



A systematic review of the effect of lavender on cancer complications

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ABSTRACT

Objective: Despite advances in the diagnosis and treatment of cancer, patients still suffer from the various physical and psychological complications of cancer. The aim of this research was to integrate and synthesize relevant scientific evidence about the effect of lavender on cancer complications.

Methods: A systematic review of the international literature was undertaken. The search process encompassed four databases of PubMed [including MEDLINE], Web of Science, Scopus, and Cochrane library without time and language limits. All types of interventional studies examining the effects of lavender on cancer complications were included in data analysis and research synthesis. Relevant data were obtained from eligible studies after quality appraisal using appropriate methodological tools. Given that meta-analysis could not be performed, the review findings were synthesized narratively.

Results: Thirteen studies were included in this review with a total of 838 patients. Nine studies used a randomized controlled trial design and the majority of them were conducted on patients with multiple types of cancer. Lavender was often used as inhalation aromatherapy. In the majority of the included studies, lavender was significantly effective in the reduction of anxiety and pain, and improved sleep quality and vital signs.

Conclusions: This review provides scientific evidence regarding the effectiveness of lavender in mitigating cancer complications. Healthcare providers are suggested to use lavender in patient care along with other healthcare interventions to relieve cancer complications.

1. Introduction

Cancer is one of the major public health challenges across the world and is considered one of the most typical reasons for morbidity and mortality¹. It has been shown that 1 898,160 new cancer cases and 608,570 cancer deaths have occurred in 2021 only in the USA².

Despite new advances in the diagnosis and treatment of cancer³, patients still suffer from various physical and psychological complications of this long-term disease, especially during the treatment process

⁴⁻⁶. Cancer widely influences patients' mental health. The prevalence of anxiety and depression is high among people with cancer⁷. Sleep problems range from 25% to 59% and are prevalent in these patients, and have disturbing effects on patients' health outcomes⁸. Pain and fatigue as the most prevalent symptoms in patients undergoing cancer treatment⁹, adversely affect cancer treatment, recovery from cancer, their quality of life and survival.

Complementary and alternative therapies can reduce cancer complications^{10,11}, given that medications are not always effective and even

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can cause drug abuse, treatment delay, dependence, and tolerance¹².

Lavandula genus, belongs to the *Lamiaceae* family, comes originally from the southern area of Europe and Mediterranean region¹³. Lavender has a prolonged history in traditional medicine and essential oil derived from lavender has a wide range of biological effects¹⁴. Three species of lavender are primarily picked to synthesize essential oils including *Lavandula angustifolia* (common lavender), *Lavandula latifolia* (spike lavender), and *Lavandula intermedia*, a sterile hybrid of *Lavandula angustifolia* and *Lavandula latifolia* (lavandin)¹⁵. Lavender essential oil has over 50 chemical constituents, permitting multiple therapeutic effects¹⁶. It has been used in different forms for therapeutic purposes for centuries. The therapeutic effects of lavender may be due to the neurochemical action of volatile composites on the limbic system in the brain and the psychological influences of its odor¹⁷.

The use of lavender essential oil for therapeutics purposes has expanded gradually and evidence suggests that lavender has antioxidant, antibacterial, antifungal, carminative, cytotoxic¹⁸, antianxiety¹⁹, antidepressant²⁰ and sedative²¹ properties. It has been shown to be effective in the treatment of migraines²² and insomnia²³. Lavender has also been used to reduce cancer complications and relieve related symptoms in patients²⁴.

Numerous reviews have been performed on the properties of lavender in different health conditions such as depression²⁰, anxiety¹⁹, physical and psychological symptoms of menopausal women²⁵, labor pain and anxiety²⁶, cardiac surgery complications²⁷, and healing of episiotomy²⁸.

Other reviews have identified the effectiveness of various essential oils on cancer complications²⁹⁻³¹. However, no systematic review has been conducted to specifically examine the effect of lavender on cancer complications experienced by these patients. Therefore, this systematic review aimed to integrate and synthesize relevant scientific evidence about the effectiveness of lavender in the reduction of cancer complications.

The review question was as follows: Does lavender influence cancer complications in patients with cancer?

2. Methods

2.1. Protocol and registration

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used to guide this systematic review (Supplementary file 1). The protocol of the review has been registered on the PROSPERO (registration number: CRD42021282038; https://www.crd.york.ac.uk/prospéro/display_record.php?RecordID=282038).

The review question was formulated by the PICOS statement as follows:

- P (Population): patients with all types of cancer;.
- I (Intervention): administration of lavender;.
- C (Comparison): all types of comparison or control;.
- (Outcomes): all complications experienced by patients with cancer;.
- S (Study design): all types of clinical trials and similar interventional studies.

2.2. Search process and eligibility criteria

The research team identified appropriate keywords using their previous experiences with complementary and alternative therapies and after conducting a pilot search on international databases. The databases of PubMed [including MEDLINE], Web of Science, Scopus, and Cochrane library were searched from inception to October 2021 to retrieve articles. Articles published in English and Farsi (the authors' mother language) were retrieved independently using the following search strategies by two authors (MM and AM):

- PubMed/MEDLINE: ((Lavender[Title/Abstract] OR silexan[Title/Abstract] OR lavandula[Title/Abstract]) AND (cancer[Title/Abstract] OR Carcin*[Title/Abstract] OR oncology[Title/Abstract] OR tumor [Title/Abstract] OR "integrative oncology" [Title/Abstract])).
- Scopus: TITLE-ABS-KEY ((Lavender OR silexan OR lavandula) AND (cancer OR Carcin* OR oncology OR tumor OR "integrative oncology"))).
- Web of Science: TOPIC: ((Lavender OR silexan OR lavandula) AND (cancer OR Carcin* OR oncology OR tumor OR "integrative oncology"))).
- Cochrane library: ((Lavender OR silexan OR lavandula) AND (cancer OR Carcin* OR oncology OR tumor OR "integrative oncology")) in Title, Abstract, Keywords.

In addition, published systematic reviews and the reference lists of finally included studies were screened to improve the search coverage.

All types of clinical trials and similar interventional studies on human subjects published in peer-reviewed scientific journals and examining the effects of lavender (regardless of lavender species, formulation, and routes of administration) on cancer complications such as anxiety, pain, and sleep problems were included. Studies with an unclear or an unspecified number of patients, studies with the use of a blend of lavender and other herbs were excluded.

2.3. Study selection

The two authors (MM and AM) independently carried out the search process on databases and screened all titles and abstracts using the EndNote software. They shared the search results and performed conversations to decide about the inclusion of studies in the review. Conflicts over the inclusion of studies were resolved through discussion and seeking the opinion of the third review author (MV).

2.4. Risk of bias assessment

The risk of bias of eligible studies was assessed independently by two authors (MM and AM). The Cochrane Collaboration's tool for judging the risk of bias for randomized controlled trials (RCTs)³² and the Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) tool for evaluating the risk of bias in nonrandomized studies³³ were used. RCT studies were appraised in terms of random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective reporting.

The risk of bias in these domains was rated as a low, high, or unclear risk of bias. In addition, seven domains including bias due to confounding, bias in the selection of participants into the study, bias in the classification of interventions, bias due to deviation from intended interventions, bias due to missing data, bias in the measurement of outcomes, bias in the selection of the reported result were applied for assessing the risk of bias in non-randomized studies. The risk of bias in these domains was classified as low, moderate, serious, critical, and no information concerning the risk of bias. Disagreements in the quality assessment of the studies were resolved through holding discussions between the authors until a consensus was reached.

2.5. Data collection process and synthesis of results

The authors developed a data extraction table that contained the general characteristics of the study including study design, sample size, setting, participants' characteristics, intervention detail, measured outcome, and findings. It was pilot-tested before use.

Since meta-analysis was not possible due to the variations in the studies' interventions in terms of duration, the dosage of lavender, and data collection tools, the review results were synthesized and presented narratively.

3. Results

3.1. Search outcome and selection of studies

The study flow diagram based on the PRISMA has been presented in Fig. 1.

A total of 272 articles were retrieved during the search process applying the pre-defined keywords. After removing duplicates and screening based on titles and abstracts, 16 articles were entered into the full-text reading phase. Finally, 13 articles were selected for data analysis and research synthesis. During the review of the reference lists of selected studies, no further studies were identified for inclusion.

3.2. Risk of bias assessment

The risk of bias evaluation of nine RCTs has been presented in supplementary file 2, Fig.1. In terms of random sequence generation and blinding of participants and personnel, four studies had low risk of bias, three studies did not provide sufficient information, and two studies were evaluated to have high risk of bias. In addition, most studies did not provide any information regarding allocation concealment and blinding of outcome assessment, and also were at low risk of bias in the view of incomplete outcome data. Moreover, seven studies due to the absence of registered protocols to assess pre-specified analysis plans were appraised as unclear in terms of bias in selective outcome reporting, but other studies were judged to have low risk of bias.

The results of risk of bias assessment for four non-randomized studies are presented in supplementary file 2, Fig. 2. Three studies were judged to have serious risk of bias and one had low risk of bias in terms of bias due to confounding. In terms of bias in the selection of participants into the study, two studies had serious risk of bias, one study had low risk of bias, and one study had critical risk of bias. All four studies in terms of classification of interventions, deviations from intended interventions,

and missing data had low risk of bias. In addition, in the view of bias in the measurement of the outcome and bias in the selection of the reported result, all studies did not provide sufficient information.

3.3. General characteristics of the selected studies

A summary of selected studies (n = 13) has been shown in Table 1. Thirteen studies were published in English and one in Farsi from 2002 to 2021. Five studies were from Turkey^{34–38}, three from Iran^{39–41}, two from the USA^{42,43}, one from Germany⁴⁴, one from the UK⁴⁵, and one from the Republic of Korea⁴⁶.

Nine studies were RCTs^{34–37,39,41,44–46}, three quasi experimental^{38,40,42}, and one prospective feasibility study⁴³. The total sample size was 838 patients with cancer. Gender of the participants was reported in 12 studies, of which 477 participants were female (57%). Seven studies were conducted on patients with multiple types of cancer^{37,38,41–45}, three on patients with colorectal cancer^{34,36,46}, one on patients with breast cancer³⁵, one on patients with acute myeloid leukemia (AML)⁴⁰, and one on patients with leukemia or solid cell carcinoma³⁹.

3.4. Intervention and safety

Inhalation aromatherapy was used in 10 studies^{35,37–44,46}, aromatherapy massage was used in two studies^{34,45}, and in one study lavender was used in the colostomy bag³⁶. Seven studies did not specify which type of lavender they used^{35,36,39–41,43,45}, but four studies used *Lavandula angustifolia*^{38,42,44,46}, and two used *Lavandula hybrida*^{34,37}.

The purity of lavender essential oil used for inhalation aromatherapy varied from 1% to 100% and the amount used varied from two drops to 55 ml. The duration of each inhalation aromatherapy session varied from 3 min to 10 h. Some studies failed to specify the purity^{36–38,44} and amount³⁷ of lavender essential oil. The lavender essential oil was applied on cotton, gauze, surgical mask, electric potpourri pot, and

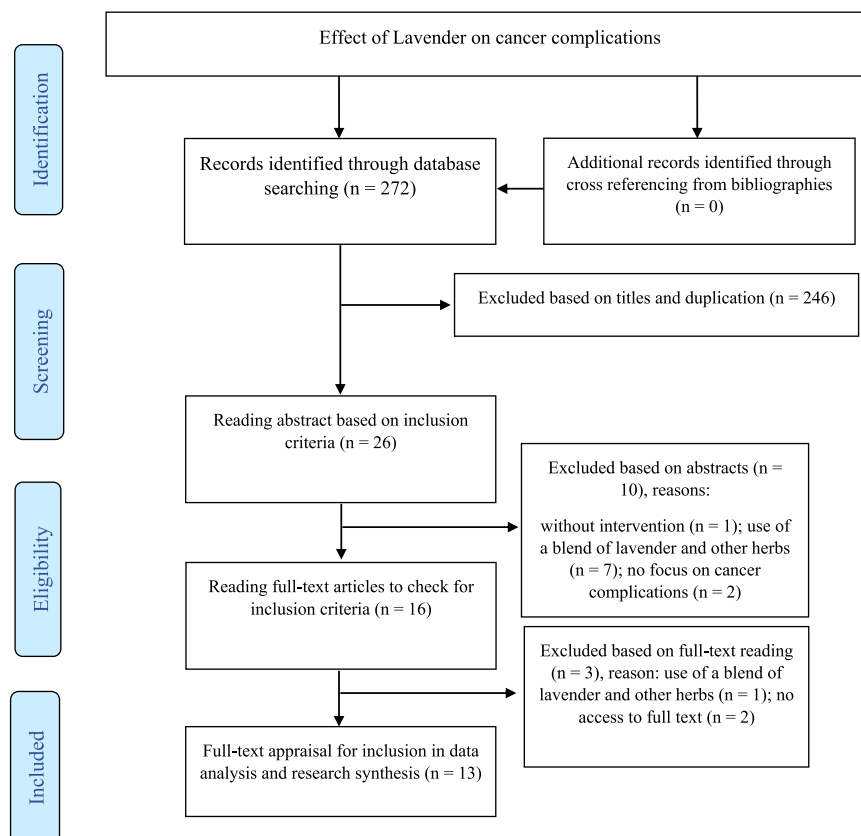


Fig. 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Table 1
General characteristics of the selected studies.

Author, country	Research design	Participants: number, age, gender, type of cancer, condition for lavender use	Intervention	Type of lavender	Outcome measurement	Result
Abbaszadeh et al. ³⁹ , Iran	RCT	n = 80; mean age = 41.5 years; 51.2% female; leukemia or solid cell carcinoma; before bone marrow biopsy	Inhalation aromatherapy: three drops of 10% lavender essential oil on cotton for 15 min before the biopsy	Not specified	Anxiety: VAS	Reduction of the anxiety level
Ayik and Ozden ³⁴ , Turkey	RCT	n = 80; mean age = 60.5 y; 45% female; colorectal cancer; before surgery	Aromatherapy massage: twice massage using "Back Massage Guide" using 5% lavender oil for ten minutes: once at night before surgery and once again in the morning before surgery	Lavandula Hybrida (Lavandula angustifolia and Lavandula latifolia)	Anxiety and sleep quality: SAI and RCSQ	Reduction of the anxiety level; improvement of sleep quality
BabashahiKohanestani et al. ⁴⁰ , Iran	Quasi-experimental	n = 70; mean age = 34 y; AML; during chemotherapy	Inhalation aromatherapy: two drops of 2% lavender essential oil on cotton near the pillow for three nights from 9 pm to 6 am	Not specified	Pain: VAS	Reduction of the pain intensity
Beyliklioglu and Arslan ³⁵ , Turkey	RCT	n = 80; mean age = 49.7 y; 100% female; breast cancer; before surgery	Inhalation aromatherapy: three to four drops of 100% lavender oil on a gauze band for 20 min on the day of surgery	Not specified	Anxiety: SAI	Reduction of the anxiety level
Duluklu and Celik ³⁶ , Turkey	RCT	n = 30; mean age: 59 years; 33.3% female; colorectal cancer; patients with permanent colostomy	For one month during colostomy bag exchange, 10 drops of lavender essential oil into a clean bag and dispersing it all over inside of the bag	Not specified	Odor, quality of life, ostomy adjustment: A question related to the problem of ostomy odor, SQOLS, OAI-23	Less ostomy odor, improvement of the quality of life and better adjustment to ostomy
Goepfert et al. ⁴⁴ , Germany	RCT	n = 20; age range = 42-73 y; 50% female; multiple types of cancer; palliative care	Inhalation aromatherapy: 3-4 drops of lavender oil through a conventional surgical mask for 10 min	Lavandula angustifolia	Heart and breathing rate, oxygen saturation, systolic and diastolic pressure, mean arterial pressure	Reduction of respiratory and heart rate, diastolic, systolic, and mean arterial blood pressure
Hamzeh et al. ⁴¹ , Iran	RCT	n = 120; mean range = 49.4 y; 56.6% female; multiple types of cancer; patients admitted to the oncology ward	Inhalation aromatherapy: for 7 days before bedtime, three drops of 100% lavender essential oil on a cotton ball placing on the patient collar for 20 min	Not specified	Sleep Quality: PSQI	Improvement of sleep quality
Louis and Kowalski ⁴² , United States	Quasi-experimental one-group	n = 17; mean age = 61 y; 47% female; multiple types of cancer; in-home hospice patients	Inhalation aromatherapy: thirty drops of 3% lavender essential oil with electric potpourri pot for 60 min	Lavandula angustifolia	Vital signs: blood pressure and pulse, pain, anxiety, depression, and perceived sense of wellbeing: automated blood pressure machine, verbal 11-point scale	Reduction of pulse and blood pressure, Reduction of pain, anxiety, and depression intensities, improvement of the sense of well-being
Özkaraman et al. ³⁷ , Turkey	RCT	n = 70; mean age = 58.2 y; 84.2% female; multiple types of cancer; patients undergoing chemotherapy	Inhalation aromatherapy: during chemotherapy and one month after chemotherapy, inhalation of lavender essential oil on a piece of cotton every night for five minutes	Lavandula hybrida	Anxiety and sleep quality: STAI, PSQI	Reduction of the anxiety level, improvement of sleep quality
Shady et al. ⁴³ , United States	Prospective feasibility	n = 40; mean age = 60 y; 62% female; multiple types of cancer; patients admitted to the hematology-oncology unit	Inhalation aromatherapy: attaching a 55 ml lavender-infused inhalation patch to gown or shirt during sleep at night for 6-10 h on average unit	Not specified	Anxiety: GAD-7	Reduction of the anxiety level
Soden et al. ⁴⁵ , United Kingdom	RCT	n = 42; age range: 44 - 85 y; 76% female; multiple types of cancer; patients in palliative care units	Aromatherapy massage: an equivalent 30- minute back massage weekly for four weeks with lavender essential oil 1%	Not specified	Pain, sleep, anxiety and depression, quality of life: VAS, VSH, HADS, RSCL	No effect on the pain intensity, anxiety and depression level, and quality of life; improvement of sleep scores
Yayla and Ozdemir ³⁸ , Turkey	Quasi experimental	n = 123; mean age = 53.7 y; 68.3% female; multiple types of cancer;	Inhalation aromatherapy: inhalation of 3 drops of lavender essential oil on a	Lavandula officinalis	Pain, anxiety: VAS, STAI	Reduction of the pain intensity;

(continued on next page)

Table 1 (continued)

Author, country	Research design	Participants: number, age, gender, type of cancer, condition for lavender use	Intervention	Type of lavender	Outcome measurement	Result
Yu and Seol ⁴⁶ , Republic of Korea	RCT	n = 66; mean age = 60.9 y; 36.4% female; colorectal cancer; before the removal of internal urinary catheters after surgery	cotton ball for 3 min before inserting needle into an implantable intravenous port catheter Inhalation aromatherapy: inhalation of 1 ml 1% lavender oil or 1% linalyl acetate (core constituent of lavender) onto gauze for about 20 min after surgery	(Lavandula angustifolia) Lavandula angustifolia	Pain, blood pressure and heart rate, and urinary symptoms and micturition function: VAS, electronic manometer, LUTS questionnaire	no effect on the anxiety level Reduction of the post-operative pain intensity both in the lavender and linalyl acetate group; no significant effect on blood pressure, heart rate and urinary symptoms; reduction of urinary residual sense

AML: Acute Myeloid Leukemia; GAD-7: Generalized Anxiety Disorder-7; HADS: Hospital Anxiety and Depression Scale; LUTS: Lower Urinary Tract Symptoms; OAI-23: Ostomy Adjustment Inventory-23; PSQI: Pittsburgh Sleep Quality Inventory; RCT: Randomized Controlled Trials; RCSQ: Richard-Campbell Sleep Questionnaire; RSCL: Rotterdam Symptom Checklist; SAI: State Anxiety Inventory; SQOLS: Stoma Quality of Life Scale; STAI: State-Trait Anxiety Inventory; VAS: Visual Analogue Scale; VSH: Verran and Snyder-Halpern

patch for inhalation aromatherapy. The purity of lavender essential oil applied for aromatherapy massage in two studies was 5% and 1% and the duration of massage was 10 min and 30 min, respectively. The studies included in the review reported no side effects from the use of lavender.

3.5. The effect of lavender on cancer complications

3.5.1. Anxiety

Eight studies evaluated the effect of lavender aromatherapy on the anxiety level. A RCT study showed that inhalation aromatherapy using three drops of 10% lavender essential oil for 15 min decreased anxiety in patients with leukemia or solid cell carcinoma before the biopsy³⁹. Another RCT reported that inhalation aromatherapy using three to four drops of 100% lavender essential oil for 20 min on the day of surgery decreased anxiety levels before the surgery in patients with breast cancer³⁵. A quasi-experimental study found that inhalation aromatherapy using thirty drops of 3% lavender essential oil for 60 min alleviated the anxiety level among in-home hospice patients with cancer⁴². In addition, the study by Ozkaraman et al³⁷, showed that inhalation aromatherapy using lavender essential oil during chemotherapy and one month after chemotherapy every night for five minutes decreased the anxiety level in patients with cancer. Moreover, in a prospective feasibility study, inhalation aromatherapy using a 55 ml lavender-infused inhalation patch during sleep at night decreased the anxiety level in patients admitted to the hematology-oncology unit⁴³. Furthermore, a RCT study reported that twice aromatherapy massage using 'Back Massage Guide' with 5% lavender oil for ten minutes decreased the anxiety level before surgery in patients suffering from colorectal cancer³⁴.

On the other hand, two studies showed that aromatherapy using lavender had no effect on the anxiety level. A quasi-experimental study in patients with cancer demonstrated that inhalation aromatherapy using 3 drops of lavender essential oil for 3 min before inserting the needle into an implantable intravenous port catheter had no effect on the anxiety level³⁸. Moreover, according to Soden et al.'s⁴⁵ study, 30-minute back massage weekly for four weeks using lavender essential oil 1% had no effect on the anxiety level among patients with cancer in palliative care units.

3.5.2. Pain

Four studies investigated the effect of lavender aromatherapy on the

pain intensity. A quasi-experimental study showed that inhalation aromatherapy using two drops of 2% lavender essential oil for three nights decreased the pain intensity in patients with AML during chemotherapy⁴⁰. In addition, the study by Yayla and Ozdemir³⁸, showed that inhalation aromatherapy using 3 drops of lavender essential oil for 3 min decreased pain raised due to inserting the needle into an implantable intravenous port catheter. Furthermore, it was shown that inhaling 1 ml 1% lavender oil or 1% linalyl acetate for about 20 min after surgery decreased the postoperative pain intensity⁴⁶. However, one study demonstrated that 30-minute back massage weekly for four weeks using lavender essential oil 1% had no effect on the pain severity in patients with cancer in palliative care units⁴⁵.

3.5.3. Sleep

Four studies evaluated the effect of lavender aromatherapy on the sleep status. A RCT study revealed that ten minutes massage applying 'Back Massage Guide' using 5% lavender oil improved sleep quality before surgery in patients with colorectal cancer³⁴. Another study using a RCT design showed that sleep quality improved in cancer patients admitted to the oncology ward after receiving inhalation aromatherapy using three drops of 100% lavender essential oil for 7 days before bedtime for 20 min⁴¹. Furthermore, inhalation aromatherapy using lavender essential oil during chemotherapy and one month after chemotherapy every night for five minutes improved sleep quality in patients with cancer³⁷. Soden et al.'s⁴⁵ study also reported that 30-minute back massage weekly for four weeks using lavender essential oil 1% improved sleep scores in patients with cancer in palliative care units.

3.5.4. Vital signs

In three studies, the effect of lavender aromatherapy on the different parameters of vital signs was evaluated. In the study by Goepfert et al⁴⁴, breath and heart rate, and diastolic, systolic, and mean arterial pressure decreased following inhalation aromatherapy using 3–4 drops of lavender oil for 10 min in palliative cancer patients. In addition, it was found that inhalation aromatherapy using thirty drops of 3% lavender essential oil for 60 min decreased heart rate and blood pressure in in-home hospice cancer patients⁴². However, one study showed that inhalation aromatherapy using 1 ml 1% lavender oil or 1% linalyl acetate had no effect on blood pressure and heart rate in patients with colorectal cancer who underwent surgery⁴⁶.

3.5.5. Other complications

In a RCT study by Duluklu and Celik³⁶, applying 10 drops of lavender essential oil into a clean bag during colostomy bag exchange for one month decreased ostomy odor and improved quality of life and adaptation to ostomy care in patients with colorectal cancer with a permanent colostomy. In addition, inhalation aromatherapy using thirty drops of 3% lavender essential oil for 60 min decreased the depression intensity and improved the sense of well-being among in-home hospice cancer patients⁴². Moreover, a RCT study showed that inhalation of 1 ml 1% lavender oil or 1% linalyl acetate for about 20 min after surgery before the removal of internal urinary catheters for colorectal cancer decreased urinary residual sense⁴⁶. On the other hand, the findings of one study showed that aromatherapy massage using lavender had no effect on the depression level and quality of life in patients with cancer in palliative care units⁴⁵.

4. Discussion

This review aimed to integrate and synthesize evidence regarding the effectiveness of lavender in the reduction of cancer complications. Our review findings showed that the use of lavender had a positive effect on complications experienced by patients with cancer.

The included studies mostly showed that inhalation aromatherapy or aromatherapy massage effectively reduced the anxiety level in patients with cancer. Similarly, a systematic review by Tabatabaiechehr and Mortazavi²⁶ reported that aromatherapy using lavender reduced maternal anxiety during labor. Another systematic review and network meta-analysis concluded that various methods for the administration of lavender including inhalation aromatherapy, aromatherapy massage, and its oral use relieved patients' anxiety⁴⁷. The effectiveness of lavender aromatherapy in reducing the anxiety level has been shown in different populations including older adults⁴⁸, menopausal women²⁵, and patients undergoing cardiac surgery²⁷. However, in our review, inhalation aromatherapy and aromatherapy massage using lavender had no effect on the anxiety level among patients with cancer before inserting needle into an implantable intravenous port catheter and also in palliative care units. Similar to our review findings, it has been shown that inhalation aromatherapy using lavender had no significant effect on anxiety prior to a scheduled colonoscopy or esophagogastroduodenoscopy⁴⁹.

The review findings demonstrated that inhalation aromatherapy using lavender essential oil reduced postoperative pain and pain intensity during chemotherapy and inserting the needle into an implantable intravenous port catheter in patients with cancer. Similarly, the findings of a systematic and meta-analysis showed that the use of lavender in any form had a significant effect on pain relief in postpartum²⁸. Other systematic reviews reported that aromatherapy using lavender reduced labor pain²⁶ and pain in patients undergoing cardiac surgery²⁷. The reduction of pain intensity after lavender aromatherapy can be attributed to the stimulation of certain receptors in the olfactory system, which in turn sends a message to the limbic system. The limbic system can release endorphins, enkephalin, and serotonin, which have pain-relieving and relaxation effects^{50,51}.

According to our review findings, aromatherapy using lavender improved sleep quality in patients with cancer. A systematic review showed that aromatherapy using lavender improved sleep quality in menopausal women²⁵. Another systematic review by Cheong et al⁵² found that the use of inhalation aromatherapy using lavender had a relieving impact on sleep problems. Other studies reported that lavender significantly improved sleep quality in cardiac patients^{53,54}, palliative care patients⁵⁵, patients with diabetes mellitus type II⁵⁶, and patients undergoing hemodialysis⁵⁷. The sleep-inducing effect of lavender is attributed to its anxiolytic and sedative effects⁵⁸.

In our review, two studies on inhalation aromatherapy supported the effect of lavender on the reduction of breath, heart rate, and blood pressure, but one study showed no effect on blood pressure and heart

rate. On the other hand, a systematic review found that lavender aromatherapy effectively decreased systolic and diastolic blood pressure in menopausal women²⁵. Another systematic review indicated that aromatherapy using lavender oil had favorable effects on the reduction of systolic blood pressure and heart rate, but it had no significant impact on diastolic blood pressure⁵⁹. Furthermore, previous studies have shown that lavender inhalation effectively decrease systolic blood pressure and heart rate in patients undergoing oral surgery⁶⁰, respiratory rate in patients with benign prostatic hyperplasia in the preoperative period⁶¹, systolic and diastolic blood pressure and heart rate in patients admitted to the open heart surgery intensive care unit⁶². Linalool and Linalyl acetate are the central component of lavender. These components have sedative and analgesic effects, provoke the parasympathetic system that can lead to the reduction of heart rate, blood pressure, and improvement of heart function⁵³. Some studies reported that lavender had no significant impact on vital signs^{63,64}.

Based on our review findings, in one RCT study, lavender essential oil into a clean bag during colostomy bag exchange, decreased ostomy odor and adaptation to ostomy care. Appropriate ostomy odor management maintain patient dignity⁶⁵. The results of a comprehensive review showed that different natural compounds with a natural origin such as lavender were suggested to control wound malodor⁶⁶.

According to our review findings, two studies supported the use of lavender for the improvement of quality of life and well-being in patients with cancer whereas the other one reported that it had no effect on quality of life. Similarly, previous studies showed that the use of lavender aromatherapy improved quality of life in patients undergoing hemodialysis⁶⁷, postmenopausal women⁶⁸, patients with diabetes⁶⁹, and patients with fibromyalgia⁷⁰.

In the included studies in this systematic review, no side effects associated with lavender use in patients with cancer were reported. This indicates the safety of lavender use in these patients. Despite rare side effects associated with lavender use, healthcare providers should assess patients to identify probable lavender's side effects such as allergic reaction in terms of eczema, shortness of breath, swollen, redness, erythema, lichenification, contact dermatitis, and estrogenic and antiandrogenic activity such as gynecomastia⁷¹.

4.1. Strengths and limitations

To the best of our knowledge, this systematic review has been the first one to investigate the effect of lavender on cancer complications. However, the included studies in this review mostly did not provide sufficient methodological information that hindered the appropriate assessment of their risk of bias. In addition, a meta-analysis could not be conducted due to the great disparity in data collection procedures, lavender doses, administration methods, and exposure times. Therefore, a definite decision about how to use lavender in patient care should be made with caution.

5. Conclusion

The use of lavender for mitigating cancer complications including the anxiety level, pain intensity, sleep quality, and vital signs has been suggested. The findings of this systematic review can be used to incorporate lavender as an alternative and complementary method into routine care for the reduction of cancer complications and related sufferings in patients with cancer. This safe and non-pharmacological therapy can be educated to patients and their informal caregivers for use along with other therapeutic measures at home. Further studies using strong experimental designs should be conducted to identify the standardized form, concentration, duration, and route of the administration of lavender and examine its effect on cancer complications.

CRedit authorship contribution statement

Abbas Mardani and Maryam Maleki: Conceptualization, Methodology, Validation, Resources, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Nasrin Hanifi and Yasaman Borghai:** Methodology, Investigation, Data curation, Writing – original draft. **Mojtaba Vaismoradi:** Conceptualization, Methodology, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization.

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Declaration of Competing Interest

The authors declare no conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ctim.2022.102836](https://doi.org/10.1016/j.ctim.2022.102836).

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