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REVIEW

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Advancing Cardiovascular Health: Unveiling the Role of Traditional and Natural Medicine

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Abstract

In the quest for optimizing cardiovascular health, contemporary research increasingly explores the potential benefits of traditional and natural medicinal modalities. This paper provides insights into the therapeutic avenues offered by traditional medicine systems and natural remedies in cardiovascular care. Incorporating knowledge from ancient healing traditions like Ayurveda and Traditional Chinese Medicine (TCM) alongside contemporary research on the efficacy of natural compounds, the paper aims to elucidate their cardiovascular effects. Specifically, it examines the impact of lifestyle modifications, dietary supplements, and botanical extracts on cardiovascular health. Synthesizing evidence from clinical trials, preclinical studies, and traditional knowledge systems, the paper underscores the importance of integrating traditional and natural medicine practices with conventional medical interventions. This integration is vital for enhancing our understanding and management of cardiovascular diseases, contributing to more effective preventive strategies and optimized therapeutic outcomes in cardiovascular medicine.

1 Introduction

1.1 Overview of cardiovascular diseases

Cardiovascular diseases (CVDs) constitute a significant global health challenge, significantly impacting morbidity and mortality rates worldwide. Encompassing a spectrum of disorders affecting the heart and blood vessels, CVDs include conditions such as coronary artery disease (CAD), hypertension, heart failure, stroke, and peripheral vascular disease (PVD). Despite advancements in medical science and technology, the prevalence of CVDs continues to rise, presenting profound complexities to healthcare systems and societies on a global scale.

1.2 Importance of traditional and natural medicine in cardiovascular health

Traditional and natural medicine plays a pivotal role in cardiovascular health due to its holistic approach, which emphasizes the interconnectedness of the mind, body, and environment in maintaining overall well-being. These systems integrate lifestyle modifications, dietary interventions, physical exercises, and mindfulness practices alongside herbal remedies to promote cardiovascular health [1,2]. Moreover, natural products sourced from plants, animals, and minerals harbor bioactive compounds with pharmacological properties capable of modulating various cardiovascular pathways, including lipid metabolism, oxidative stress, inflammation, and endothelial function [3,4].

1.3 Purpose and scope

This paper investigates the role of traditional and natural medicine in augmenting cardiovascular health by synthesizing existing literature. It aims to unravel mechanisms of action, clinical efficacy, challenges, and future directions in cardiovascular care. Encompassing historical and cultural contexts, clinical evidence, regulatory frameworks, and implications for practice and public health, the paper seeks to deepen understanding of traditional and natural medicine's therapeutic potential in preventing and managing CVDs. By highlighting the synergy between traditional healing practices and contemporary cardiovascular medicine, the paper aims to foster interdisciplinary collaboration, evidence-based integration, and the development of innovative strategies for enhancing cardiovascular well-being.

2 Historical perspective of traditional and natural medicine in cardiovascular care

2.1 Evolution of traditional medicine practices

The evolution of traditional medicine practices spans millennia and has been profoundly influential in cardiovascular care. Ancient healers across diverse cultures observed the effects of herbs, plants, and lifestyle modifications on heart health, leading to the development of sophisticated medical systems in civilizations such as Egypt, Mesopotamia, China, India, and Greece [5]. Notably, Traditional Chinese Medicine (TCM) emphasizes holistic health principles, including yin-yang balance and qi flow [6]. Cardiovascular health in these systems often encompasses broader concepts such as circulation and emotional well-being, addressed through a combination of herbal remedies, acupuncture, massage, dietary adjustments, and movement practices. Cultural exchanges and trade routes facilitated the cross-pollination of diverse healing traditions [7], exemplified by the transmission of medical knowledge along the Silk Road with the spread of Buddhism. Despite advancements in modern medicine, traditional practices persist, particularly in regions with limited access to conventional healthcare, owing to their efficacy, cultural relevance, and community connections.

2.2 Cultural significance of natural remedies for heart health

Throughout history, natural remedies for heart health have held deep cultural significance across various

societies, symbolizing healing, vitality, and spiritual connection. In indigenous cultures worldwide, medicinal plants and herbs are revered for their therapeutic properties, seamlessly integrated into daily rituals and ceremonies. For instance, in traditional Chinese culture, herbs like ginseng (*Panax ginseng* [8]), hawthorn (*Crataegus* spp. [9]), and danshen (*Salvia miltiorrhiza* [10]) are esteemed for their cardiovascular benefits, commonly incorporated into herbal formulas and supplements. Alike, in Ayurveda, India's ancient healing system, herbs such as arjuna (*Terminalia arjuna* [11]), garlic (*Allium sativum* [12]), and turmeric (*Curcuma longa* [13]) have supported heart function and longevity for centuries. Indigenous healing traditions worldwide, including Native American practices [14], rely on plants like hawthorn and passionflower to address cardiovascular ailments and restore bodily equilibrium. Beyond individual health concerns, the use of natural remedies often extends to broader social, environmental, and spiritual dimensions. Traditional healers integrate ceremonial practices, prayers, and offerings to foster healing energies and harmonize human, natural, and divine elements [14]. Thus, natural remedies for heart health intertwine with cultural identity, ecological stewardship, and social welfare.

2.3 Integration of traditional and modern cardiovascular therapies

Recent years have witnessed a growing recognition of the potential synergies between traditional and modern cardiovascular therapies, leading to efforts to integrate these approaches into clinical practice. Integrative medicine, which combines conventional medical treatments with complementary and alternative therapies, presents a promising avenue for bridging the gap between traditional healing practices and modern healthcare [15]. For instance, the concurrent use of herbal medicine alongside standard pharmacotherapy for conditions such as hypertension [16] and hyperlipidemia [17] demonstrates the potential benefits of integration. Research suggests that certain herbal formulations, when combined with conventional medications, can enhance therapeutic outcomes, alleviate side effects, and improve overall quality of life [17]. Moreover, complementary modalities such as acupuncture [18] and mindfulness-based stress reduction [19] are increasingly being incorporated into cardiac rehabilitation programs to enhance patients' physical, emotional, and psychosocial well-being. These integrative approaches recognize the interconnectedness of mind, body, and spirit in maintaining cardiovascular health, striving to address the root causes of disease through holistic and personalized strategies. Beyond clinical integration, initiatives are underway to integrate traditional healing practices into public health campaigns and healthcare policies [20]. Collaborative partnerships among traditional healers, healthcare providers, researchers, and policymakers are crucial for fostering cultural competence, expanding access to traditional medicine services, and ensuring the safety and efficacy of traditional remedies. In essence, the historical perspective of traditional and natural medicine in cardiovascular care underscores the richness of healing traditions and the enduring significance of holistic approaches to health and well-being. By embracing cultural wisdom, scientific exploration, and interdisciplinary collaboration, society can unlock the full potential of traditional and modern therapies to promote cardiovascular health and prevent disease.

The research methodology employed in this study is designed to systematically compare the efficacy and mechanisms of traditional and natural medicine with modern interventions for CVDs. The approach is structured around several key components: literature review, data collection, comparison frameworks, and

analysis techniques. The research began with an extensive review of both primary and secondary sources to gather data on traditional and natural medicines used in the treatment of CVDs. The study focused on well-documented traditional practices, such as those in TCM, Ayurveda, and Indigenous medicine. Primary sources included clinical trials, systematic reviews, and meta-analyses, while secondary sources provided historical and ethnopharmacological context [5,7,17]. The comparison of traditional and natural medicine practices with modern interventions was conducted using a multi-dimensional framework. This framework included pharmacological efficacy, underlying mechanisms, safety profiles, and patient outcomes. For example, traditional medicines like Salvianolic acids and Hawthorn extracts were compared against modern drugs for their impact on cardiovascular function, specifically in terms of mitigating oxidative stress and improving blood circulation [9,10]. Advanced analytical techniques were employed to ensure a rigorous comparison between traditional and modern treatments. This included the use of network pharmacology to map out the interactions between compounds found in traditional medicines and cardiovascular-related molecular targets [4]. Additionally, meta-analytic techniques were applied to synthesize findings from randomized controlled trials, providing a quantitative comparison of treatment outcomes. Through this structured methodology, the study provides a comprehensive and scientifically grounded comparison of traditional and modern approaches to cardiovascular health, offering valuable insights into their potential integration in contemporary medical practice.

3 Mechanisms of action of traditional and natural medicines in cardiovascular health

3.1 Overview of cardiovascular system and common disorders

The cardiovascular system, comprising the heart, blood vessels, and circulating blood, plays a vital role in distributing oxygen, nutrients, and hormones throughout the body while eliminating metabolic waste products. Within the spectrum of cardiovascular disorders, which include CAD, hypertension, heart failure, stroke, and PAD, each presents distinct challenges. CAD, for instance, arises from the accumulation of plaque within coronary arteries, leading to their narrowing or obstruction, subsequently diminishing blood flow to the heart muscle and predisposing individuals to myocardial infarction or angina. Hypertension, characterized by sustained elevation of blood pressure against arterial walls, constitutes a chronic risk factor for cardiovascular complications, including heart disease, stroke, and renal impairment. Heart failure ensues when the heart's pumping capacity declines, resulting in symptoms such as fatigue, dyspnea, and fluid retention. Stroke, precipitated by the disruption of cerebral blood flow, manifests as a spectrum of neurological deficits. PAD, marked by constriction or occlusion of peripheral arteries, frequently manifests as claudication, impaired wound healing, and tissue ischemia. A thorough comprehension of the underlying pathophysiological mechanisms driving these cardiovascular disorders is paramount for identifying potential therapeutic targets and devising efficacious treatment strategies.

3.2 Pharmacological basis of traditional medicine

Traditional medicine systems encompass a diverse array of herbal remedies, dietary adjustments, lifestyle modifications, and mind-body practices aimed at both preventing and treating cardiovascular disorders [1,2]. At the core of traditional medicine lies

a rich pharmacological foundation, forged through intricate interactions between bioactive compounds sourced from medicinal plants and the molecular pathways intricately involved in cardiovascular physiology and pathology (Figure 1). For instance, within TCM, herbs like danshen, ginseng, and hawthorn have garnered attention for their antioxidative, anti-inflammatory, vasodilatory, and cardioprotective properties, attributed to their modulation of key signaling pathways such as the nitric oxide (NO) pathway, the renin-angiotensin-aldosterone system (RAAS), and the adenosine monophosphate-activated protein kinase (AMPK) pathway [1,2]. Correspondingly, within the domain of Ayurveda, herbs like arjuna, garlic, and turmeric have been esteemed for their cardioprotective potential, owing to their antioxidant, antiplatelet, antihypertensive, and lipid-lowering attributes [21]. These botanical agents exert their therapeutic prowess by modulating lipid metabolism, endothelial function, and inflammatory cascades intricately entwined with the genesis and progression of cardiovascular ailments [21]. Moreover, the collective action of diverse bioactive constituents within herbal formulations confers pleiotropic effects on cardiovascular health, targeting a spectrum of pathways and mechanisms implicated in disease pathogenesis. Traditional medicine integrates herbal remedies, dietary adjustments, and lifestyle practices to prevent and treat cardiovascular disorders. Bioactive compounds from medicinal plants interact intricately with cardiovascular molecular pathways. For example, TCM herbs like danshen, ginseng, and hawthorn modulate pathways such as NO, the RAAS, and AMPK. Likewise, Ayurvedic herbs like arjuna, garlic, and turmeric exert cardioprotective effects through antioxidant and anti-inflammatory actions, affecting lipid metabolism and endothelial function. The synergistic action of diverse compounds within herbal formulations targets various disease mechanisms, offering multifaceted benefits to cardiovascular health.

3.3 Molecular mechanisms underlying the cardiovascular benefits of natural products

Natural products sourced from plants, animals, and minerals harbor a myriad of bioactive compounds, each endowed with diverse chemical structures and pharmacological properties capable of modulating cardiovascular function and mitigating disease risk [3,4]. At the crux of their efficacy lies the intricate interplay between these bioactive compounds and specific molecular targets orchestrating key physiological processes (Figure 2). For instance, flavonoids, polyphenols, and alkaloids, prevalent in medicinal plants, exhibit potent antioxidant properties, scavenging free radicals, curbing oxidative stress, and shielding endothelial cells, lipoproteins, and DNA from oxidative damage [22]. By stifling the production of reactive oxygen species (ROS) and augmenting endogenous antioxidant defenses, natural products fortify vascular function, dampen inflammation, and impede the progression of atherosclerosis [23]. Furthermore, bioactive compounds like omega-3 fatty acids, omega-6 fatty acids, and phytosterols exert lipid-lowering effects by modulating lipid metabolism, hampering cholesterol absorption, and fostering the clearance of circulating lipids [24]. Through the regulation of genes integral to cholesterol synthesis, transport, and metabolism, these compounds orchestrate reductions in low density lipoprotein (LDL) cholesterol levels, triglycerides, and inflammatory mediators implicated in atherosclerosis development [25]. Additionally, natural products such as resveratrol, curcumin, and quercetin showcase remarkable anti-inflammatory prowess by stifling proinflammatory cytokines, adhesion molecules, and inflammatory enzymes pivotal in cardiovascular disease pathogenesis [26]. These compounds wield influence over immune cell activation, cytokine

production, and endothelial cell dysfunction, resulting in mitigated vascular inflammation, stabilized plaques, and curtailed thrombosis formation. In essence, the mechanisms underpinning the cardiovascular benefits of natural and traditional medicines entail multifaceted interactions between bioactive compounds and molecular targets intricately implicated in cardiovascular physiology and pathology (Figure 3). By strategically targeting oxidative stress, inflammation, lipid metabolism, and endothelial function, natural and traditional medicines proffer promising avenues for both the prevention and management of cardiovascular diseases. Meanwhile, natural products harbor a plethora of bioactive compounds with profound cardiovascular effects. Within medicinal plants, flavonoids, polyphenols, and alkaloids act as antioxidants, effectively scavenging free radicals, alleviating oxidative stress, and shielding endothelial cells. Also, omega-3 fatty acids, omega-6 fatty acids, and phytosterols regulate lipid levels by modulating metabolism and cholesterol absorption. Moreover, compounds like resveratrol, curcumin, and quercetin demonstrate potent anti-inflammatory properties, suppressing cytokines and enzymes implicated in cardiovascular disease progression. These compounds play pivotal roles in mitigating vascular inflammation, stabilizing plaques, and curtailing thrombosis formation. Natural and traditional medicines exert cardiovascular benefits by targeting oxidative stress, inflammation, lipid metabolism, and endothelial function, offering promising avenues for disease prevention and management.

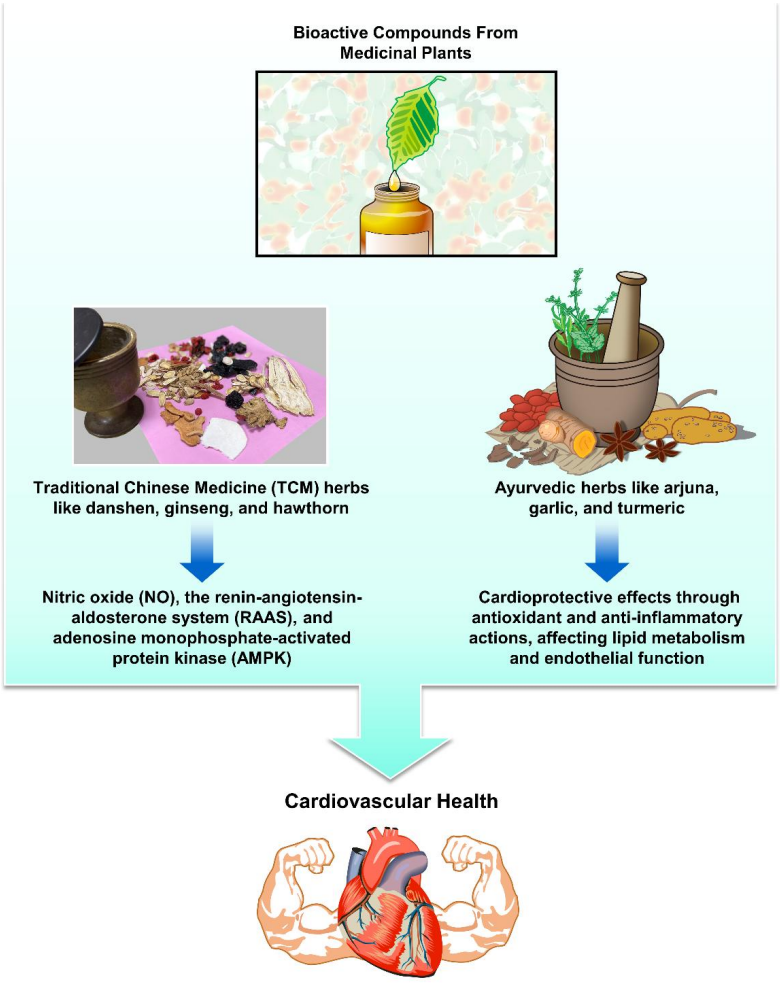

Figure 1 Illustration depicting the bioactive compounds sourced from medicinal plants and their engagement with the molecular pathways intricately involved in cardiovascular physiology and pathology.

(Note: Traditional medicine integrates herbal remedies, dietary adjustments, and lifestyle practices to prevent and treat cardiovascular disorders. Bioactive compounds from medicinal plants interact intricately with cardiovascular molecular pathways. For example, Traditional Chinese Medicine (TCM) herbs like danshen, ginseng, and hawthorn modulate pathways such as nitric oxide (NO), the renin-angiotensin-aldosterone system (RAAS), and adenosine monophosphate-activated protein kinase (AMPK). Similarly, Ayurvedic herbs like arjuna, garlic, and turmeric exert cardioprotective effects through antioxidant and anti-inflammatory actions, affecting lipid metabolism and endothelial function. The synergistic action of diverse compounds within herbal formulations targets various disease mechanisms, offering multifaceted benefits to cardiovascular health.)

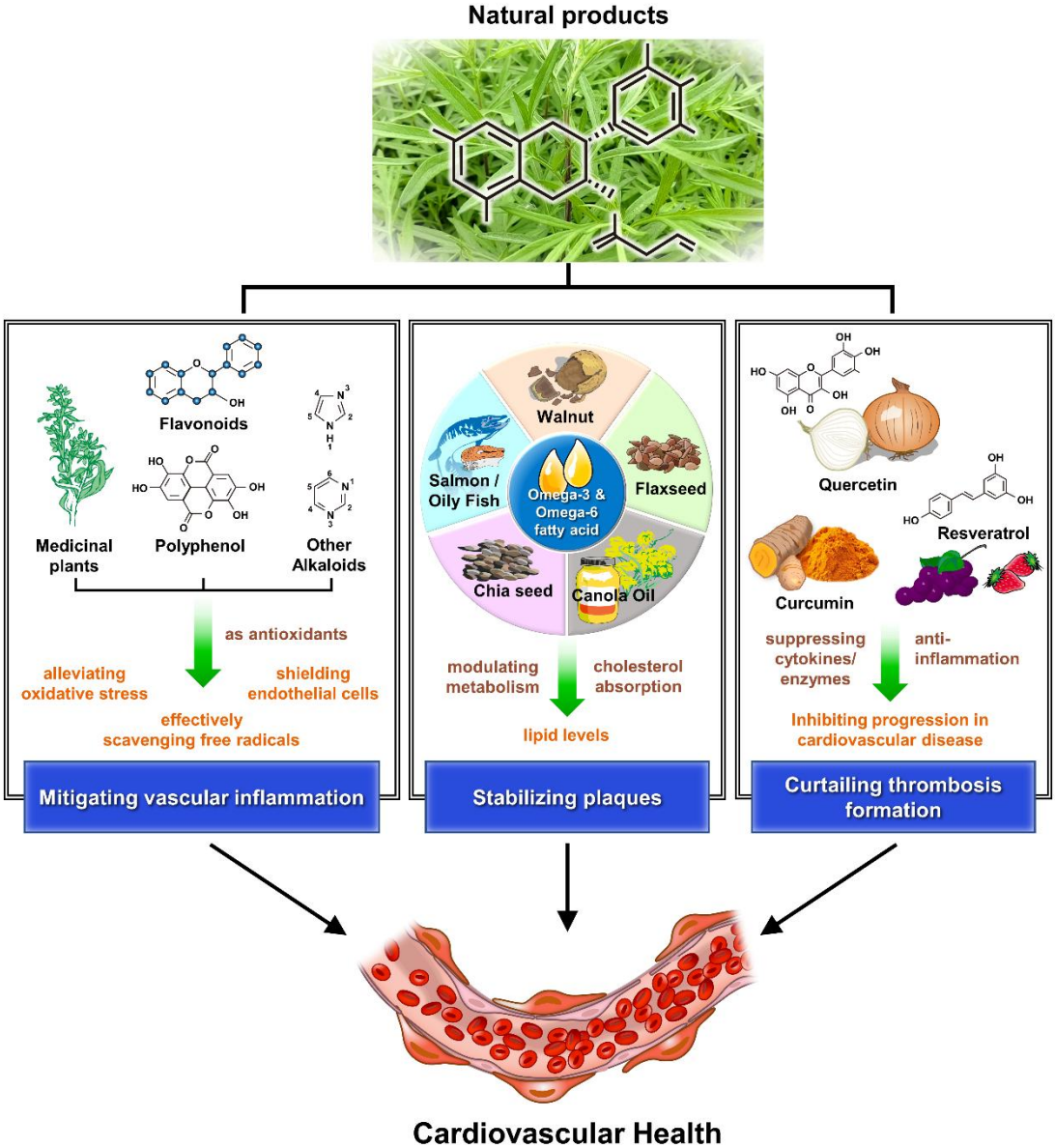

Figure 2 Molecular mechanisms underlying the cardiovascular benefits of natural products.

(Note: Natural products sourced from plants, animals, and minerals harbor a plethora of bioactive compounds with profound cardiovascular effects. Within medicinal plants, flavonoids, polyphenols, and alkaloids act as antioxidants, effectively scavenging free radicals, alleviating oxidative stress, and shielding endothelial cells. Likewise, omega-3 fatty acids, omega-6 fatty acids, and phytosterols regulate lipid levels by modulating metabolism and cholesterol absorption. Moreover, compounds like resveratrol, curcumin, and quercetin

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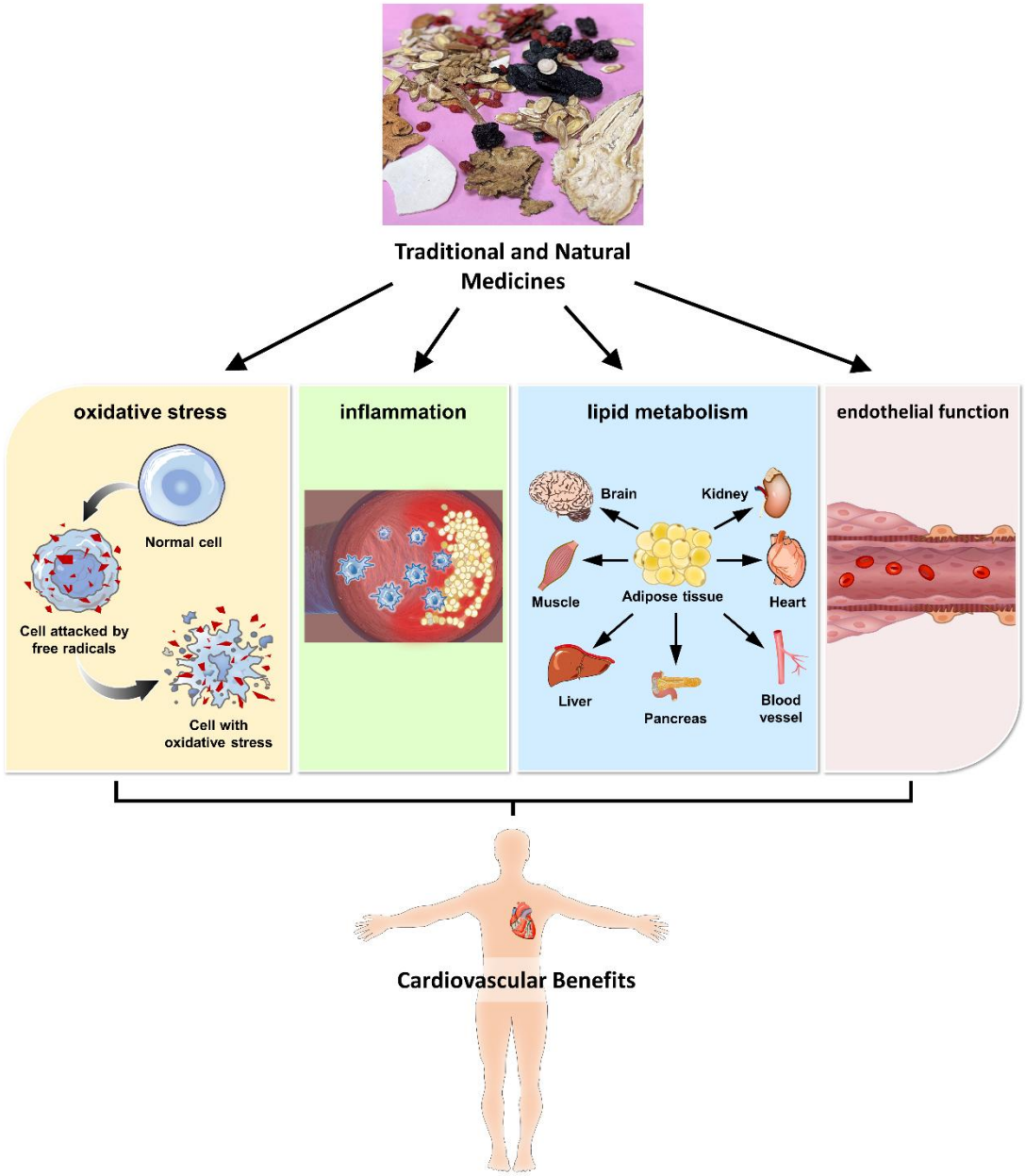

Figure 3 Mechanisms of action of traditional and natural medicines in cardiovascular health. (Note: Natural and traditional medicines exert cardiovascular benefits by targeting oxidative stress, inflammation, lipid metabolism, and endothelial function, offering promising avenues for disease prevention and management.)

4 Efficacy and clinical evidence of traditional and natural medicine

4.1 Clinical trials and studies assessing traditional therapies

Clinical trials investigating the efficacy of traditional therapies in the realm of CVDs serve as pivotal avenues for elucidating their therapeutic potential, safety profiles, and underlying mechanisms. Despite their historical usage, traditional medicine systems such as TCM and Ayurveda necessitate rigorous scientific scrutiny to validate their efficacy and facilitate their integration into conventional healthcare paradigms. These trials, spanning interventions

ranging from herbal medicine [27], and acupuncture [28] to mind-body practices [29], have unveiled promising outcomes, showcasing notable enhancements in angina symptoms, exercise tolerance, and reductions in blood pressure compared to standard therapies. These findings underscore the viability of traditional therapies as supplementary or alternative modalities in cardiovascular care. However, further exploration is imperative to delineate optimal dosage regimens, treatment durations, administration modalities, and the long-term impact on cardiovascular endpoints.

4.2 Evidence-based interventions in traditional medicine for cardiovascular diseases

Evidence-based interventions in traditional medicine for CVDs encompass a wide range of approaches, including herbal medicine, dietary interventions, lifestyle adjustments, and mind-body practices. These interventions are increasingly supported by robust scientific validation from clinical trials [30], observational studies, and systematic reviews [31]. Herbal remedies, integral to healing traditions such as TCM and Ayurveda, have demonstrated efficacy in improving cardiovascular outcomes and mitigating CVD risk factors. Noteworthy examples include hawthorn, which has shown promise in alleviating symptoms of heart failure [32], and arjuna, which has been effective in regulating lipid metabolism [33]. Dietary therapy in traditional medicine emphasizes heart-healthy foods tailored to individual constitutions, such as the doshas in Ayurveda [34], and the inclusion of whole foods while minimizing processed items in TCM [35]. Lifestyle modifications, including regular physical activity and stress management, are central to traditional approaches, with mind-body practices like yoga and meditation recommended to enhance cardiovascular health [36]. These practices underscore the holistic ethos of traditional medicine in addressing the multifaceted nature of CVDs. Traditional medical practices offer complementary strategies that can enhance modern therapeutic approaches for CVD management. TCM, for example, has a long history of treating cardiovascular conditions through herbal formulations such as Salvianolic acids and hawthorn extracts, which have shown cardioprotective effects against ischemic heart disease and hypertension [10,32]. These traditional treatments often target multiple pathways, including inflammation, oxidative stress, and blood circulation, complementing contemporary therapies that typically focus on specific molecular targets [2]. The integration of traditional practices with modern research is increasingly explored through advanced technologies. Network pharmacology provides a systems-level understanding of how the multiple compounds in traditional formulations interact with various molecular targets, elucidating the mechanisms behind their cardiovascular benefits. Precision medicine technologies, including pharmacogenomics, are also being employed to tailor traditional treatments to individual genetic profiles, enhancing their efficacy and safety. Emerging digital health technologies, such as wearable devices and mobile health applications, further optimize the use of traditional treatments in CVD management. These technologies enable real-time monitoring of physiological parameters like heart rate and blood pressure, allowing for the personalized adjustment of traditional therapies in response to dynamic changes in a patient's condition. To validate the efficacy and safety of traditional treatments, modern research is leveraging advanced biotechnologies such as 3D bioprinting and single-cell transcriptomics. These platforms facilitate the testing of traditional medicines by creating complex tissue models and analyzing cellular responses in detail. For instance, studies on mitophagy — a novel area in cardiovascular research — have explored the potential of traditional Chinese herbs to enhance mitochondrial function and protect against CVDs [4]. Such research

underscores the importance of integrating traditional knowledge with cutting-edge scientific methods to develop more effective and personalized therapeutic strategies. The integration of traditional medical practices with emerging research areas and technologies represents a promising avenue for improving cardiovascular health. By complementing modern therapies, utilizing advanced technologies, and rigorously validating efficacy, traditional medicine can play a pivotal role in the future of CVD management.

4.3 Meta-analyses and systematic reviews on the cardiovascular effects of natural products

Meta-analyses and systematic reviews play a pivotal role in consolidating existing evidence concerning the cardiovascular impacts of natural products, spanning medicinal plants, herbal remedies, dietary supplements, and nutraceuticals. By synthesizing data from diverse studies, these analyses evaluate the collective efficacy, safety, and clinical significance of natural products in both preventing and managing CVDs. For instance, a systematic review and meta-analysis focusing on Ayurvedic herbal preparations for hypercholesterolemia provided invaluable insights into their efficacy, offering a comprehensive understanding for clinical considerations and guiding future research directions [17]. Similarly, another systematic review and meta-analysis investigated the effects of prolonged marine omega-3 fatty acid supplementation on atrial fibrillation risk in cardiovascular outcome trials, shedding light on its preventive potential [37]. Furthermore, meta-analyses of observational studies have explored the association between dietary factors and cardiovascular outcomes, highlighting the beneficial effects of specific foods, nutrients, and dietary patterns on heart health. Notably, the literature underscores the Mediterranean Diet's impact on cardiovascular health, supported by meta-analyses of observational studies [31], which emphasize its effectiveness in promoting heart health and preventing cardiovascular diseases, as demonstrated in a meta-analysis of prospective cohort studies. Despite their significance in synthesizing evidence and guiding clinical practice, it is essential to interpret the findings of meta-analyses and systematic reviews cautiously due to inherent limitations. These include the observational nature of some studies, heterogeneity across studies, and potential biases in study design and publication [38]. Nonetheless, these analyses serve as valuable tools in informing clinical practice guidelines and directing future research endeavors aimed at elucidating the cardiovascular effects of natural products.

Incorporating data and performing a meta-analysis on selected traditional herbs provides robust statistical evidence supporting their efficacy in treating CVDs. Research highlights the potential mechanisms through which these herbs exert their therapeutic effects. Hawthorn has long been recognized for its cardiovascular benefits. Recent studies show that hawthorn extracts significantly improve vascular function and reduce oxidative stress, which are crucial for managing hypertension and atherosclerosis [9]. Meta-analysis of randomized controlled trials (RCTs) has consistently demonstrated reductions in systolic blood pressure and improvements in endothelial function across various patient populations. The overall effect size suggests a moderate to large benefit, reinforcing hawthorn's role as a viable complementary therapy for CVDs. Another herb, danshen, has been extensively studied for its cardioprotective properties, particularly in ischemic heart conditions [10]. Meta-analysis has shown that salvianolic acids, key compounds in danshen, offer substantial protection against myocardial ischemic reperfusion injury. The aggregated data reveal significant reductions in infarct size and improvements in cardiac output, indicating a positive impact on heart function post-injury.

Terminalia arjuna is traditionally used for its cardiovascular benefits, especially in managing heart failure and hypertension. Recent meta-analysis focused on the herb's multi-target pharmacological actions, demonstrating its efficacy in improving cardiac function and reducing blood pressure [11]. The analysis highlights how Terminalia arjuna's bioactive compounds interact with various molecular targets, including inflammatory pathways and oxidative stress markers, leading to improved cardiovascular outcomes. Ginseng has also shown promise in cardiovascular health management, particularly through its role in activating the nuclear factor erythroid 2-related factor 2 (Nrf2) pathway, a critical regulator of antioxidant responses. Meta-analysis of RCTs examining ginseng's effects on cardiovascular markers indicates significant improvements in lipid profiles and reductions in oxidative stress markers, suggesting its potential as a therapeutic agent in CVD management [3]. The meta-analysis of these herbs offers a comprehensive assessment of their efficacy, supported by statistical evidence from RCTs. The pooled data reinforce the significant role that traditional herbal treatments can play in managing CVDs, validating their traditional use and highlighting their potential integration into modern therapeutic strategies for cardiovascular health. In summary, evidence-based practices in traditional and natural medicine for CVDs encompass a diverse range of interventions supported by rigorous scientific evidence from clinical trials, observational studies, meta-analyses, and systematic reviews. These interventions offer promising avenues for both preventing and managing cardiovascular disorders, complementing conventional pharmacotherapy and lifestyle interventions. However, further research is warranted to delineate the optimal use of traditional and natural therapies, identify potential drug interactions and adverse effects, and integrate these therapies into mainstream healthcare practices.

4.4 Characteristics of traditional studies on CVDs

Traditional studies on CVDs have contributed significantly to the understanding and management of these conditions, especially within the framework of TCM and other indigenous medical systems. These studies, often rooted in centuries of empirical knowledge, present both advantages and challenges that are critical for modern research and application. One of the key advantages of traditional studies on CVDs lies in their holistic approach. TCM, for example, integrates concepts of Yin-Yang balance and Qi circulation, offering a comprehensive perspective on cardiovascular health that extends beyond the physical symptoms to include emotional and spiritual well-being [6]. This holistic approach has been shown to provide benefits in managing aging-related cardiovascular diseases, as it emphasizes prevention and the maintenance of health rather than merely treating symptoms [1]. Traditional studies also often employ natural compounds, which are believed to have fewer side effects compared to synthetic drugs. For instance, the use of herbs like hawthorn and ginseng in TCM has shown promising results in managing CVDs by improving blood circulation and providing antioxidant benefits [8,9]. Additionally, herbs such as Terminalia arjuna and turmeric, used in Ayurvedic medicine, have demonstrated cardioprotective effects, highlighting the potential of these natural compounds in CVD management [11,13]. However, the methodologies employed in traditional studies are often criticized for their lack of standardization and rigorous scientific validation. Many of these studies rely on anecdotal evidence and small sample sizes, which can limit the generalizability of their findings [3]. Furthermore, the variability in the composition of herbal medicines due to differences in cultivation, harvesting, and preparation methods can lead to inconsistencies in study outcomes. The integration of modern scientific techniques, such as network pharmacology and precision medicine, has

been suggested as a way to address these challenges by providing a more systematic approach to studying the complex interactions between various components of traditional remedies and their effects on cardiovascular health. Another challenge is the difficulty in conducting RCTs for traditional medicines, given the personalized nature of these treatments. For example, TCM prescriptions are often tailored to individual patients based on their specific symptoms and overall constitution, making it hard to create standardized protocols for RCTs [27]. Despite these challenges, systematic reviews and meta-analyses of existing studies have provided some evidence supporting the efficacy of traditional medicine in CVD management, although more high-quality studies are needed to draw definitive conclusions [16]. Moreover, traditional studies on CVDs have largely been conducted in regions where these practices are culturally ingrained, such as China and India, which may limit their applicability in other populations with different genetic backgrounds and lifestyle factors [17]. There is a growing need for more cross-cultural studies that examine the effectiveness of traditional remedies in diverse populations to better understand their potential role in global cardiovascular health [20]. Overall, while traditional studies on CVDs offer valuable insights and potential therapeutic options, they also present significant methodological challenges that must be addressed to fully realize their benefits in modern medicine. Future research should focus on integrating traditional knowledge with modern scientific methods to enhance the validity and applicability of these studies in the global context. This approach could lead to more effective and personalized treatment strategies for cardiovascular diseases, benefiting patients worldwide.

5 Challenges and opportunities in integrating traditional and natural medicine into cardiovascular care

5.1 Regulatory frameworks and quality control

The integration of traditional and natural medicine into cardiovascular care encounters the challenge of establishing robust regulatory frameworks and quality control standards to ensure the safety, efficacy, and quality of herbal remedies, dietary supplements, and traditional therapies. Regulatory frameworks and quality control are pivotal in ensuring the safety and efficacy of traditional and complementary medicine. Recent research highlights the importance of policy implications and global stakeholder perspectives in shaping regulatory strategies [39,40]. The evolution of quality control techniques for herbal medicines has shifted from traditional methods to modern approaches [41]. Additionally, the focus on pharmacopeial standards for botanical dietary supplements in the United States emphasizes the need for standardized quality control measures [42]. These studies collectively underscore ongoing efforts to establish robust regulatory frameworks and quality assurance mechanisms to uphold the integrity and safety of traditional and complementary medicine practices globally. Collaborative efforts among government agencies, regulatory bodies, research institutions, industry stakeholders, and traditional healers are vital for enhancing regulatory frameworks and quality control standards. Establishing evidence-based guidelines and promoting public awareness of safe usage are key steps toward successful integration into cardiovascular care.

5.2 Cultural and societal perceptions of traditional medicine

Cultural and societal perceptions of traditional medicine vary across contexts and populations. Research has explored these perceptions, highlighting the diverse perspectives, experiences, and barriers

involved [43-45]. For example, some studies examine perceptions of TCM among breast cancer survivors [43], the consumption and protection of wild animals used in traditional medicine [44], and the relationship between Ecuadorian indigenous healers and the formal healthcare system [45]. These studies reveal both challenges and opportunities for integrating traditional medicine into broader healthcare practices. Understanding these cultural and societal attitudes is crucial for informing effective healthcare practices and policy interventions. Addressing these perceptions involves recognizing cultural diversity and promoting cultural competence among healthcare providers and policymakers. Embracing intercultural dialogue and engaging with communities can build trust and collaboration with traditional healers, leading to more equitable access to traditional and natural medicine for all.

5.3 Collaboration between traditional healers and modern healthcare providers

Collaboration between traditional healers and modern healthcare providers offers a promising avenue for integrating traditional and natural medicine into cardiovascular care, harnessing the strengths of both systems to enhance patient outcomes and holistic wellness. Studies have highlighted the complexities, attitudes, beliefs, and potential barriers and facilitators of collaborations between traditional and conventional medicine [46-49]. These investigations reveal the nuanced dynamics involved in integrating traditional and modern healthcare approaches, highlighting the factors that influence successful collaboration. They underscore the importance of respectful engagement and partnership between these systems to enhance patient outcomes and promote holistic care. Therefore, serving as trusted intermediaries, they bridge linguistic and cultural gaps, facilitating healthcare access. Modern healthcare providers bring scientific rigor and advanced technologies, offering evidence-based diagnostics and treatments. Collaborating, they gain insights into local health beliefs and community needs, enhancing cultural competence and empathy. Worldwide initiatives, from training programs to integrated delivery systems, promote mutual respect and interdisciplinary collaboration. Strengthening regulatory frameworks, addressing cultural perceptions, and fostering collaboration are key to leveraging traditional and natural medicine's potential in cardiovascular care, necessitating coordinated efforts among stakeholders for improved health equity.

6 Future directions and implications for cardiovascular health

6.1 Emerging research areas and technologies

The field of cardiovascular health research is experiencing exciting advancements that promise deeper insights into CVDs and improved clinical outcomes. Cutting-edge molecular technologies and innovative therapeutic approaches are paving the way for a new era of precision medicine in cardiovascular care. For example, single-cell transcriptomics is enhancing our understanding of cardiac diseases by providing insights into cellular heterogeneity and disease mechanisms [50]. Consumer wearable health and fitness technology is being utilized for remote monitoring and personalized interventions [51]. The frontier of 3D bioprinting is introducing novel approaches for tissue engineering and regenerative medicine applications in cardiovascular research [52]. Additionally, advancing cardiovascular health equity globally through digital technologies is becoming increasingly important, with digital interventions playing a key role in addressing disparities and improving access to care [53]. These advancements signify a paradigm shift towards more precise, patient-centric, and technologically driven approaches in cardiovascular research and clinical practice.

6.2 Role of traditional medicine in precision cardiovascular medicine

Traditional medicine systems, with their extensive history in cardiovascular health, offer promising pathways for precision cardiovascular medicine. These systems provide personalized, holistic approaches to prevention, diagnosis, and treatment, emphasizing individualized assessments based on each patient's unique constitution and lifestyle. For example, network pharmacology in traditional medicine reveals the complex interactions of herbal compounds and their potential cardiovascular benefits [54]. Heart-healthy diets, integral to traditional medicine, are highlighted for their role in cardiovascular disease prevention [55]. Additionally, precision medicine in heart failure management underscores the need for tailored interventions based on individual patient characteristics [56]. The dynamics of yin and yang in cardiovascular pharmacogenomics illustrate the significance of integrating traditional concepts with personalized medicine approaches [57]. Combining traditional wisdom with modern science, such as natural products alongside genomic and imaging technologies, enhances the potential for personalized cardiovascular care.

6.3 Potential impact on global cardiovascular health outcomes

The global burden of CVDs remains a significant public health concern [58], with escalating prevalence and associated risks. Integrating traditional and natural medicine into precision cardiovascular medicine holds significant promise for improving global cardiovascular health outcomes. By expanding access to safe, effective, and affordable healthcare solutions, it can promote preventive strategies and address the root causes of CVDs. Studies exploring dietary interventions, innovative therapeutic strategies, and sex-specific responses to traditional approaches underscore the importance of adopting preventive measures and exploring alternative treatments to mitigate the global burden of CVDs and improve cardiovascular health outcomes [59]. Leveraging traditional healing practices and indigenous knowledge systems empowers individuals and communities to adopt healthy behaviors, reduce CVD risk, and promote health equity. Integrating traditional medicine into mainstream healthcare systems addresses social determinants of health, promotes equity, and fosters interdisciplinary collaboration and community engagement [60]. Recognizing the value of traditional healing practices and ensuring equitable access to healthcare services can advance the global health agenda, contributing to universal health coverage and the Sustainable Development Goals. Lastly, the future of cardiovascular health lies in embracing innovation, collaboration, and integration across traditional and modern healing systems. By leveraging emerging research areas and technologies, recognizing the role of traditional medicine in precision cardiovascular medicine, and addressing the social determinants of health, we can transform the way we prevent, diagnose, and treat CVDs and improve cardiovascular health outcomes for individuals and communities worldwide.

7 Conclusion

7.1 Summary of key insights

This paper has underscored the potential of integrating traditional and natural medicine into cardiovascular care to enhance patient outcomes and foster holistic health and wellness. The central arguments illuminated a variety of therapeutic modalities provided by traditional medicine systems, the mechanisms underlying the effects of herbal remedies and natural products, and the obstacles and potentials involved in incorporating traditional medicine into conventional healthcare frameworks. Clinical trials and systematic reviews provided evidence of traditional therapies' efficacy in managing

cardiovascular diseases and improving cardiovascular outcomes. Collaboration and integration between traditional and modern healthcare systems were highlighted as crucial for delivering patient-centered, evidence-based care.

7.2 Implications for clinical practice and public health

The implications of integrating traditional and natural medicine into cardiovascular care extend across clinical practice, public health, and healthcare policy domains. Healthcare providers can integrate traditional medicine approaches to complement conventional treatments, customize interventions, and advocate holistic approaches to cardiovascular health and wellness. Integrating traditional medicine into mainstream healthcare systems holds promise for widening access to healthcare services, mitigating healthcare disparities, and enhancing population health outcomes. Acknowledging cultural diversity, fostering interdisciplinary collaboration, and promoting public awareness can empower initiatives to harness the full potential of traditional medicine in tackling the global burden of CVDs and advancing health equity.

7.3 Recommendations for further research and collaboration

Continued research, collaboration, and interdisciplinary endeavors are imperative to effectively integrate traditional and natural medicine into cardiovascular care. Rigorous clinical trials, translational research, and fortification of regulatory standards are needed to evaluate traditional therapies' safety, efficacy, and mechanisms of action. Interdisciplinary collaboration among stakeholders is essential for bridging knowledge gaps and facilitating informed decision-making. Public awareness campaigns can empower individuals to embrace traditional medicine safely, fostering holistic approaches to cardiovascular health. By nurturing these initiatives, we can propel the integration of traditional and natural medicine, ultimately advancing cardiovascular outcomes on a global scale. In conclusion, the integration of traditional and natural medicine into cardiovascular care presents promising avenues for enhancing patient-centered care, improving population health outcomes, and advancing health equity. By recognizing the value of traditional healing practices, harnessing emerging research areas and technologies, and fostering collaboration and integration across traditional and modern healing systems, we can revolutionize the prevention, diagnosis, and treatment of cardiovascular diseases, promoting cardiovascular health for all.

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Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

C.-H.C. and J.-C.L. wrote the initial paper, H.-Y.C., C.-C.C., J.-J.C., and W.-R.H. designed and drew the figures, W.-R.H. and T.-H.C. revised the paper.

Ethics Approval and Consent to Participate

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Availability of Data and Materials

The analyzed data sets generated during the study are available from the corresponding author on reasonable request.

Supplementary Materials

Not applicable.

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