation as an alternative to conventional drugs (Chithra S.M. et al. 2022). In rats, *Veera Meezhugu* exhibited dose-dependent anticoagulant activity, supporting its use in Siddha cardiovascular therapy by modulating coagulation parameters including APTT, PT, and INR (Agasthian A, G.Esakki Pandiyan, 2024). Chockalingam et al. (2022) explored how Siddha self-inquiry meditation improves physical and emotional health in cardiac patients, with high patient engagement in mindful lifestyle practices. Their research highlighted lifestyle transformation as integral to Siddha therapy, operating through psychological resilience and positive psychology mechanisms. Witkowska *et al*. (2024) conducted detailed phytochemical characterization of six herbs including garlic and hawthorn, demonstrating in vitro cardiovascular benefits through antioxidant, anti-inflammatory, and vasodilatory effects, positioning herbal products as complements to standard pharmacological treatments.

Sharifi-Rad *et al.* (2020) examined how natural bioactive compounds from diet reduce cardiovascular risk factors, emphasizing lifestyle adherence to healthy diet and exercise. They profiled polyphenols, peptides, and vitamins, showing that dietary and lifestyle integration reduces coronary artery disease through molecular mechanisms including antioxidant and anti-inflammatory actions. Cicero *et al*. (2017) found that food and plant bioactives improve lipid profile and blood pressure, with lifestyle modification prioritized as the first therapeutic step. Their research quantified bioactives like berberine and curcumin, noting synergistic effects with lifestyle changes on endothelial function and arterial stiffness.

Nayak et al. (2023) demonstrated that Ayurvedic plants effectively manage hyperlipidemia when combined with lifestyle and diet modifications. They identified plant-based medicines for lipid lowering and showed that Ayurveda combined with lifestyle modifications shows clinical promise through lipid metabolism modulation and antioxidant activity. Sudha (2024) evaluated Vyoshadi Sakthu, which significantly reduces serum cholesterol and LDL when integrated with lifestyle changes including diet and exercise, with herbal Lekhana properties targeting fat metabolism enhancing lipid control.

Mohiuddin (2019) reviewed Indian herbs and spices possessing antithrombotic and hypolipidemic properties, emphasizing dietary factors as crucial in cardiovascular disease prevention. The study profiled phytochemicals like carotenoids and flavonoids, showing that

herbal dietary use complements pharmacological treatments through antioxidant and anti-inflammatory mechanisms. The review on "Nutraceuticals: The Potential Agents" (2022) examined how nutraceuticals from herbs show potential in managing CVD risk factors, with lifestyle factors like diet and physical activity emphasized. Kitchen spices and plant components were analyzed, positioning nutraceuticals as adjuncts to lifestyle interventions through anti-inflammatory and metabolic regulation pathways.

Bianchi (2017) found that herbal remedies prevent and reverse heart diseases effectively when lifestyle and diet are integral to the treatment strategy. Key herbs were scientifically studied for cardiac conditions, demonstrating that traditional medicine complements modern cardiology through vasodilation and antiatherosclerotic effects. Gavagan showed that alternative therapies like n-3 fatty acids and garlic show mild cardiovascular benefits, with integrated diet, exercise, and stress reduction adherence noted, though combined lifestyle and herbal supplements improve outcomes through antioxidant and lipid-lowering mechanisms despite limited phytochemical profiling.

K et al. (2014) demonstrated that Siddha herbs lower lipid levels without major adverse effects, identifying multiple plants with lipid-lowering phytochemicals that support lifestyle-based hyperlipidemia management through anti-hyperlipidemic and antioxidant pathways. The standardization study of *Maaradaippuku chooranam* (2022) confirmed no contaminants through phytochemical and biochemical evaluation, with the presence of steroids, alkaloids, and phenols linked to efficacy, supporting quality control for integration into clinical use.

Babu et al. (2014) showed that *Venthamarai chooranam* reduces blood pressure via eNOS and AT1R pathways, with the Siddha formulation demonstrating molecular pathway modulation by upregulating eNOS, downregulating AT1R, and reducing inflammation. Yue et al. (2024) found that integrated TCM and Western care improves blood pressure and quality of life, with high adherence to combined lifestyle and medical interventions showing superior outcomes over conventional care through combined exercise, diet, and herbal therapies.

Borah & Ojha (n.d.) described how Ayurveda offers dietary and lifestyle modifications for ischemic heart disease, with lifestyle and diet central to disease management. Their work showed that Ayurveda integrates with modern care for ischemic heart disease by focusing on correcting pathogenesis factors like Dhamanipratichaya. Susila et al. (2013) explained how Siddha herbs pacify dosha imbalances in cardiovascular disease, identifying key cardioprotective herbs in classical texts and validating traditional herbs through recent research showing dosha modulation linked to cardiovascular protection.

Velmurugan et al. (2014) demonstrated that polyherbal Siddha formulation is effective for hypertension and coronary disorders, with ingredients pharmacologically characterized to support cardiovascular health through multi-targeted herbal actions on hypertension. Fields et al. (2002) showed that multimodality natural medicine reduces carotid atherosclerosis in elderly patients with high adherence to diet, exercise, herbal supplements, and stress reduction. Their traditional multimodal approach outperformed modern and usual care, demonstrating reduction in carotid intima-media thickness.

Kunte & Hingane (2024) profiled multiple herbs like arjuna and garlic for lipid lowering effects in various models, showing that herbal treatment complements lifestyle for hyperlipidemia through natural compounds modulating lipid metabolism. Rayadurgam et al. (2023) standardized a polyherbal formulation showing antioxidant activity in cell assays, with

phytomarkers quantified by densitometry and LC-MS, identifying potential therapeutic formulation for atherosclerosis through antioxidant and anti-inflammatory cellular effects.

Rajalakshmi et al. (2020) demonstrated that Siddha polyherbal decoctions exhibit antioxidant and anti-atherogenic properties, with polyphenolic content and antioxidant capacity measured, identifying potential anti-atherogenic Siddha drugs through radical scavenging and lipid peroxidation inhibition. In another study, Rajalakshmi et al. (2020) proposed integrative medicine combining Siddha and biomedicine for NCD control, emphasizing scientific validation of Siddha medicines, with a co-location model supporting integration and cost-effectiveness to optimize preventive and therapeutic outcomes.

Elangovan et al. (2023) described Siddha dietary guidelines tailored to body constitution promoting health, with food compatibility with dosha types described, showing that traditional diet aligns with lifestyle modification principles through personalized nutrition supporting disease prevention. Rajalakshmi et al. (2016) identified over 60 Siddha medicinal plants used for hypertension management, with scientific validation of antihypertensive herbs reviewed, showing that Siddha herbs complement lifestyle for blood pressure control with herbal efficacy supported by pharmacological evidence.

Saxena et al. (2024) demonstrated that AYUSH integration enhances preventive medicine for NCDs including CVD, though standardization and research advancement are needed. Their work showed that integrative care models improve health outcomes, with policy and education critical for mainstreaming Siddha. Kalra et al. (2024) explored how traditional Indian medicine integrated with modern methods for chronic diseases, with herbal treatments scientifically evaluated and collaborative healthcare models proposed, emphasizing evidence-based validation and cultural preservation.

Singh (2024) showed that herbal nutraceuticals show promise in managing lifestyle diseases in India, profiling popular herbs like turmeric and ashwagandha as complementary to modern medicine for lifestyle disease management, though calling for further research on efficacy and safety. Zarenezhad et al. (2024) used in silico studies to identify herbal bioactives with anti-CVD potential, characterizing bioactive compounds like quercetin and naringenin, with computational screening supporting herbal drug development through mechanisms including inflammation inhibition and oxidative stress reduction.

Singhai et al. (2024) demonstrated that natural products exhibit antioxidative and anti-ischemic cardiovascular effects, reviewing multiple medicinal plants and phytochemicals as alternatives or adjuncts to conventional drugs through platelet aggregation inhibition and lipid modulation mechanisms. Sreedevi & Mavilavalappil (2024) showed that natural resources provide antioxidant and anti-inflammatory cardiovascular benefits, profiling bioactive agents like hawthorn, garlic, and turmeric, with dietary and herbal interventions supporting cardiovascular therapy through vasodilation and lipid modulation pathways.

Kaur & Kumar (2024) identified flavonoids, polyphenols, and terpenoids from medicinal plants that reduce cardiovascular risks, proposing herbal drugs for integration into CVD management with mechanistic insights into lipid lowering and oxidative stress control. Grewal et al. (2023) profiled catechin, quercetin, and isoflavones from plant secondary metabolites offering antioxidant and cardioprotective effects, positioning herbal phytochemicals as alternatives to toxic drugs through anti-inflammatory, vasorelaxant, and antihypertensive actions.

Bankar et al. (2023) showed medicinal plants' cardioprotective potential with specific

phytomolecules including taxifolin, quercetin, and arjunolic acid as key compounds, providing safer alternatives to allopathic drugs through multiple modes of action including antioxidant and anti-inflammatory effects. Kshirsagara et al. (2023) analyzed hawthorn, garlic, ginkgo, and turmeric, showing herbal compounds modulate cardiovascular activities via multiple mechanisms supporting integrative cardiovascular care through vasodilation, lipid metabolism, and anti-inflammatory effects.

Pawar et al. (2024) studied garlic, hawthorn, and ginger phytochemicals exhibiting anti-inflammatory and lipid-lowering effects in CVD, emphasizing integration of traditional knowledge with pharmacology while highlighting the need for rigorous clinical validation. Skowronek et al. (2024) characterized Apiaceae and Rosaceae plants showing hypotensive and anti-hyperlipidemic effects, with traditional uses supported by experimental evidence through mechanisms including vasorelaxation and antithrombotic effects.

Witkowska et al. (2024) analyzed six herbs including garlic and hawthorn showing therapeutic cardiovascular potential, with leaves, fruits, and seeds analyzed for bioactive compounds. Their research confirmed antioxidant and anti-inflammatory properties, positioning herbal therapy as complementary to lifestyle and pharmacological treatments. Ritu et al. (2024) showed that Indian dietary herbs mitigate diabetic cardiomyopathy via molecular pathways, with herbs modulating oxidative stress and inflammation as adjunct therapy potential for diabetic cardiovascular complications through targeted molecular signaling pathways.

Pandey & Singh (2022) demonstrated that Spirulina and herbal combinations improve metabolic alterations in CVD, reviewing ethnopharmacological properties of herbs supporting cardiovascular metabolic health through antioxidant and anti-inflammatory effects. Sud & Sud (2024) described how Ayurveda offers lifestyle and herbal management for diabetes-associated CVD, with lifestyle modification central to therapy and herbal interventions like Ashwagandha and Arjuna providing an integrated approach that reduces cardiovascular risk in diabetics through holistic lifestyle and herbal synergy.

Lal et al. (2024) showed that Ayurvedic drugs and yoga practices are effective in managing heart diseases, with lifestyle and spiritual practices improving cardiovascular risk factors. Herbs like Arjuna and Tagara were identified as complementing modern cardiovascular care through preventive and therapeutic effects on hypertension and anxiety. Finally, Sharma et al. (2023) described Ayurvedic protocols for hypertension including lifestyle and herbal remedies, with high emphasis on diet, exercise, and stress management using herbs such as Ashwagandha and Brahmi, showing personalized treatment integrating lifestyle and herbal therapy through Panchakarma and doshic balance to restore cardiovascular health.

Therapeutic Efficacy:

Over 30 studies demonstrated significant reductions in blood pressure, lipid profiles, and other cardiovascular risk markers following Siddha and herbal treatments, with some formulations showing comparable effects to allopathic drugs (Chitra, 2024; M. et al., 2022; Sudha, 2024). Several clinical and preclinical studies reported improvements in hypertension, hyperlipidemia, and atherosclerosis through herbal interventions, often enhanced by concurrent lifestyle modifications ("Herbal Remedies for Lifestyle Diseases...", 2022; Babu et al., 2014; Fields et al., 2002). Some studies highlighted the need for larger controlled trials to confirm efficacy and long-term safety of herbal therapies in cardiovascular disease management.

Lifestyle Intervention Adherence:

Approximately 10 studies emphasized high patient adherence to Siddha-recommended lifestyle modifications, including diet, exercise, stress reduction, and mindful practices, which contributed to improved cardiovascular outcomes (Chockalingam et al., 2022; Yue et al., 2024). Integration of lifestyle changes with herbal treatments was reported to enhance therapeutic success, though adherence rates were variably documented across studies. A few studies noted challenges in measuring adherence rigorously, indicating a gap in standardized assessment of lifestyle compliance.

Phytochemical Profiling:

More than 20 studies identified and quantified active phytochemicals such as flavonoids, polyphenols, alkaloids, and terpenoids in Siddha and herbal formulations linked to cardioprotective effects (Witkowska et al., 2024; "Standardization and Physico-chemical ana...", 2022; Zarenezhad et al., 2024). Advanced analytical techniques including LC-MS, molecular docking, and densitometry were employed to characterize bioactive compounds and predict their molecular targets (Rayadurgam et al., 2023; Zarenezhad et al., 2024). Some reviews called for further phytochemical standardization to ensure quality and reproducibility of herbal medicines.

Integration Outcomes:

Around 15 studies reported that combining Siddha or traditional herbal medicine with modern dietary and lifestyle approaches yielded superior cardiovascular endpoints compared to conventional care alone (Cheng et al., 2024; Yue et al., 2024; Rajalakshmi et al., 2020). Multimodal interventions incorporating herbal supplements, lifestyle modifications, and stress reduction demonstrated reductions in atherosclerosis and improved quality of life (Fields et al., 2002; Saxena et al., 2024). Integration efforts face challenges including standardization, practitioner collaboration, and evidence-based validation but show promising potential for holistic cardiovascular care.

Mechanistic Insights:

Numerous studies elucidated molecular mechanisms by which Siddha herbs and lifestyle changes exert cardiovascular benefits, including anti-inflammatory, antioxidant, vasodilatory, and lipid metabolism modulation pathways (Sharifi-Rad et al., 2020; Babu et al., 2014; Grewal et al., 2023). Molecular docking and in silico analyses revealed specific interactions of phytoconstituents with targets such as ACE, eNOS, and inflammatory cytokines (Chitra, 2024; Zarenezhad et al., 2024). Psychological and stress-related mechanisms were also recognized, particularly in mindfulness and meditation-based Siddha interventions (Chockalingam et al., 2022).

Critical Analysis and Synthesis

The reviewed literature collectively underscores the promising role of Siddha medicine, herbal interventions, and lifestyle modifications in managing cardiovascular diseases (CVD). Strengths include the integration of traditional knowledge with modern scientific approaches, identification of bioactive phytochemicals, and exploration of molecular mechanisms underlying therapeutic effects. However, limitations persist in the form of insufficient large-scale clinical trials, lack of standardization of herbal formulations, and variability in methodological rigor. The synthesis reveals a need for more robust, evidence-based validation and harmonization of traditional practices with contemporary cardiovascular guidelines to

optimize patient outcomes.

In examining the efficacy of Siddha and herbal formulations, several studies demonstrate significant antihypertensive and lipid-lowering effects of Siddha polyherbal formulations such as Kurudhiazhal choornam and Veppampoo Mathirai, supported by molecular docking and pharmacological evidence indicating ACE inhibition and anti-inflammatory actions (Chitra, 2024; M. et al., 2022; Babu et al., 2014). Herbal remedies like garlic, hawthorn, and turmeric have also shown potential in reducing blood pressure and cholesterol levels, aligning with traditional uses ("Herbal Remedies for Lifestyle Diseases:...", 2022; Witkowska et al., 2024). However, despite promising preclinical and small-scale clinical findings, many Siddha formulations lack rigorous randomized controlled trials (RCTs) to confirm efficacy and safety. Standardization issues and variability in phytochemical content limit reproducibility and clinical translation ("Standardization and Physico-chemical ana...", 2022; Kunte & Hingane, 2024). The majority of evidence remains preliminary or based on in vitro/in silico studies, necessitating further validation (Zarenezhad et al., 2024).

Regarding the integration of lifestyle modifications with traditional medicine, the literature highlights the holistic approach of Siddha medicine incorporating lifestyle changes such as mindful eating, stress reduction, and physical activity, which complement herbal therapies and align with modern cardiovascular prevention strategies (DiCaro et al., 2025; Chockalingam et al., 2022; Elangovan et al., 2023). Integrated care models combining traditional and Western medicine show improved blood pressure control and quality of life in elderly hypertensive patients (Yue et al., 2024). Nevertheless, there is a paucity of standardized protocols detailing how lifestyle modifications are systematically integrated with Siddha treatments. Many reports are descriptive or case series lacking control groups, limiting generalizability (Chockalingam et al., 2022). Additionally, the cultural specificity of Siddha lifestyle recommendations may pose challenges for broader applicability without adaptation (Elangovan et al., 2023).

The extensive identification of bioactive compounds such as quercetin, naringenin, and catechin elucidates mechanisms including antioxidant, anti-inflammatory, vasodilatory, and lipid-modulating effects, providing a scientific basis for cardioprotective properties of Siddha herbs (Zarenezhad et al., 2024; Grewal et al., 2023; Kshirsagara et al., 2023). Molecular docking and cell-based assays further support these mechanistic insights (Chitra, 2024; Rayadurgam et al., 2023). However, many mechanistic studies rely heavily on computational or in vitro models, which may not fully replicate in vivo complexities. Pharmacokinetic and pharmacodynamic profiles of these phytochemicals remain underexplored, limiting understanding of bioavailability and therapeutic dosing (Zarenezhad et al., 2024). The synergistic effects within polyherbal formulations are also insufficiently characterized (Rayadurgam et al., 2023).

When comparing Siddha dietary and lifestyle recommendations with contemporary guidelines, Siddha emphasizes personalized dietary regimens based on body constitution (Thegi), promoting equilibrium of doshas through specific food choices, which resonates with modern emphasis on individualized nutrition and lifestyle for CVD prevention (Elangovan et al., 2023; Sharma et al., 2023). The use of natural antioxidants and anti-inflammatory herbs parallels current recommendations for plant-based diets and bioactive compounds (Sharifi-Rad et al., 2020; Sreedevi & Mavilavalappil, 2024). However, Siddha dietary principles are often qualitative and lack quantifiable parameters, making direct comparison with evidence-based

guidelines challenging. Scientific validation of these personalized recommendations is limited, and integration into mainstream dietary counseling requires further research (Elangovan et al., 2023; Sharma et al., 2023). Moreover, potential herb-drug interactions are not comprehensively addressed (Mohiuddin, 2019).

The body of research includes diverse methodologies ranging from molecular docking, in vitro assays, animal models, to clinical observational studies, providing a multi-tiered evidence base (Chitra, 2024; Rajalakshmi et al., 2020; Fields et al., 2002). Some meta-analyses and systematic reviews support integrative approaches combining traditional and modern medicine (Yue et al., 2024; Rajalakshmi et al., 2020). However, many studies suffer from small sample sizes, lack of control groups, and short durations, reducing the strength of evidence. There is a notable scarcity of high-quality RCTs and standardized outcome measures. Additionally, heterogeneity in formulations and intervention protocols complicates meta-analytical synthesis (M. et al., 2022; Sudha, 2024; Rajalakshmi et al., 2020). Publication bias and limited reporting on adverse effects further constrain conclusions (Saxena et al., 2024).

The literature recognizes the potential of integrative medicine models to enhance cardiovascular care by combining Siddha and herbal therapies with lifestyle interventions and conventional treatments (Rajalakshmi et al., 2020; Kalra et al., 2024; Saxena et al., 2024). Policy initiatives and co-location models in India exemplify practical steps toward integration (Rajalakshmi et al., 2020). Challenges include limited awareness among modern practitioners, lack of standardized treatment protocols, regulatory hurdles, and insufficient interdisciplinary collaboration. The need for rigorous scientific validation and education to overcome skepticism and ensure safety is emphasized (Saxena et al., 2024; Kalra et al., 2024). Furthermore, the cultural and systemic barriers to widespread adoption remain underexplored.

Siddha's focus on mindfulness, positive psychology (Uvagai), and psychobehavioral interventions offers a unique dimension to cardiovascular health, potentially improving resilience and emotional well-being alongside physical outcomes (Chockalingam et al., 2022; DiCaro et al., 2025). This aligns with emerging evidence on the role of stress reduction and psychosocial factors in CVD management (DiCaro et al., 2025). However, empirical evidence supporting these psychobehavioral approaches is limited to descriptive case series with potential placebo effects and lacks rigorous clinical evaluation. The mechanisms by which these interventions translate into measurable cardiovascular benefits require further elucidation (Chockalingam et al., 2022).

Thematic Review of Literature

The literature on cardiovascular disease (CVD) management through Siddha medicine, herbal interventions, and lifestyle modifications reveals a multifaceted approach combining traditional botanical knowledge with modern preventive strategies. Major themes include the efficacy of Siddha and herbal formulations in managing hypertension and hyperlipidemia, the role of lifestyle and dietary practices within Siddha and integrative medicine frameworks, and the biochemical mechanisms underlying their cardioprotective effects. Emerging research also highlights integrative models combining traditional and modern medicine, emphasizing holistic care, while gaps remain in standardization and clinical validation. This synthesis elucidates how lifestyle modification synergizes with herbal therapies to enhance cardiovascular outcomes, calling for further rigorous interdisciplinary research.

The theme of efficacy of Siddha and herbal formulations in cardiovascular disease management

appears in 29 out of 50 papers. Siddha medicine and herbal remedies have demonstrated significant potential in controlling hypertension, hyperlipidemia, and other CVD risk factors through various polyherbal formulations like Kurudhiazhal Choornam and Veppampoo Mathirai. Studies report these botanical preparations exert blood pressure-lowering and lipid-modulating effects with minimal side effects, supported by clinical, preclinical, and molecular docking evidence highlighting active phytoconstituents targeting ACE inhibition and inflammatory pathways (Chitra, 2024; M. et al., 2022; K et al., 2014; Kunte & Hingane, 2024; Rajalakshmi et al., 2016; Kaur & Kumar, 2024).

Lifestyle modification and dietary practices in Siddha and integrative medicine appears in 27 out of 50 papers. Lifestyle interventions, including mindful eating, physical activity, stress reduction, and adherence to Siddha dietary regimens tailored to body constitution (Thegi), are central to cardiovascular prevention and management. Integrative approaches combining traditional lifestyle guidance with modern exercise and dietary recommendations show promise in improving cardiovascular outcomes and patient well-being (DiCaro et al., 2025; Chockalingam et al., 2022; Yue et al., 2024; Elangovan et al., 2023; Saxena et al., 2024; Kalra et al., 2024; Sharma et al., 2023).

The molecular and physiological mechanisms of herbal cardioprotective effects theme appears in 22 out of 50 papers. Research elucidates that cardioprotective herbal compounds exert effects via antioxidant, anti-inflammatory, vasodilatory, lipid-lowering, and endothelial function-enhancing mechanisms. Phytochemicals like quercetin, naringenin, and bioactive secondary metabolites modulate signaling pathways, reduce oxidative stress, and inhibit atherosclerosis progression, offering mechanistic insights validated by in silico, in vitro, and in vivo studies (Sharifi-Rad et al., 2020; Zarenezhad et al., 2024; Grewal et al., 2023; Kshirsagara et al., 2023; Pawar et al., 2024).

Integration of Siddha medicine with modern healthcare for cardiovascular care appears in 18 out of 50 papers. There is growing advocacy for integrating Siddha and other traditional systems with biomedicine to provide comprehensive cardiovascular care. This includes co-location models, standardization of formulations, combined therapeutic strategies, and collaborative research to enhance accessibility, optimize treatment efficacy, and address the burden of non-communicable diseases effectively (Rajalakshmi et al., 2020; RAJALAKSHMI et al., n.d.; Saxena et al., 2024; Kalra et al., 2024).

Herbal nutraceuticals and functional foods in managing lifestyle diseases including CVD appears in 14 out of 50 papers. The use of herbal-based nutraceuticals and functional foods such as garlic, turmeric, green tea, and flaxseed is recognized for their role in managing metabolic and cardiovascular disorders. These natural products offer cost-effective, culturally acceptable options that complement pharmacological treatments and support preventive health by modulating risk factors like obesity, diabetes, and dyslipidemia ("Herbal Remedies for Lifestyle Diseases:...", 2022; Cicero et al., 2017; "Nutraceuticals: The Potential Agents to...", 2022; Singh, 2024).

Siddha polyherbal formulations and standardization efforts appears in 12 out of 50 papers. Several classical Siddha polyherbal formulations are traditionally used for CVD management, with contemporary efforts focusing on their physicochemical standardization, phytochemical profiling, and safety evaluation to ensure quality and reproducibility for clinical use ("Standardization and Physico-chemical ana...", 2022; Velmurugan et al., 2014; Rayadurgam

et al., 2023; Rajalakshmi et al., 2020).

The role of specific medicinal plants in cardiovascular health appears in 11 out of 50 papers. Specific medicinal plants such as garlic, hawthorn, white mulberry, and motherwort have been systematically evaluated for their cardiovascular benefits, including antihypertensive, lipid-lowering, and anti-thrombotic effects, supported by both traditional knowledge and experimental studies (Witkowska et al., 2024; Sreedevi & Mavilavalappil, 2024; Witkowska et al., 2024).

Mindfulness and psychobehavioral interventions in Siddha for cardiovascular disease appears in 8 out of 50 papers. Mindfulness-based Siddha practices like self-inquiry meditation and Hunger Gratitude Experience (HUGE) have been reported to enhance psychological well-being, resilience, and possibly improve cardiovascular health outcomes by addressing stress and promoting positive lifestyle changes (DiCaro et al., 2025; Chockalingam et al., 2022; Fields et al., 2002).

Ayurvedic perspectives on cardiovascular diseases and lifestyle interventions appears in 7 out of 50 papers. Ayurvedic principles emphasize holistic management of CVD through lifestyle regulation, diet, herbal remedies, and detoxification therapies, paralleling Siddha approaches and underscoring the importance of balancing bodily doshas in cardiovascular health (Bhukan et al., 2024; Nayak et al., 2023; Borah & Ojha, n.d.; Sud & Sud, 2024; Lal et al., 2024; Sharma et al., 2023).

Challenges and future directions in Siddha and herbal cardiovascular research appears in 6 out of 50 papers. Challenges include the need for rigorous clinical trials, standardization, safety assessments, and integration with modern medicine. Future research priorities focus on validating efficacy, elucidating molecular mechanisms, and developing integrative care models tailored for diverse populations (Sudha, 2024; Rajalakshmi et al., 2020; Saxena et al., 2024; Kalra et al., 2024; Kaur & Kumar, 2024).

Chronological Review of Literature

The research on cardiovascular disease integrating Siddha medicine, herbal medicine, and lifestyle modification has evolved significantly over the past two decades. Early studies focused on multimodal traditional approaches combining diet, exercise, herbal supplements, and stress reduction to address cardiovascular risk factors. More recent works emphasize the molecular mechanisms and pharmacological validation of specific Siddha and herbal formulations, alongside modern integrative strategies that blend traditional systems with contemporary medical practice. Advances have also highlighted the importance of lifestyle interventions, phytochemical characterization, and the role of nutraceuticals in cardiovascular prevention and management.

From 2002 to 2010, early multimodality traditional interventions explored the effects of combined traditional medicine approaches including dietary changes, exercise, herbal supplements, and stress reduction on cardiovascular health. Studies demonstrated potential atherosclerosis attenuation and emphasized the role of holistic nonpharmacological strategies in older populations.

Between 2013 and 2016, focus shifted to Siddha-specific herbal formulations targeting hypertension, hyperlipidemia, and cardiac conditions. Reviews highlighted key Siddha herbs with cardioprotective properties and documented traditional uses alongside emerging scientific validation. Efforts also included standardization and phytochemical analyses of classical

Siddha formulations.

From 2017 to 2019, research expanded on bioactive plant compounds, natural products, and the impact of lifestyle factors on cardiovascular disease prevention. Emphasis was placed on dietary phytochemicals, antioxidants, and the therapeutic potential of commonly used herbs and spices in Indian traditional medicine. Integration of traditional practices with modern lifestyle guidelines gained attention.

Between 2020 and 2022, studies increasingly synthesized herbal medicine, Siddha principles, and lifestyle modification for managing cardiovascular and related lifestyle diseases. This period saw meta-analyses, clinical evaluations of herbal efficacy, and detailed investigations into traditional dietary and behavioral recommendations. The role of mindfulness, self-inquiry, and multimodal natural medicine programs were explored for chronic cardiac conditions.

From 2023 to 2025, recent research centers on molecular docking studies, in silico screening of herbal bioactives, and clinical trials validating Siddha and herbal formulations for hypertension and hyperlipidemia. Integration of Siddha and other AYUSH systems with modern medical protocols is emphasized to enhance prevention and treatment outcomes. Lifestyle modifications and personalized dietary recommendations based on traditional doctrines are increasingly aligned with contemporary cardiovascular guidelines.

Agreement and Divergence Across Studies

Across the reviewed literature, there is broad consensus on the potential efficacy of Siddha medicine, herbal interventions, and lifestyle modifications in managing cardiovascular diseases. Many studies converge on the importance of phytochemical bioactives from herbs and integration of traditional and modern lifestyle approaches to improve cardiovascular outcomes. However, divergence arises in the extent of clinical validation, standardization of formulations, and mechanistic clarity, with some studies emphasizing preliminary in silico or animal models while others report clinical findings. Differences in research design, populations, and the integration of complementary therapies with conventional care contribute to these variations.

Regarding therapeutic efficacy, studies in agreement show that Siddha and herbal formulations demonstrate efficacy in reducing hypertension, hyperlipidemia, and other CVD markers (Chitra, 2024; M. et al., 2022; Sudha, 2024; K et al., 2014; Kunte & Hingane, 2024). Polyherbal Siddha tablets show antihypertensive effects (M. et al., 2022) and lipid lowering (Sudha, 2024; Kunte & Hingane, 2024). Herbal bioactives offer antioxidant and anti-inflammatory benefits reducing cardiovascular risk (DiCaro et al., 2025; Sharifi-Rad et al., 2020; Singhai et al., 2024). However, some studies highlight limited clinical trial data or emphasize preliminary computational docking or in vitro results without extensive clinical validation (Chitra, 2024; Zarenezhad et al., 2024; Rajalakshmi et al., 2020). The magnitude and consistency of effects vary across studies ("Herbal Remedies for Lifestyle Diseases:", 2022; Kaur & Kumar, 2024). This variability can be explained by differences in study design (clinical vs. in silico/in vitro), sample size, and duration of interventions. Different formulations and dosing regimens also contribute.

For lifestyle intervention adherence, studies agree that lifestyle modifications including diet, physical activity, and stress reduction are key components in Siddha and complementary medicine approaches and generally improve cardiovascular health (DiCaro et al., 2025; Chockalingam et al., 2022; Saxena et al., 2024; Sharma et al., 2023). The integration of Siddha

lifestyle practices with modern guidelines is seen as beneficial (Saxena et al., 2024; Sharma et al., 2023). However, few studies report quantitative adherence data or long-term compliance rates; some suggest challenges in standardizing Siddha lifestyle interventions or in patient engagement (Saxena et al., 2024; Chockalingam et al., 2022). Differences in study focus, cultural contexts, and measurement tools for adherence, as well as heterogeneity in lifestyle prescriptions, lead to divergent observations.

In phytochemical profiling, there is agreement that active phytochemicals such as flavonoids, polyphenols, alkaloids, and saponins identified in Siddha herbs and polyherbal formulations contribute to cardioprotective effects (Chitra, 2024; K et al., 2014; Rayadurgam et al., 2023; Zarenezhad et al., 2024; Grewal et al., 2023). Several studies confirm presence of bioactive molecules with antioxidant, antihypertensive, and lipid-lowering properties (Bankar et al., 2023; Kshirsagara et al., 2023). Yet some Siddha formulations lack full standardization and detailed phytochemical quantification, leading to variability in reported results and uncertainties regarding active constituents ("Standardization and Physico-chemical ana...", 2022; Velmurugan et al., 2014). Differences in analytic methods, formulation complexity, and proprietary nature of some Siddha medicines affect depth of phytochemical characterization.

For integration outcomes, studies agree that combining use of Siddha/traditional medicine with modern lifestyle and dietary approaches improves cardiovascular parameters better than conventional care alone (Cheng et al., 2024; Yue et al., 2024; Rajalakshmi et al., 2020; Saxena et al., 2024; Kalra et al., 2024). Integrated care shows enhanced blood pressure control, quality of life, and patient satisfaction (Yue et al., 2024). Despite promising integration models, evidence on long-term clinical outcomes and standard protocols remains limited; some studies caution about lack of large-scale, high-quality RCTs validating integrative strategies (Rajalakshmi et al., 2020; Kalra et al., 2024). Variability in integration models, heterogeneity in patient populations, and the nascent stage of research on combined approaches lead to inconsistent evidence.

Regarding mechanistic insights, studies agree that herbal and Siddha medicines act via antioxidant, anti-inflammatory, vasodilatory, lipid metabolism modulation, and ACE inhibition mechanisms (Chitra, 2024; M. et al., 2022; Zarenezhad et al., 2024; Grewal et al., 2023; Kshirsagara et al., 2023). Molecular docking and in vivo studies demonstrate interactions with targets like ACE and pathways regulating endothelial function (Chitra, 2024; Babu et al., 2014). Lifestyle changes reduce stress and inflammatory markers (DiCaro et al., 2025; Chockalingam et al., 2022). However, some mechanistic studies are preliminary or computational only, lacking in vivo or clinical confirmation; the complexity of multi-ingredient formulations complicates clear mechanistic elucidation (Rayadurgam et al., 2023; Zarenezhad et al., 2024; Rajalakshmi et al., 2020). Differences in research focus (computational vs. experimental), complexity of formulations, and limited clinical biomarker studies contribute to partial mechanistic understanding.

Theoretical and Practical Implications

Theoretical Implications

The synthesis of evidence underscores the multifaceted mechanisms by which Siddha medicine and herbal formulations exert cardioprotective effects, including antioxidant, anti-inflammatory, lipid-lowering, and vasodilatory actions. These findings align with and extend existing theories on the pathophysiology of cardiovascular diseases (CVDs), emphasizing the

modulation of oxidative stress, inflammation, and endothelial function as critical therapeutic targets (Grewal et al., 2023; Kshirsagara et al., 2023; Zarenezhad et al., 2024).

The integration of lifestyle modifications with traditional Siddha and herbal interventions supports holistic models of cardiovascular health that incorporate behavioral, dietary, and psychosocial factors. This integrative perspective challenges reductionist biomedical models by highlighting the synergistic effects of combined therapies on cardiovascular risk reduction (DiCaro et al., 2025; Saxena et al., 2024; Kalra et al., 2024).

Molecular docking and silico studies provide mechanistic insights into the bioactive phytoconstituents of Siddha formulations, such as their inhibitory action on angiotensin-converting enzyme (ACE) and modulation of nitric oxide pathways. These findings contribute to a growing theoretical framework that bridges traditional knowledge with molecular pharmacology (Chitra, 2024; Babu et al., 2014; Zarenezhad et al., 2024).

The concept of body constitution (Thegi) in Siddha medicine, with its tailored dietary and lifestyle recommendations, offers a personalized medicine approach that resonates with contemporary precision medicine paradigms. This theoretical alignment suggests potential for individualized cardiovascular prevention strategies based on constitutional typologies (Elangovan et al., 2023).

The evidence from integrative care models combining traditional and modern medicine highlights the theoretical importance of pluralistic healthcare systems that respect cultural contexts while applying scientific validation, thereby enriching cardiovascular disease management frameworks (Yue et al., 2024; Rajalakshmi et al., 2020; Kalra et al., 2024).

Practical Implications

The demonstrated efficacy of Siddha polyherbal formulations and herbal remedies in managing hypertension, hyperlipidemia, and atherosclerosis suggests their potential as cost-effective, accessible adjuncts or alternatives to conventional pharmacotherapy, particularly in resource-limited settings (M. et al., 2022; "Standardization and Physico-chemical ana...", 2022; Velmurugan et al., 2014).

Lifestyle modification strategies rooted in Siddha medicine, including mindful eating, stress reduction, and physical activity, can be incorporated into public health policies to enhance cardiovascular disease prevention programs, addressing both physiological and psychosocial determinants of health (DiCaro et al., 2025; Chockalingam et al., 2022; Saxena et al., 2024).

The standardization and quality control of Siddha herbal formulations, as evidenced by physicochemical and phytochemical analyses, are critical for ensuring safety, efficacy, and regulatory compliance, thereby facilitating their integration into mainstream healthcare and pharmaceutical industries ("Standardization and Physico-chemical ana...", 2022; Rayadurgam et al., 2023).

The integration of Siddha and herbal medicine with modern cardiovascular care requires interdisciplinary collaboration, practitioner training, and development of evidence-based clinical guidelines to optimize patient outcomes and foster acceptance among healthcare providers (Yue et al., 2024; Saxena et al., 2024; Kalra et al., 2024).

The identification of specific bioactive compounds with defined molecular targets opens avenues for novel drug discovery and nutraceutical development, encouraging industry investment in research and development of plant-based cardiovascular therapeutics (Zarenezhad et al., 2024; Grewal et al., 2023; Sreedevi & Mavilavalappil, 2024).

Public awareness and education initiatives promoting the safe use of herbal medicines alongside lifestyle modifications can mitigate risks related to herb-drug interactions and enhance patient adherence, supporting a more holistic and patient-centered approach to cardiovascular health management (Pandey & Singh, 2022; Kshirsagara et al., 2023; Singh, 2024).

Limitations of Literature

Several limitations constrain the current body of literature on Siddha medicine and cardiovascular disease management. Small sample sizes affect several studies, particularly Sudha (2024) and Chockalingam et al. (2022), which employ small or single-arm sample sizes, limiting the statistical power and generalizability of findings. This constrains external validity and raises concerns about the robustness and reproducibility of reported effects.

Lack of standardization is evident in many Siddha formulations and herbal remedies, which lack standardized preparation and dosage protocols, hampering reproducibility and comparison across studies. This methodological constraint affects the reliability of efficacy claims, as noted in "Standardization and Physico-chemical ana..." (2022) and Velmurugan et al. (2014).

Limited clinical trials represent a significant gap, with a scarcity of rigorous randomized controlled trials evaluating Siddha and herbal interventions, leading to reliance on preclinical or observational data. This limits the strength of evidence for clinical efficacy and safety, as seen in studies by Chitra (2024), M. et al. (2022), Yue et al. (2024), and Sudha (2024).

Geographic and cultural bias affects most research, which is regionally concentrated in South India or specific populations, limiting the applicability of findings to broader or diverse populations, thereby affecting external validity and generalizability. This limitation is evident in Chitra (2024), M. et al. (2022), and Rajalakshmi et al. (2016).

Insufficient mechanistic insights persist, as while some studies explore molecular docking or phytochemical constituents, comprehensive elucidation of mechanisms underlying Siddha and herbal effects on cardiovascular health remains limited, restricting mechanistic understanding. This limitation affects Chitra (2024), Zarenezhad et al. (2024), and Grewal et al. (2023).

Integration challenges are revealed in literature, with lack of standardized protocols, limited interdisciplinary collaboration, and insufficient high-quality evidence impeding holistic healthcare adoption. These challenges are documented in Rajalakshmi et al. (2020), RAJALAKSHMI et al. (n.d.), Saxena et al. (2024), and Kalra et al. (2024).

Potential herb-drug interactions are inadequately addressed in most studies, with few adequately examining safety concerns, including herb-drug interactions and adverse effects, which is critical for clinical translation and patient safety in integrative cardiovascular care, as noted by Mohiuddin (2019) and Pandey & Singh (2022).

Placebo and bias effects affect some descriptive or case series studies, particularly Chockalingam et al. (2022), which acknowledge the potential influence of placebo effects and lack control groups, undermining the internal validity and interpretability of reported benefits.

Gaps and Future Research Directions

Multiple critical gaps exist in current literature that require targeted future research. The lack of large-scale randomized controlled trials (RCTs) for Siddha formulations represents a high-priority gap. Most Siddha herbal formulations show promising antihypertensive and lipid-lowering effects but lack rigorous large-scale RCTs to confirm efficacy and safety. Future research should conduct well-designed, multicenter RCTs with standardized Siddha

formulations to evaluate long-term efficacy, safety, and dosage optimization in cardiovascular disease (CVD) patients. Current evidence is largely preliminary or based on small clinical/preclinical studies, limiting clinical translation and acceptance in mainstream medicine (Chitra, 2024; M. et al., 2022; Sudha, 2024).

Standardization and quality control of Siddha herbal medicines is another high-priority area. Variability in phytochemical content and lack of standardization in Siddha formulations hinder reproducibility and clinical application. Future research should develop and implement standardized protocols for phytochemical profiling, quality control, and batch-to-batch consistency using advanced analytical techniques like LC-MS and densitometry. Ensuring consistent quality and safety is essential for clinical validation and regulatory approval of Siddha herbal medicines ("Standardization and Physico-chemical ana...", 2022; Rayadurgam et al., 2023; Zarenezhad et al., 2024).

Integration protocols for lifestyle modifications with Siddha medicine require urgent attention as a high-priority gap. There is a paucity of standardized, evidence-based protocols detailing how lifestyle modifications are systematically integrated with Siddha treatments for CVD. Future research should design and validate structured intervention protocols combining Siddha lifestyle recommendations with herbal therapies, including adherence monitoring tools and outcome measures. Integration enhances therapeutic success but lacks reproducible, scalable models for clinical practice (Chockalingam et al., 2022; Elangovan et al., 2023).

Limited pharmacokinetic and pharmacodynamic data on Siddha phytochemicals represents a medium-priority gap. The bioavailability, metabolism, and therapeutic dosing of key phytochemicals in Siddha herbs remain underexplored. Future research should conduct in vivo pharmacokinetic and pharmacodynamic studies to elucidate absorption, distribution, metabolism, excretion, and dose-response relationships of active compounds. Understanding these parameters is critical for optimizing efficacy and minimizing toxicity in clinical use (Zarenezhad et al., 2024; Rayadurgam et al., 2023).

Insufficient clinical evidence on psychobehavioral and mindfulness interventions in Siddha is a medium-priority area. Siddha's mindfulness and psychobehavioral approaches show potential benefits but lack rigorous clinical evaluation and mechanistic understanding. Future research should implement controlled clinical trials assessing psychological and cardiovascular outcomes of Siddha-based mindfulness practices, with biomarker and neurophysiological correlates. Empirical support is limited to descriptive case series; mechanistic insights could enhance holistic CVD management (Chockalingam et al., 2022).

Comparative analysis of Siddha dietary guidelines with modern cardiovascular nutrition requires medium-priority attention. Siddha dietary recommendations are qualitative and personalized but lack quantitative validation and direct comparison with evidence-based guidelines. Future research should perform comparative nutritional studies assessing Siddha diet effects on cardiovascular risk markers versus standard dietary guidelines, including potential herb-drug and food-drug interactions. Scientific validation is needed to integrate Siddha dietary principles into mainstream cardiovascular nutrition counseling (Elangovan et al., 2023; Sharma et al., 2023).

Synergistic effects and interactions within polyherbal Siddha formulations represent a medium-priority gap. The complex interactions and synergistic mechanisms among multiple herbs in Siddha polyherbal formulations are poorly characterized. Future research should use systems

pharmacology, metabolomics, and network analysis to dissect multi-component interactions and identify key bioactive combinations responsible for therapeutic effects. Elucidating synergy can optimize formulation design and improve therapeutic outcomes (Rayadurgam et al., 2023; Velmurugan et al., 2014).

Barriers to mainstream integration of Siddha medicine in cardiovascular care is a high-priority challenge. Challenges include limited awareness among modern practitioners, lack of standardized protocols, regulatory issues, and cultural barriers. Future research should develop educational programs for healthcare providers, establish regulatory frameworks, and conduct implementation research to facilitate integrative care models. Overcoming these barriers is essential for wider acceptance and utilization of Siddha in CVD management (Rajalakshmi et al., 2020; Saxena et al., 2024; Kalra et al., 2024).

Limited research on herb-drug interactions in Siddha cardiovascular therapies represents a high-priority safety concern. Potential interactions between Siddha herbs and conventional cardiovascular drugs are inadequately studied. Future research should conduct systematic in vitro and clinical interaction studies to identify and manage herb-drug interactions, ensuring patient safety during integrative treatments. Safety concerns may limit clinical adoption without clear interaction profiles (Mohiuddin, 2019; Pawar et al., 2024).

Underexplored molecular mechanisms of Siddha herbs in cardiovascular disease is a medium-priority gap. While some molecular targets (e.g., ACE, eNOS) are identified, comprehensive mechanistic pathways of Siddha herbs in CVD remain insufficiently elucidated. Future research should employ multi-omics approaches and in vivo models to map signaling pathways, gene expression changes, and molecular targets modulated by Siddha herbal compounds. Detailed mechanistic insights will support evidence-based validation and novel therapeutic development (Chitra, 2024; Babu et al., 2014; Grewal et al., 2023).

Overall Synthesis and Conclusion

The collective body of literature on cardiovascular disease management through Siddha medicine, herbal interventions, and lifestyle modifications strongly indicates a promising integrative approach that combines traditional wisdom with contemporary healthcare practices. Evidence consistently demonstrates that Siddha polyherbal formulations and specific herbal remedies such as garlic, hawthorn, turmeric, and other botanicals exhibit significant antihypertensive, lipid-lowering, antioxidant, anti-inflammatory, and vasodilatory properties. These bioactive effects are frequently supported by phytochemical profiling and mechanistic studies revealing interactions with key molecular targets like ACE receptors, eNOS pathways, and inflammatory cytokines. Moreover, computational and in vitro analyses reinforce the potential of these herbal compounds to modulate cardiovascular risk factors effectively.

Lifestyle modifications, including mindful eating, physical activity, stress reduction, and personalized dietary regimens aligned with individual body constitutions (Thegi), are integral components of Siddha therapy that complement the pharmacological actions of herbal formulations. High adherence to holistic lifestyle practices enhances therapeutic outcomes, reflecting a synergy between behavioral interventions and herbal medicine. The principles of Siddha dietary guidelines resonate with contemporary cardiovascular prevention strategies, emphasizing antioxidant-rich, anti-inflammatory diets and personalized nutrition, although standardization and empirical validation remain areas for further research.

The integration of Siddha medicine with modern cardiovascular care models shows superior

clinical outcomes, including improved blood pressure control, lipid profiles, and reduced atherosclerosis, especially when combined with conventional treatments and lifestyle changes. However, challenges persist in standardizing herbal formulations, conducting rigorous randomized controlled trials, and establishing universally accepted protocols for integrating traditional medicines with allopathic care. Additionally, the psychobehavioral aspects of Siddha, such as meditation and mindfulness practices, offer valuable psychosocial benefits that potentially enhance cardiovascular resilience but require more robust clinical evaluation.

Overall, the literature advocates for a multidisciplinary, evidence-based integration of Siddha herbal therapies and lifestyle modification strategies within modern cardiovascular healthcare frameworks. This approach promises culturally sensitive, cost-effective, and holistic management of cardiovascular diseases, addressing both physiological and psychosocial dimensions. Future research should prioritize large-scale clinical trials, standardized phytochemical characterization, and mechanistic elucidation to consolidate the therapeutic potential and safety of Siddha medicine alongside lifestyle interventions in cardiovascular disease prevention and management.

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