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Review Article

Role and mechanism of aromatherapy on hemodynamic parameters for patients with cardiovascular disease: A systematic review

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Abstract

Background and aims: Since cardiovascular diseases (CVDs) are the most common cause of morbidity and mortality in the world, this systematic review aimed to investigate the effectiveness and mechanism of aromatherapy on hemodynamic parameters in patients with CVDs.

Methods: This review was performed in accordance with PRISMA guidelines. Using relevant keywords, an extensive search was done in 1.30.2022 in most important databases including Scopus, PubMed, Web of Science, and Google Scholar. A form was designed for recording data related to randomized clinical trials (RCTs), hemodynamic changes (e.g., heart rate, respiratory rate, systolic, and diastolic blood pressure), and information about possible mechanisms in non-RCT works was also extracted.

Findings: In RCTs, aromatherapy with lavender (*Lavandula angustifolia*) oil, orange (*Citrus sinensis*) oil, lemon (*Citrus limon*), rose (*Rosa damascena*), and almond (*Prunus dulcis*) oil regulates pulse rate, respiratory rate, and blood pressure in patients with CVD. Aromatherapy can affect the sympathetic and parasympathetic systems through inducing local effects on veins, resulting in vasodilation, increased blood flow, and decreased peripheral resistance.

Conclusion: Aromatherapy can be used as a complementary agent for regulating heart rate, blood pressure, and respiratory rate in patients with CVD. However, certain precautions such as allergic reactions in patients should be taken before administration.

Keywords: Aromatherapy, Essential oil, Medicinal plants, Cardiovascular disease, Hemodynamics

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Introduction

Cardiovascular disease (CVD) is the main cause of mortality and morbidity around the world (1). CVD originates from reduced myocardial perfusion that causes angina because of ischemia and can result in heart failure and myocardial infarction (2). This debilitating disease, in addition to disrupting a patient's daily life and reducing his/her health-related quality of life (3), imposes stupendous direct and indirect costs on the individual, society, and health care system (4,5). In addition, it seems that hemodynamic variables such as heart rate, respiratory rate, and systolic and diastolic blood pressure increase in CVD patients (6). These patients generally have unstable hemodynamic indices, and chemical drugs such as beta-blockers, renin-angiotensin system inhibitors, and angiotensin receptor blockers at higher and more effective doses expose patients to more complications (7,8). Therefore, both pharmacological and non-pharmacological interventions are needed for the treatment of CVD. Recently, the popularity of herbal remedies has increased due to their easy access, fewer complications, unique diversity of chemical structures, and biological activities (9). Medicinal plant aromas were shown to be effective in improving hemodynamic variables and treating stress and anxiety in several studies (10-12). Aromatherapy and the use of medicinal plant oils in reducing anxiety have long been considered in traditional medicine. Essential oils extracted from the popular plants are used in aromatherapy including different Rosa species, especially *Rosa damascena* Mill. and *Rosa centifolia* L., and plants from the *Lamiaceae* family (i.e., *Lavandula angustifolia* Mill.) have been administered for complementary medicine in various diseases. The clinical trials have revealed that aromatherapy with essential oil of these plants has positive psychological effects and improves vital signs such as pulse rate, respiratory rate, and blood pressure (13-17). Although several studies have reported the beneficial effects of aromatherapy on the vital signs of CVD patients, some studies have not reported a positive effect on these patients. Given the above considerations,

this systematic review was conducted to investigate the effects of plant aromas on vital signs in patients with CVDs.

Materials and Methods

Data sources and search strategy

This review was done in accordance with PRISMA guidelines (http://prisma-statement.org/prismastatement/Checklist.aspx). To this end, an extensive search was performed in 1.30.2022 in several databases including Scopus, PubMed, Web of Science, and Google Scholar. The following keywords (main and MeSH words) were used to conduct the search: ("arteriosclerosis" OR "coronary disease" OR "coronary arteries" OR "angina pectoris" OR "acute coronary syndrome" OR "cardiovascular diseases" OR "chronic heart failure" OR "myocardial infarction" OR "heart failure" OR "cardiac failure") AND ("essential oil" OR aroma* OR "aromatherapy" OR "inhalation") AND ("high blood pressure" OR "hypertension" OR "systolic blood pressure" OR "pulse rate" OR "breathing rate" OR "respiration rate").

Study selection

After searching, the publications were imported into EndNote X8 (8 November 2016, Thomson Reuters) to detect and remove irrelevant publications. Two independent investigators screened the titles and abstracts of the articles according to the inclusion and exclusion criteria. The inclusion criteria in this review study involved the studies that addressed the inhalation of plants aroma and its impact on hemodynamic variables in patients with CVDs. Exclusion criteria were animal studies, lack of accessing the full text, study protocols, and publication in non-English languages. The full texts of all included publications were independently reviewed. If any disagreement was found during the review, an agreement was achieved by discussing the question with a third research team member. The flowchart of the search strategy is illustrated in Figure 1.

Data extraction and quality assessment

Two individuals extracted the data independently, and inconsistencies were resolved through discussion. From

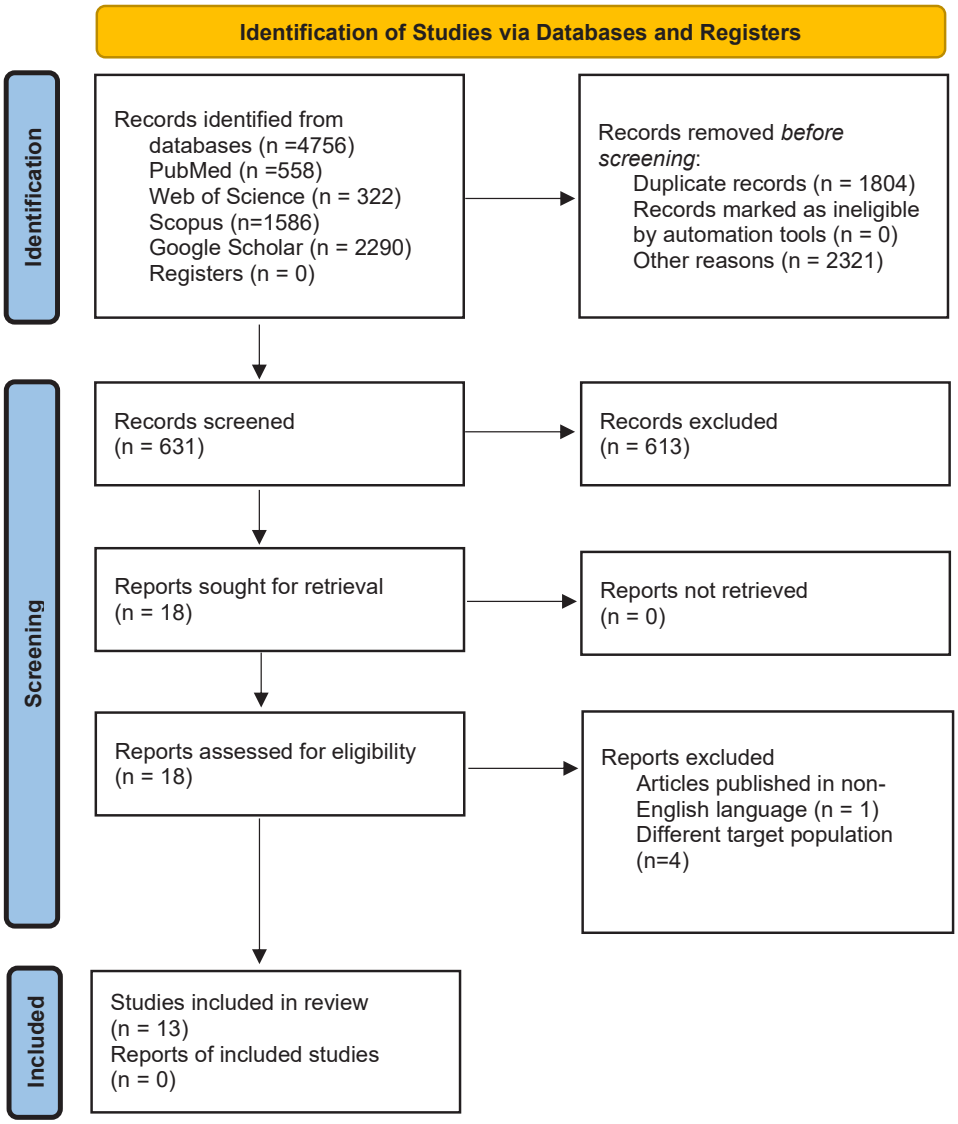

Figure 1. Flowchart of selection of studies for systematic review.

the studies included, the following information was extracted: the first author's name, year of publication, country of study, type of essential oil, type and duration of intervention, and outcome.

Results

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flowchart of the search strategy is illustrated in Figure 1. The initial electronic search retrieved 4756 titles/abstracts. From the total articles retrieved, 1804 articles were removed due to duplicate titles. Some other titles/abstracts were also excluded (n = 5) because one of them was not published in English (18) and four titles failed to conduct a study on the target population (19-23). Finally, 13 articles were selected for the final review.

The characteristics of the randomized clinical trials (RCTs) included in the systematic review are shown in Table 1. Except for one study that was done in Indonesia (24), the other studies were conducted in Iran (25-36).

Main mechanisms of action

Essential oils extracted from aromatic plants, in addition to modulating the hemodynamic parameters of patients, serve as preventive agents by suppressing the effects of cardiac risk factors. For example, they induce an antiplatelet effect, help lower blood pressure, reduce lipids and glucose, and attenuate diabetes symptoms in patients as a complementary treatment (37). Moreover, when they induce relaxation in patients and alleviate the stress and

Table 1. Characteristics of randomized clinical trials on aromatherapy used in regulating hemodynamic parameters

Lead author (year)	Country	Patients	Intervention essential oil	Intervention type and duration	Outcomes
Tahmasbi (25)	Iran	90 Patients affected by coronary angiography	Lavender (*Lavandula angustifolia*) oil	3 drops (10 ml) on cotton balls in a pot at 5-cm distance from nose for 3 min/daily	Reduced respiratory rate, systolic and diastolic blood pressure as well as heartbeat
Bikmoradi (26)	Iran	60 Patients after coronary artery bypass surgery	Lavender oil (*Lavandula angustifolia*)	2 drops of 2% lavender essential oil inside oxygen mask for 20 minutes	No change was seen in systolic and diastolic blood pressure, heart rate, and respiratory rate
Mirbastegan (27)	Iran	60 Patients with myocardial infarction	Lavender oil (*Lavandula angustifolia*)	Lavender essential oil 3 days for 20-30 min/daily and 3 times/daily	Significant reduction was seen in blood pressure in the intervention group
Rajai (28)	Iran	60 Patients candidate for coronary artery bypass graft surgery	Lavender oil (*Lavandula angustifolia*)	Inhaled through a piece of cotton impregnated with 2 drops of essential oil	Systolic blood pressure heart in the intervention group was reduced
Bahrami (29)	Iran	90 Senile women with acute coronary syndrome	Almond (*Prunus dulcis*) oil	6 drops of almond oil applied for total foot massage	Mean diastolic blood pressure, arterial blood pressure, and heart rate substantially reduced
Salamati (30)	Iran	40 Patients in coronary intensive care units	Lavender (*Lavandula angustifolia*) oil	Inhaled aroma through cotton swab, which was impregnated with two drops of essential oil 2%	Significant reduction was seen in systolic blood pressure, diastolic blood pressure and heart rate
Ziyaeifard (31)	Iran	80 Patients hospitalized for coronary angiography	Lavender (*Lavandula angustifolia*) oil	5 drops a piece of cotton wool 5 cm from the nose deep inhalations for 5 min	Reduction was seen in systolic and diastolic blood pressure and heart rate
Bahrami (32)	Iran	135 Senile female patients with acute coronary syndrome	Almond oil (*Prunus dulcis*)	Total massage of each foot with 6 drops of almond oil for 5 times in both directions	Reduction in heart rates, but no significant changes were seen in diastolic blood pressures
Ebrahimi(33)	Iran	60 Patients after coronary artery bypass graft surgery	Lavender (*Lavandula angustifolia*) oil	5 drops of 20% concentrated lavender essential oil in the experimental group were poured onto sterile gauze.	After 2 days, systolic and diastolic blood pressure significantly reduced
Tahmasebi (34)	Iran	101 Patients hospitalized for coronary angiography	Orange (*Citrus sinensis*) oil and lavender oil administered separately	2 drops of non-absorbent tissue paper were tied to the collar	Downregulated pulse rate, systolic blood pressure and respiration rate in the lavender and orange essential oils administered individuals
Rambod (35)	Iran	100 Acute myocardial infarction patients	Lemon (*Citrus limon*) oil	5 drops of lemon essential oil were poured on a cotton pad at least for 2 hours	Reduced systolic blood pressure and changes in percentage of ST-segment and T wave during the 3rd and 4th days
Tahmasebi (36)	Iran	70 Patients candidate for coronary angiography	Orange (*Citrus sinensis*) oil	2 drops of essential oil were dripped by emitters on a polyethylene handkerchief sticking to the collar of the participants	Significant difference was seen in pulse rate, respiratory rate and systolic blood pressure
Af'idah (24)	Indonesia	32 Patients with heart failure	Rose (*Rosa damascena*) essential oil	Soaking feet with warm water dissolved in essential oil in a bucket with a warm water for 10 minutes	Warm feet soak with and without aromatherapy reduced heart rate

anxiety of the patients, hemodynamic parameters are indirectly adjusted due to the patient's mental disorder (38). Aromatic plant essential oils are mainly composed of citronellol, geraniol, nerol, kaempferol, 2-phenylethanol, nonadecane, and heneicosane (39). Hence, phenolic compounds, terpenes, and alkaloids are responsible for the main aromatic activity of plants for the treatment of various diseases (40,41). The most important relevant mechanisms of plants in body tissues are as follows:

Effect on the autonomic nervous system

The autonomic nervous systems spontaneously innervate the smooth musculature of all body organs, the glands, and the heart. Sympathetic and parasympathetic nerves are two arms of this system (42). Inhalation of essential oils can transmit signals to the olfactory system and induce the brain to release neurotransmitters that regulate functions (43). The brain affects the heart directly through the sympathetic and parasympathetic systems (44). Aromatherapy could be an appropriate method for the promotion of regulators of sympathetic nervous system dysfunctions. Many types of hypertension are initiated and sustained by a raised sympathetic tone (45). The parasympathetic system generally decreases heart rate and blood pressure (46). Therefore, therapies that modulate autonomic system functions can produce a beneficial effect on hypertension. Meniki (*Chamaecyparis formosensis*) essential oil decreases heart rate and systolic blood pressure and increases diastolic blood pressure. Moreover, sympathetic nervous system activity was significantly mitigated, and the parasympathetic nervous system activity was significantly intensified (47). The bradycardic impact of clove basil (*Ocimum gratissimum*) seems to depend on both parasympathetic and sympathetic systems because the effect was reduced by bilateral vagotomy (48).

Effect on the local pathway of veins

The autonomic nervous system can induce vasorelaxation via several mechanisms, but vasorelaxation can also occur independently through local pathways. Kunth (*Aniba canelilla*) oil generates dose-dependent hypotension, while bradycardia can occur by itself. Bradycardia seems to be mainly dependent on the existence of parasympathetic induced resting in the heart. However, hypotension is due to an active vascular relaxation rather than a withdrawal of sympathetic tone. This relaxation is partially mediated by an endothelial L-arginine/nitric oxide (NO) pathway through peripheral muscarinic receptor activation (endothelium-dependent relaxation) and mainly via inhibition of inward calcium current (endothelium-independent relaxation) (49). The essential oil of *Pectis brevipedunculata* intensifies a vasorelaxant effect dependent on the NO/cyclic guanine monophosphate pathway because the pretreatment with L-NG-Nitroarginine methyl ester, an endothelial NO synthase (NOS) inhibitor, reduces the vasodilation (50). Oleo-gum (*Ferula assa-foetida*) essential oil has a potent vasodilatory effect that is both endothelium-dependent and endothelium-independent. Furthermore, it decreases the influx of calcium into the cell via plasma membrane calcium channels. These vasodilatory effects are induced due to their dependence on NOS activity because the presence of L-NG-Nitroarginine methyl ester partially reduces the effect. Furthermore, the activity appears to be mediated by prostaglandin activity because indomethacin, a cyclooxygenase inhibitor, decreases vasorelaxation (51). The vasorelaxation induced by the essential oil from long-stamen chive (*Allium macrostemon*) appears to be due to an endothelium-dependent mechanism involving Ca^{2+} entry, protein kinase A-dependent NOS phosphorylation, and NO signaling (52). The vasorelaxation activity reported for the oil from ajwain (*Trachyspermum Ammi*) depends on the extracellular Ca^{2+} flux because pretreatment with a calcium channel blocker decreases its vasodilation activity (53). Field sagewort (*Artemisia campestris*) essential oil appears to increase vasorelaxation through modulation of L-type Ca^{2+} channels and the activation of the SERCA pumps of reticulum plasma (54).

Effect on respiration

Aromatherapy can also affect respiratory rate by impressing the autonomic nervous system. Studies have indicated that orange and lavender oil decrease respiration rate substantially (54). In patients who amyloidosis affects their autonomic nervous system, multiple disorders impact respiratory rate, heart rate, and blood pressure (55). A study indicated that the therapeutic potentials of the volatile oil obtained from long-stamen chive (*Allium macrostemon* Bunge) could affect pulmonary hypertension through protein kinase A-dependent NOS phosphorylation and NO signaling (52).

Therefore, as Figure 2 illustrates, aromatherapy can affect the sympathetic and parasympathetic systems and alter heart rate, blood pressure, as well as respiratory rate. Local effects on veins can also induce vasodilation, increase blood flow, and decrease peripheral resistance.

Although no severe allergic reactions were observed in the studies, most researchers took skin sensitivity tests from patients before the study. Therefore, there were no specific side effects due to the studied aromatic plants. For example, lavender oil that is commonly used for aromatherapy has the lowest risk of toxicity and allergy-related side effects among herbal ingredients.

One of the limitations of the reviewed studies was that the hemodynamic parameters of the patients were not examined independently, rather they were investigated along with a psychological disorder or pain. In addition, some studies did not comprehensively examine all patients' hemodynamic parameters, which should be addressed in the future in more robust clinical trials.

Conclusion

Aromatherapy can affect the sympathetic and parasympathetic systems and subsequently regulate heart

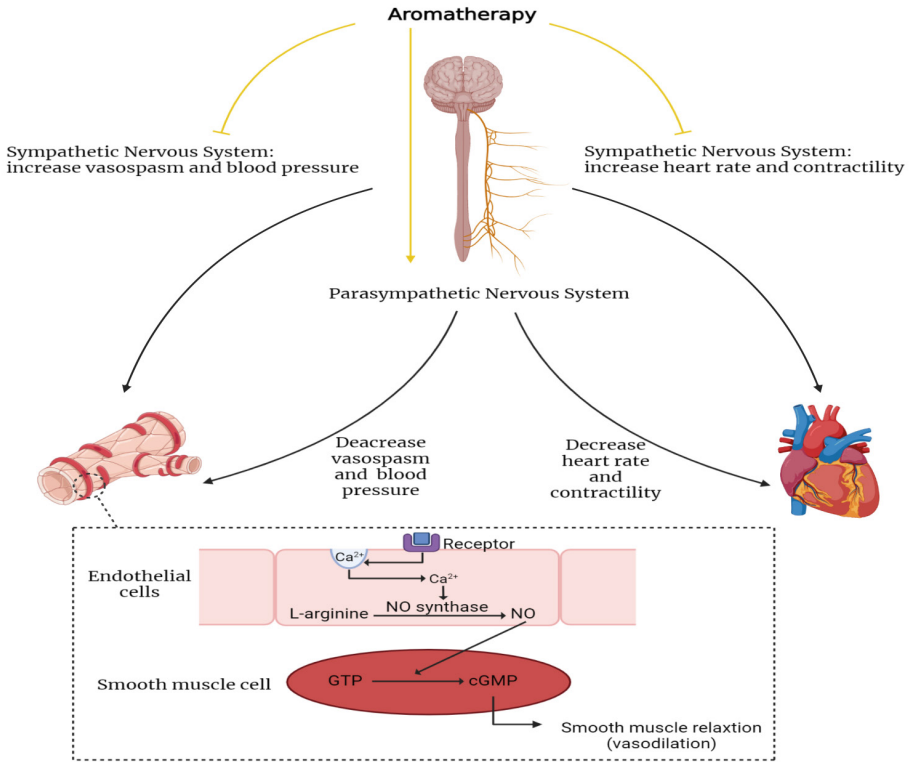

Figure 2. The most important known mechanisms of aromatherapy on hemodynamic indicators.

rate, blood pressure, and respiratory rate in patients with CVDs. Therefore, aromatherapy with essential oils of plants can be used as a complementary treatment in improving the conditions of patients with CVDs. However, certain precautions such as allergic reactions in the patients should be taken into consideration before administration. The findings of this study can be used in the provision of higher quality care and along with other treatment strategies to accelerate the healing process in patients with CVDs.

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Authors' Contribution

All authors contributed to the conception of the study. MA and MR designed the protocol. MA and PTB collected the data. Further, MR wrote the first draft of the manuscript, and then MA and PTB thoroughly revised the manuscript.

Conflict of Interests

The authors declare no conflict of interests.

Ethical Approval

Not applicable.

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