

Research Article

The Use of Essential Oils in Pediatric Care: An Integrative Review

Márcia Regina Rigon^{1,2*}, Nathalia Nahas Donatello^{1,3*}, Lia Karina Volpato^{1,2}, and Anna Paula Piovezan^{1,2#}

¹Postgraduate Program in Health Sciences, University of Southern Santa Catarina at Palhoça, Brazil

²School of Medicine, University of Southern Santa Catarina at Palhoça, Brazil

³Experimental Neuroscience Laboratory (LaNEx), University of Southern Santa Catarina at Palhoça, Brazil

#The authors Márcia Regina Rigon e Nathalia Nahas Donatello collaborated equally in this study

*Corresponding author

Anna Paula Piovezan, PhD. Universidade do Sul de Santa Catarina (UNISUL), Campus Grande Florianópolis, Avenida Pedra Branca, 25, Palhoça, SC, Brasil, 88137-270, Tel: 55 48 98490-7241; Email: anna.piovezan@unisul.br

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Abstract

Problem: It is quite common the appearance of disorders of various natures in children and its adequate management its necessary to prevent worsening and improve quality of life. Complementary therapies are an available and growing resource to assist in a nurse setting, such as aromatherapy which can be an excellent tool within clinical practice and assist in the treatment of many childhood conditions. This review aimed to gather evidence of studies that used essential oils as treatment, in children up to 12 years old, and the outcomes observed by them.

Eligibility criteria: Clinical trials or observational studies that evaluated the use of essential oils on the treatment of childhood conditions published till April of 2021, in English, Portuguese, Spanish, Italian or French. The data bases NDLTD, Brazilian digital library of theses and dissertations (BDLTD), CAPES Repository, BIREME, The Directory of Open Access Journals (DOAJ), EMBASE, and Pubmed were searched for studies.

Sample: 22 studies were included in this review.

Results: Pain and anxiety are the most studied conditions, and Lavender is the most used essential oil on the studies included. It is inferred from the studies that aromatherapy is a low-cost and easy-to-apply method, which can be applied with some safety throughout childhood.

Conclusion: It is concluded that Aromatherapy can be used within pediatric care by nurses and other health professionals, but it is important to carry out more studies that also check for side effects and standardize effective and safe doses, to allow the professionals to make a safe prescription. When performed, it is important that the studies' methodology is adequate and the scientific name of essential oils, as well as their concentrations and chemical profile are specified.

Implications: Aromatherapy as care in childhood has been adopted by the multidisciplinary team and parents/guardians, demonstrating the importance of physical and mental well-being in this age group. Given its wide use in childhood disorders, as well as multiple application routes, ease of use and good cost-effectiveness, new studies are essential for individual or collective implementation for the benefit of children, family members and professionals involved in the care.

INTRODUCTION

Because of their developing organism and an immature immune system, children are subject to the appearance of various disorders, which often, despite being simple, generate great discomfort and cause parents' apprehension [1]. When it comes to child morbidity and mortality, much has been done, but it is still a major public health problem in the world [2].

Among the common childhood illnesses, we have insomnia, which affects up to 27% of children intermittently, persisting in 4% of them, thus worsening the quality of life and health of this age group, increasing the risk of developing another disease, such as functional abdominal pain disorders that lead to anxiety in 42% to 85% of children affected by the disease, bringing substantial costs, unnecessary invasive procedures, school dropout and socio-emotional problems [3,4].

Appropriate and conscientious behavior of mothers/guardians regarding childhood diseases is one of the ways to prevent their complications, however, there is clear evidence of underutilization of medicines to control childhood disease among social groups, when the professional provider of the prescription, discusses in a limited way the use of complementary medicine, thus verifying the relevance of communication and knowledge in this area of medicine [5].

Intervention with allopathic drugs is not always necessary or it could be reduced if associated with another complementary alternative. The American Academy of Pediatrics described the need for reliable information and quality studies to support pediatricians, recognizing the growing use of complementary medicine in pediatrics. For example, in asthma this practice has been increasing, not in a competitive way, but as an adjuvant to

conventional medicine, suggesting that physicians be receptive to the families who use it, thus aiming to increase adherence to the follow-up proposed by the professional [6,7].

In a survey by the American Academy of Allergy, Asthma and Immunology, which examined the use and adverse effects of complementary and alternative medicine, it revealed that more than 80% of physicians had patients who used this practice, sometimes with adverse effects, thus requiring study its use and effects in a standardized way [8].

Aromatherapy is a safe, effective, and fast-acting practice in the treatment of various childhood conditions, and it can be an excellent tool within clinical practice. However, because essential oils are highly concentrated plant extracts rich in chemical substances, there is a need for their use with knowledge, precaution, and precision, especially in the case of children [1]. In addition to its action on the Central Nervous System, helping to balance emotions, behavior and stress control, aromatherapy has been shown to be an effective therapy in combating bacteria and viruses, as it enhances the immune system. Because they have a complex and varied chemical composition, in addition to not creating dependence on the body, essential oils also have the advantage of being less likely to create viral resistance, unlike conventional drugs [9].

This review aimed to gather evidence of clinical trials and observational studies that applied essential oils in treatments for different childhood conditions, in children up to 12 years old. Emphasizing the conditions studied, outcomes observed, essential oils studied, and their forms of application and the outcomes observed by them.

MATERIAL AND METHODS

Search characterization and strategy

The present work is characterized as an integrative review. The data bases ND LTD, Brazilian digital library of theses and dissertations (BD LTD), CAPES Repository, BIREME, The Directory of Open Access Journals (DOAJ), EMBASE, and Pubmed were searched for studies. The objective was to find studies that evaluated the use of essential oils on the treatment of childhood conditions published till April of 2021. The keywords used in the search were: aromatherapy AND children; aromatherapy AND infants; aromatherapy AND pediatrics; aromatherapy AND babies; essential oil AND children; essential oil AND infants; essential oil AND pediatrics; essential oil AND babies. In the data bases that allowed filters, the limit "research articles" was applied.

The entire process was performed independently by two reviewers and then results were compared. Disagreements of which studies should be included were resolved by consulting a third reviewer. All duplicates were excluded.

Eligibility Criteria

Inclusion criteria were: application of essential oils as treatment, children as subjects, clinical trials or observational studies as study design, published in Portuguese, English, Spanish, French or Italian. The established exclusion criteria were: children over the age of 12, articles that couldn't be read on full.

Data extraction and management

The selected studies were added to the Mendeley software and adapted and tabulated in the Microsoft Office Word® program, organized into tables to better expose systematically the findings analyzed: authors' names; date of publication of the study; sample size and age; conditions studied; form of intervention; results; conclusion and limitations.

RESULTS

Study selection

Screening and selection process for the trials are delineated in Figure 1. Our initial search obtained 660 records. A total of 274 records were retained after removing the duplicated. After screening on the titles and abstracts, we removed 194 records which were not clinical trials, observational studies, or did not fit our inclusion criteria. 69 Full-text articles were assessed for eligibility. Of those, 4 had to be excluded for being in another language, 37 because the age of the subjects was out of the scope or the authors did not state clearly, and 6 because the methodology did not fit the criteria, some didn't specify the essential oil used, others did not use essential oils, or due the type of study.

Study characteristics

Characteristics of the 22 included trials are summarized in Table 1. These trials were published between 2000 and 2021, with sample sizes ranging from 16 to 195 patients, age of participants ranging from neonates to 12 years old.

Table 2 presents the conditions studied, main outcomes observed, essential oils studied and how they were used.

Some of the studies included evaluated the action of essential oils on bacteria, and insects, with satisfactory results. Lobo et al. [18], published a double-blind randomized controlled study that investigated the efficacy of three formulations of the essential oil of Rosemary pepper (*Lippia sidoides Cham*) in reducing salivary Streptococcus mutans in children with caries. Eighty-one participants aged 6 to 12 years were divided into groups and each group received different topical treatments. Treatments were with toothpaste with 1.4% essential oil, or gel with 1.4% essential oil, or mouthwash with 0.8% essential oil or gel with 1% chlorhexidine or mouthwash with 0.12% chlorhexidine. The treatment was applied for 1 minute, once a day for 5 consecutive days. The researchers concluded that the essential oil toothpaste demonstrated the most lasting and effective reduction of caries-causing bacteria in the participants' saliva [18]. The dose and formulation of toothpaste and gel with these essential oils was determined through a previous study carried out by the same research group published in 2011 [14].

Published in 2010 by Barker and colleagues, this randomized-blind, comparative efficacy study with 123 participants compared the efficacy and safety of three topical pediculicides: one containing 10% Tea Tree essential oil with 1% Lavender essential oil; and two conventional ones, one "suffocation" product and one containing pyrethrins and piperonyl butoxide. The treatment was according to the manufacturer's guidelines and the presence of lice was observed the day after the end of

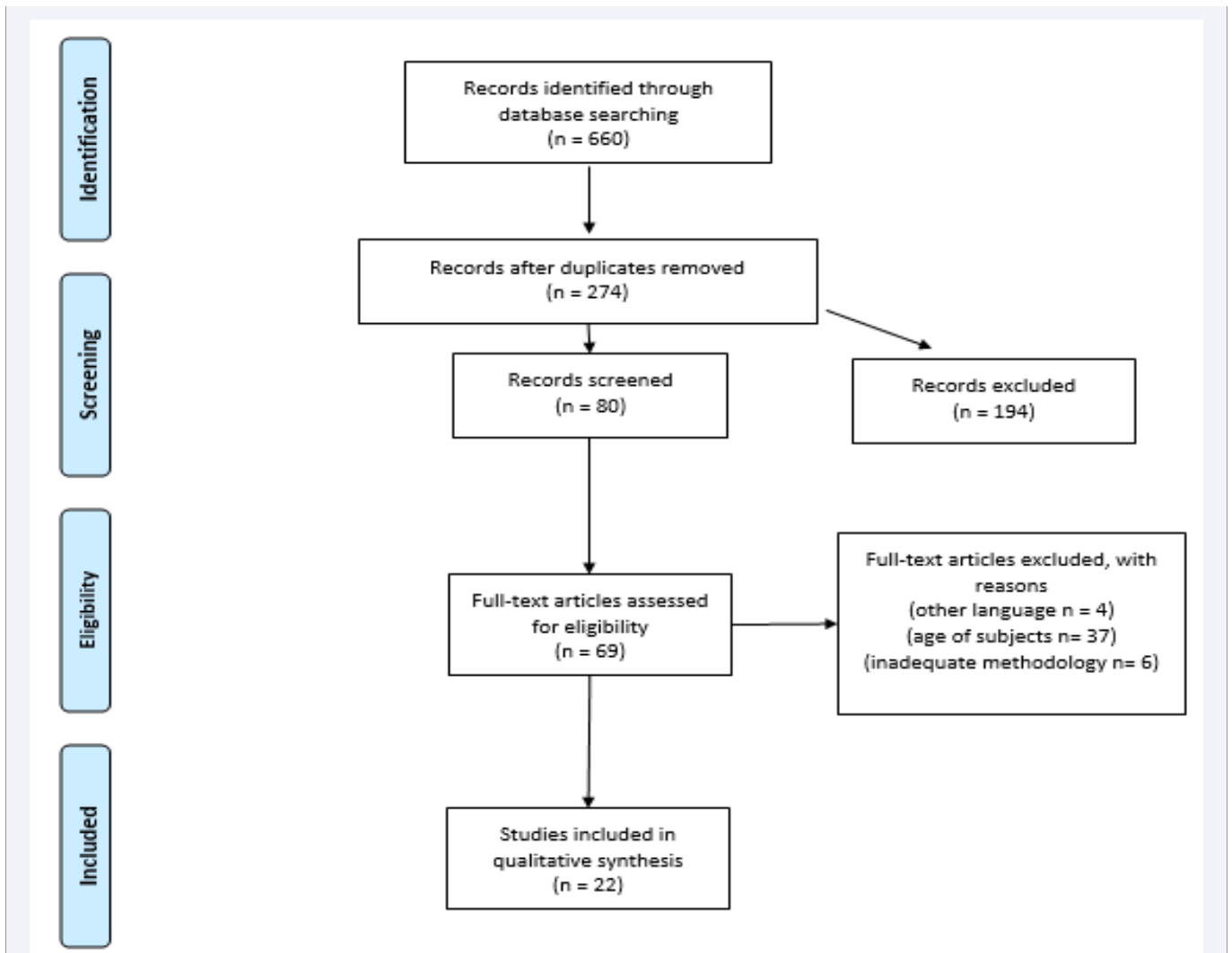


Figure 1 Flow Diagram.

Table 1: Characteristics of the studies.

Author	Title	Year	Sample N	Age	Type of Study
Anderson et al [10]	Evaluation of massage with essential oils on childhood atopic eczema.	2000	16	3-7 y	Preliminary trial
Fernandez et al	EEG during lavender and rosemary exposure in infants of depressed and non-depressed mothers.	2004	20	nbn	Preliminary trial
Barker et al [11],	A randomised, assessor blind, parallel group comparative efficacy trial of three products for the treatment of head lice in children - melaleuca oil and lavender oil, pyrethrins and piperonyl butoxide, and a "suffocation" product.	2010	123	4-12 y	randomised, assessor-blind, comparative, parallel study
Barker et al [12]	An <i>ex vivo</i> , assessor blind, randomised, parallel group, comparative efficacy trial of the ovicidal activity of three pediculicides after a single application - melaleuca oil and lavender oil, eucalyptus oil and lemon tea tree oil, and a "suffocation" pediculicide.	2011	92	4-12 y	assessor-blind, randomised, parallel group, comparative study.
De Jong et al [13]	Does postoperative 'M' technique® massage with or without mandarin oil reduce infants' distress after major craniofacial surgery?	2011	60	3-36 m	single center, observer blinded, randomized controlled trial
Lobo et al [14]	Dose-response evaluation of a novel essential oil against Mutans streptococci in vivo.	2011	37	6-12 y	Randomized clinical trial

Çetinkaya et al [15]	The effectiveness of aromatherapy massage using lavender oil as a treatment for infantile colic.	2012	40	2-6 w	quasi-experimental trial with randomized research with a control group not given the intervention in a 'time series' model
Jafarzadeh et al [16]	Effect of aromatherapy with orange essential oil on salivary cortisol and pulse rate in children during dental treatment: A randomized controlled clinical trial.	2013	30	6-9 y	Randomized control trial, crossover design study,
Soltani et al [17]	Evaluation of the effect of aromatherapy with lavender essential oil on post-tonsillectomy pain in pediatric patients: a randomized controlled trial.	2013	48	6-12 y	randomized controlled prospective clinical trial.
Lobo et al [18]	The efficacy of three formulations of Lippia sidoides Cham. essential oil in the reduction of salivary Streptococcus mutans in children with caries: a randomized, double-blind, controlled study.	2014	81	6-12 y	randomized, double-blind, in parallel with an active control study
Cagetti et al	Effect of a toothpaste containing triclosan, cetylpyridinium chloride, and essential oils on gingival status in schoolchildren: a randomized clinical pilot study.	2015	48	8-10 y	randomized clinical pilot study
Bikmoradi et al [19],	Effect of inhalation aromatherapy with lavender essence on pain associated with intravenous catheter insertion in preschool children: A quasi-experimental study.	2017	60	3-6 y	quasi-experimental study
Keyhanmehr	The Effect of Aromatherapy with Rosa damascena Essential Oil on Sleep Quality in Children.	2017	30	5-12 y	experimental pretest-posttest evaluation that
Vaziri et al [20],	Lavender Oil Aromatherapy on Infantile Colic and Maternal Mood: A Double Blind Randomized Clinical Trial.	2018	66	4-8 w	Double Blind Randomized Clinical Trial
Ahirwar et al [21],	A clinical trial comparing antimicrobial efficacy of "essential oil of Ocimum sanctum" with triple antibiotic paste as an intracanal medicament in primary molars.	2018	40	4-9 y	Longitudinal Clinical trial
Hawkins et al [22],	Bergamot Aromatherapy for Medical Office-Induced Anxiety Among Children with an Autism Spectrum Disorder.	2019	28	6-11 y	blinded, randomized controlled trial
Vaziri et al [23],	The Effect of Aromatherapy by Lavender Oil on Infant Vaccination Pain: a Double Blind Randomized Controlled Trial.	2019	97	2 m	Double Blind Randomized Controlled Trial
Küçük Alemdar et al [24],	The Use of the Buzzy, Jet Lidokaine, Bubble-blowing and Aromatherapy for Reducing Pediatric Pain, Stress and Fear Associated with Phlebotomy.	2019	195	5-10 y	prospective, randomized controlled trial
Ghaderi et al [25],	The effects of lavender aromatherapy on stress and pain perception in children during dental treatment: A randomized clinical trial.	2020	24	7-9 y	crossover randomized clinical trial
Razaghi, et al [26]	The effectiveness of familiar olfactory stimulation with lavender scent and glucose on the pain of blood sampling in term neonates: A randomized controlled clinical trial.	2020	120	nbn	single-blind, clinical trial
Arslan et al [27],	Can lavender oil inhalation help to overcome dental anxiety and pain in children? A randomized clinical trial.	2020	126	6-12 y	randomized controlled clinical trial
Usta el al [28],	Pain Control with Lavender Oil in Premature Infants: A Double-Blind Randomized Controlled Study.	2021	61	premature infants	double-blind randomized controlled clinical study

N = number; y= years old; m= months old; nbn= newborns; w= weeks old;

Table 2: Conditions and treatments studied.

Author	Study	Condition	Essential oil	Application
Ahirwar et al [21]	A clinical trial comparing antimicrobial efficacy of "essential oil of <i>Ocimum sanctum</i> " with triple antibiotic paste as an intracanal medicament in primary molars.	Teeth with evident clinical signs of furcal abscess/periapical abscess/draining sinus	Tulsi/Basil (<i>Ocimum sanctum</i> Linn.)	One drop applied directly in root canal.
Cagetti et al, 2015	Effect of a toothpaste containing triclosan, cetylpyridinium chloride, and essential oils on gingival status in schoolchildren: a randomized clinical pilot study	Supragingival dental plaque and bleeding	<i>Thymus vulgaris</i> , <i>Melaleuca alternifolia</i> , <i>Commiphora myrrha</i>	toothpaste containing sodium fluoride (0.1%), triclosan (0.05%), cetylpyridinium chloride (0.03%) and essential oils (concentrations not specified)
Lobo et al [14]	Dose-response evaluation of a novel essential oil against Mutans streptococci in vivo.	Dental caries	<i>Lippia sidoides</i> Cham.	topical treatment rinse at 0.6%; 0.8%; 1%; or 1.2%; gel formulations at concentrations of 0.8%; 1%; 1.2%; or 1.4%.
Lobo et al [14]	The efficacy of three formulations of <i>Lippia sidoides</i> Cham. essential oil in the reduction of salivary <i>Streptococcus mutans</i> in children with caries: a randomized, double-blind, controlled study.	Dental caries	<i>Lippia sidoides</i> Cham.	Toothpaste or gel with a 1.4% concentration. Mouthwash with a 0.8% concentration.
Barker et al [11]	A randomised, assessor blind, parallel group comparative efficacy trial of three products for the treatment of head lice in children - melaleuca oil and lavender oil, pyrethrins and piperonyl butoxide, and a "suffocation" product	Head lice	Melaleuca (tea tree) and lavender	Topic application of a clear oily solution containing Melaleuca oil 10% w/v and lavender oil 1% w/v (NeutraLice Lotion® Key Pharmaceuticals Pty Ltd, Australia)
Barker et al [12]	An <i>ex vivo</i> , assessor blind, randomised, parallel group, comparative efficacy trial of the ovicidal activity of three pediculicides after a single application - melaleuca oil and lavender oil, eucalyptus oil and lemon tea tree oil, and a "suffocation" pediculicide.	Head lice	1. Melaleuca (tea tree) and lavender 2. Eucalyptus and lemon tea tree	1. Topic application of a clear oily solution containing Melaleuca oil 10% w/v and lavender oil 1% w/v (NeutraLice Lotion® Key Pharmaceuticals Pty Ltd, Australia) 2. Topic application of a clear oily solution containing eucalyptus oil 11% w/w and lemon tea tree oil 1% (MOOV Head Lice Solution®, Ego Pharmaceuticals Pty Ltd, Australia)
Hawkins et al [22]	Bergamot Aromatherapy for Medical Office- Induced Anxiety Among Children with an Autism Spectrum Disorder	Anxiety among children who have an autism spectrum disorder.	Bergamot (<i>Citrus bergamia</i>)	inhalation - 5 drops of undiluted
Arslan et al [27]	Can lavender oil inhalation help to overcome dental anxiety and pain in children? A randomized clinical trial	Anxiety during dental intervention	Lavender (<i>Lavandula angustifolia</i> Mill)	Inhalation - Two drops undiluted (0.1 cc per drop)
Jafarzadeh et al [16]	Effect of aromatherapy with orange essential oil on salivary cortisol and pulse rate in children during dental treatment: A randomized controlled clinical trial	Anxiety during dental treatment	Orange (<i>Citrus sinensis</i>)	Inhalation – 2 ml diffused per 10m ²
Ghaderi et al [14]	The effects of lavender aromatherapy on stress and pain perception in children during dental treatment: A randomized clinical trial	Anxiety and pain during dental treatment	Lavender (<i>Lavandula angustifolia</i>)	Inhalation – 2 drops pure
De Jong et al [13]	Does postoperative 'M' technique® massage with or without mandarin oil reduce infants' distress after major craniofacial surgery?	Levels of pain and distress, heart rate and mean arterial pressure after major craniofacial surgery	Mandarin (<i>Citrus reticulata</i>)	Massage with mandarin 1% (in carrier oil - <i>Prunus amygdalus</i> var. <i>Dulcis</i>).

Bikmoradi et al [19]	Effect of inhalation aromatherapy with lavender essence on pain associated with intravenous catheter insertion in preschool children: A quasi-experimental study	Pain severity of intravenous catheter insertion	Lavender	Inhalation - 5 drops of 2% lavender essence oil distilled in alcohol
Soltani et al [17]	Evaluation of the effect of aromatherapy with lavender essential oil on post-tonsillectomy pain in pediatric patients: a randomized controlled trial	Post-tonsillectomy pain	Lavender	Inhalation - 4 droplets
Usta el al [28]	Pain Control with Lavender Oil in Premature Infants: A Double-Blind Randomized Controlled Study.	Pain in preterm infants during heel lancing	<i>Lavandula angustifolia</i> Miller	Inhalation (6 drops—80 mg, Nova Relaxa)
Vaziri et al [20]	The Effect of Aromatherapy by Lavender Oil on Infant Vaccination Pain: a Double Blind Randomized Controlled Trial	Pain during vaccination	Lavender	Inhalation – 5 drops of a 0.5% concentration in sweet almond oil
Razaghi, et al [26]	The effectiveness of familiar olfactory stimulation with lavender scent and glucose on the pain of blood sampling in term neonates: A randomized controlled clinical trial	blood sampling pain in term neonates.	Lavender	Inhalation - 10 drops of a 0.5% concentration in glycerin solution
Küçük Alemdar et al [24]	The Use of the Buzzy, Jet Lidokaine, Bubble-blowing and Aromatherapy for Reducing Pediatric Pain, Stress and Fear Associated with Phlebotomy	Pain, stress, and fear during phlebotomy	Lavender	Inhalation – 5 ml of the following mixture: 1 drop of lavender oil into a 20 ml-glass jar containing 20 ml of distilled water.
Çetinkaya et al [15]	The effectiveness of aromatherapy massage using lavender oil as a treatment for infantile colic.	Infantile colic	Lavender	Massage – 1 drop of essential oil in 20 cc of almond oil. Only allowed to use 1cc per day.
Vaziri et al [23]	Lavender Oil Aromatherapy on Infantile Colic and Maternal Mood: A Double Blind Randomized Clinical Trial	Infantile colic	Lavender	Inhalation – 5 drops of 1% concentration in sweet almond oil
Keyhanmehr [29]	The Effect of Aromatherapy with Rosa damascena Essential Oil on Sleep Quality in Children	Sleep disorders	<i>Rosa damascena</i>	Inhalation – 5 drops in a 10% concentration.
Anderson et al [10]	Evaluation of massage with essential oils on childhood atopic eczema	atopic eczema	<i>Litsea cubeba</i> , sweet marjoram, spike lavender, frankincense, myrrh, red thyme, benzoin (resinoid, not a true essential oil) and German chamomile	Massage – selected oils in a 1:1:1 proportion diluted in almond oil to give a 2% solution
Fernandez et al	EEG during lavender and rosemary exposure in infants of depressed and non-depressed mothers	activity and behavior in infants of depressed and non-depressed mothers.	Rosemary and lavender.	Inhalation - diluted in odorless grapeseed oil to form a 10% (v/v) solution.

the treatment. It was concluded that the “smothering” product, as well as the one with essential oils were more effective in reducing lice [11]. Both treatments also demonstrated greater ovicidal activity than another pediculicide made with Eucalyptus essential oil and Lemon Tea Tree in another study published in 2011 by the same researchers [11].

Four studies included, evaluated the action of essential oils on children’s anxiety, under different circumstances. In 2013, Jafarzadeh and colleagues published a randomized controlled clinical trial showing the effect of inhaling the essential oil of Orange (*Citrus sinensis*) on salivary cortisol and pulse rate in children aged 6 to 9 years during dental treatment. The treatment was performed using an electric aromatic diffuser with 2ml of essential oil for 10 m², which was activated for 2 minutes every 10 minutes half an hour before the arrival of the first patient. The study concluded that the use of aromatherapy with Orange

essential oil was able to significantly reduce salivary cortisol and pulse rate in children due to anxiety [16]. In 2020 Arslan et al. [27], published a randomized clinical trial in which they correlated psychological and physiological findings in 126 children between 6 and 12 years old, who underwent tooth extraction. The groups were randomly divided into control and lavender, in which the lavender group inhaled 2 drops (0.1 cc) of lavender oil poured on medical patches for 3 minutes before the interventions, as the control group did not receive any inhalation prior dental intervention. Groups were evaluated by facial image scale (FIS), Wong-Baker pain rating scale (WBS) and vital signs, before and after inhalation, anesthesia injection and tooth extraction; as a result, the lavender group had lower anxiety and pain scores after tooth extraction ($p < 0.05$) and lower heart rate levels after anesthesia injection and tooth extraction compared to the control group ($p < 0.05$). The study concluded that lavender oil may be preferred as the treatment of choice in routine pediatric

dentistry to alleviate children's anxiety and facilitate dental care [27].

Ghaderi et al, in the same year of 2020, in a randomized clinical trial with 24 children aged 7 to 9 years, evaluated the effects of lavender aromatherapy on stress and on the perception of pain during dental injection; the aromatherapy group was exposed to 2 drops of lavender essential oil poured into 100 ml of water in the humidifier and diffused into the air for 30 minutes before patient arrival; to assess the level of anxiety salivary cortisol and pulse rate were measured, and the facial rating scale (FRS), to assess the perception of pain during injection at both visits. The study concluded that lavender can reduce dental anxiety and the pain experienced in this environment by children [25].

Hawkins et al. [22], in a randomized and blind clinical trial evaluated the effects of Bergamot essential oil on anxiety triggered by the doctor's office, in 28 children aged 6 to 11 years with autism spectrum disorder. They were randomized into aromatherapy and control groups while awaiting medical consultation. Whereas the aromatherapy group was exposed to 5 drops of Bergamot essential oil for 15 minutes. The study concluded after adjusting for the baseline score, that there was no significant difference between the two groups, and the introduction of the studied oil may increase the subjective feelings of anxiety in these children [22].

The action of essential oils on the digestive system of children was also investigated by some researchers. Researchers published in 2012 a randomized quasi-experimental study that evaluated the effectiveness of lavender essential oil massage in the treatment of childhood colic. The study included 40 children aged 2 to 6 weeks of age, with gestational age of 38-42 weeks, as well as normal development and growth. For the massage, the mothers used 1 drop of lavender essential oil diluted in 20 ml of almond vegetable oil provided by the researchers and were instructed to start the massage within 1 to 2 minutes of the onset of the colic crisis, for 5 to 15 min. The intervention lasted for 5 weeks, and it was possible to conclude that the massage with essential oil of Lavender was effective in reducing colic in babies and can be indicated as a treatment option [15]. Another group also researched the effect of lavender oil inhalation on duration of daily crying in 66 infants, 4 to 8 weeks old, who suffered infantile colic. Treatment consisted in five drops of the lavender or sweet almond oil (control group) on a cotton ball tissue and held close to the infants' face at least for 15 minutes during colicky crying. The results showed that at baseline, the two groups were not different in relation to infant's crying duration, but they were significantly different after intervention in all seven days of the study ($p < 0.001$), suggesting that a 1% concentration of the lavender oil can alleviate colic symptoms [23].

Pain in children was the most frequent research object. In 2013, a randomized controlled prospective clinical trial was published evaluating the effect of inhaling Lavender essential oil (*Lavandula angustifolia*), on post-tonsillectomy pain in pediatric patients. There were 48 participants aged 6 to 12 years. After surgery, all patients received paracetamol every 6h as needed to relieve pain. The lavender-treated group dripped 4 drops of the essential oil into the palm of their hands and inhaled the essential

oil for 3 minutes every 6 hours. The group that received lavender essential oil showed a statistically significant reduction in daily use of paracetamol on the three postoperative days but had no significant effects on pain intensity and nighttime awakening frequency. It is thus concluded that the inhalation of Lavender essential oil decreases the number of analgesics needed after tonsillectomy in pediatric patients [17].

Vaziri et al, published in 2019 a clinical trial with lavender, where they evaluated the effects of aromatherapy with lavender oil in babies on vaccination' pain. Concluding that a low concentration of inhalation can reduce pain and calm children in the application of the vaccine [20]. Also evaluating the effectiveness of lavender oil, in 2020, Usta et al, published a double-blind randomized controlled trial with 61 infants, confirming the efficacy, safety, and low cost of the lavender inhalation effect on pain control, in preterm infants during heel puncture in a neonatal intensive care unit third level, where it did not interfere with the medical care provided [28]. In 2017, a quasi-experimental research was published with the objective of evaluating the effect of Aromatherapy by inhalation of Lavender essential oil on the intensity of pain of intravenous catheter insertion in hospitalized preschool children. Sixty children participated in the study and the treatment consisted of inhaling 5 drops of lavender 20 minutes before the procedure. The treated group had a significant reduction in pain when compared to the control group [19].

However, 3 studies did not demonstrate the effectiveness of aromatherapy in children in invasive procedures. Jong et al, in 2012 reported a randomized clinical trial of the effects of 'M' massage technique with or without tangerine oil compared to standard post-operative care after craniofacial surgery in infants, evaluating infant pain and distress levels, concluding that there was no difference in postoperative comfort related to the intervention, described that the likely reasons for this result would be: massage given too early after general anesthesia, fear of strangers touch, and not habituated to receiving massage [13]. In 2020, Razaghi et al, carried out a randomized, blind clinical trial with 80 full-term neonates, with a control and intervention groups, evaluating the efficacy of familiar olfactory stimulation with lavender and glucose in the pain of blood collection. Using the Douler Aigue du Nouveau-ne (DAN) scale to calculate pain score, found that the two interventions can reduce pain during blood collection and are easy and applicable procedures for the nursing staff, but there was no significant difference between the lavender and edible glucose aromatherapy groups [26].

Thus, Küçük Alemdar et al. [24], investigated the effects of Buzzy, Lidocaine jet, bubble blowing and lavender oil inhalation on pain, stress and fear in children undergoing phlebotomy in a prospective, randomized and controlled study. Thirty-nine children were divided in groups and the Oucher pain scale, Children's fear scale and salivary cortisol analysis were conducted to assess pain, fear and stress levels. A significant difference was found between the intervention and control groups in terms of pain levels during and after phlebotomy in favor of the Buzzy group and the bubble blower, therefore recommending that they be used during phlebotomy in children to reduce pain intensity [24].

Sleep disorders were assessed by Keyhanmehr et al. [29], in an experimental study published in 2018, investigating the effect of aromatherapy with *Rosa damascena* essential oil on sleep quality in 30 children with this disorder. In the intervention group, they inhaled 5 drops of the oil in a cotton ball for 20 minutes every night after going to bed, for a 2 weeks period. Before and after the intervention, the BEARS questionnaire was asked, concluding that aromatherapy was safe and can improve the quality of sleep in children [30].

Only one study included evaluated a skin problem. Anderson et al. [10], studied the effect of massage with different essential oils on atopic eczema, testing the hypothesis that used as complementary therapy in conjunction with normal medical treatment, they help to alleviate the symptoms of this disease. Sixteen children were randomly assigned to massage, and essential oil combine to massage groups, with weekly visits by the therapist throughout the treatment that taught the mother, who performed the daily massage and bath procedure with drops of the same essential oil added to water. Finally, the study showed a significant improvement in eczema in the two groups of children, but there was no significant difference in the improvement between the massage with aromatherapy and massage groups alone, showing that tactile contact between mother and child benefits eczema symptoms. The essential oil massage group showed deterioration in the eczematous condition after two additional 8-week periods of therapy, performed after a rest period, indicating the need for extended studies with new plant extracts [10].

DISCUSSION

Analyzing all included studies, negative results often reflect a methodological flaw or small sample size, and do not necessarily rule out the effectiveness of essential oils and aromatherapy as a treatment option in pediatrics. Many of the studies first analyzed also did not clearly specify their method of treatment, such as concentration, full scientific name of the essential oil, where it was obtained, etc. Clarity and precision of the supplied data and methodology used in a study it is of vital importance, to avoid confusion in the clinical practice and to guide further studies. Specially because that in the aromatherapy field, many essential oils are referred to the same popular name in different countries, and also due to the huge variety of existing essential oils. For instance, there are four main types of Lavender with different chemical compositions, therefore, they might have different effects in the organism. For this reason, we also reinforce the importance of, when possible, for authors to provide the gas chromatography of the essential oil used. This information would allow comparisons and associations with knowledge already obtained in the literature and further other researches.

It was observed in the initial search performed that there are several other studies with essential oils still in *in vitro* models that demonstrate great potential. Some studies also investigated the effect of essential oils on respiratory problems in children, but they could not be added to this review because they could not be found in full text or they were in Russian.

In the analyzed studies, it is verified the application of aromatherapy in all stages of childhood, from preterm newborns

to pre-adolescence, demonstrating its practicality and possibility, with various techniques and absorption through different routes (topical and inhalation). With a wide potential in clinical practice, from prescription by the professional to use by parents/guardians; thus, reinforcing a certain safety and positive results in its use.

It is possible to observe that the essential oil most frequent in studies it was Lavender. Its use is not just frequent in studies with children but as well in adult populations. That might be, because it is one of the most popular essential oils in aromatherapy, it is accessible, it is consider safe, and it is also very versatile. For instance some of its effects have that have been reported throughout history are: sedative, calming, analgesic, antifungal, antidepressant, antispasmodic [29,31,32]. It is evident in several of the studies with the use of Lavandula oil, in the most diverse procedures/diseases that are frequently affected in this age group, a significant reduction in anxiety, fear and pain, which can have future consequences when not treated properly in childhood. Highlighting in one of these studies, the decrease in the use of analgesics in the postoperative period, pointing to a non-pharmacological option, aiming at a better cost-benefit [17,19,20,24-28]. Another essential oil property evaluated in children was the aerobic and anaerobic antimicrobial efficacy with *Ocimum sanctum* Linn essential oil, used in long-term infection, showing a statistically significant reduction in relation to bacterial growth; given that the use of antibiotics is often associated with the development of resistance due to misuse, further studies are suggested to better understand this effect [21].

It is inferred from the studies that aromatherapy is a low-cost and easy-to-apply method, which can be applied with some safety throughout childhood, but it needs to continue to carry out studies, with an adequate design, examining its effects on childhood disorders, thus, the way to support and disseminate its safe practice and adherence by professionals in the area, contributing to more clinical trials.

CONCLUSION

It is concluded that Aromatherapy can be used within pediatrics, but it is important to carry out more studies that also check for side effects and standardize effective and safe doses, to allow the professionals to make a safe prescription. When performed, it is important that the studies' methodology is adequate and the scientific name of essential oils, as well as their concentrations and chemical profile are specified.

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