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Original Article

Effects of aromatherapy on sore throat, nasal symptoms and sleep quality in adults infected with COVID-19: A randomized controlled trial

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ABSTRACT

Background: Patients with coronavirus disease 2019 (COVID-19) usually complain of fever, cough, and sore throat. This study examined the effects of aromatherapy on sore throat, nasal symptoms, stress, fatigue, and sleep quality by administering it to adults with post-COVID-19 condition.

Methods: This study was conducted in a randomised controlled design. Its target population were adults who were released from COVID-19 quarantine treatment within 45 days from infection onset and capable of performing daily activities after isolation treatment. The participants were randomised into aromatherapy group (AG) and control group (CG). To test experimental treatment effects, the levels of sore throat, nasal symptoms, stress, fatigue and sleep quality were measured at the baseline (pre-test) and after the trial (post-test), using the numerical rating scale for sore throat, stress and fatigue, the Total Nasal Symptoms Score for nasal symptoms, and the Korean Version of Modified Leeds Sleep Evaluation Questionnaire for quality of sleep.

Results: After experimental treatment, there was a significant difference in sore throat in AG compared to CG on the 3rd day (t=-2.022 p=0.048) and 4th day (t=-2.450, p=0.017) of treatment. There was also a significant difference in fatigue between AG and CG on the 2nd day(t=-2.748, p=0.008), 3rd day (t=-2.948, p=0.005) and 4th day (t=-3.084, p=0.003) of treatment. There was no significant difference in TNSS, stress, and sleep quality between the two groups after the experimental treatment.

Conclusion: Inhaling aroma essential oils reduced sore throat and fatigue in adults with post-COVID-19 condition, demonstrating the feasibility of aromatherapy as an effective treatment.

Trial registration: The study was registered with Clinical Research Information Service (KCT0008029).

1. Introduction

COVID-19 is an infectious disease that is transmitted through droplets from an infected person through the mucous membranes of the respiratory tract, eyes, nose, and mouth. The main symptoms are fever, fatigue, cough, upper respiratory tract infection symptoms such as sore throat, and pneumonia symptoms.[1] "Long COVID" or "post-COVID-19 syndrome" is identified if one or more COVID-19 symptoms, which cannot be attributed to other diseases, persist beyond 12 weeks from infection onset. The main symptoms reported by the respondents were fatigue, anxiety, insomnia and difficulty concentrating.[2] As such, respiratory symptoms, stress, fatigue and impaired quality of sleep could be identified as common post-COVID symptoms.[2–4] Not only does COVID-19 infection cause physical symptoms such as sore throat and nasal symptoms, but it also entails psychological sequelae such as stress, fatigue and impaired quality of sleep. Recently, among intervention studies on relieving nasal and respiratory symptoms, reducing stress and fatigue and improving sleep quality, studies using nonpharmacological therapies have been actively conducted. In particular, with interest in complementary and alternative therapies continuously growing,[5] studies on aromatherapy,[6] music therapy,[7] exercise therapy[8] and meditation therapy[9,10] have been actively underway. Aromatherapy involves selecting and applying various essential oils, and eucalyptus, lemon, tea tree, and peppermint are effective in relieving upper respiratory symptoms.[11] Recent research has shown that eucalyptus is effective in relieving cough symptoms through systematic review and meta analysis of Randomized Controlled Trials.[12] Among various methods of performing aromatherapy, such as spraying, inhalation, massage, and foot bath, the method using aroma essential oil inhalation is known to be more convenient than other methods in terms of time and space.[11,13] In particular, due to the strengthened personal quarantine rules after the COVID-19 outbreak, the aroma essential oil inhalation method is considered to be the most appropriate method as it can achieve quick results without time or space constraints and allows self-administration of essential oils pro-

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vided by an aromatherapist expert.[11] Therefore, this study attempted to select aromatherapy essential oils that help relieve respiratory symptoms and essential oils that help sleep, provide them through inhalation, and confirm their effectiveness. The aim of this study was to investigate the effects of aromatherapy on sore throat, nasal symptoms, stress, fatigue, and sleep quality in adults infected with COVID-19.

2. Methods

2.1. Study design

This study is a parallel group randomized controlled trial (RCT) aimed to compare the effects of aromatherapy on sore throat, nasal symptoms, stress, fatigue, and sleep quality. Supplement 1, depicting the study design, illustrates the allocation of participants into parallel groups receiving different interventions.

2.2. Participants

After obtaining approval from the pertinent Institutional Review Board (IRB) (approval number: EU22-47), adults residing in D Metropolitan City, G Province and U City were recruited through convenience sampling by posting the recruitment announcement on bulletin boards in apartment complexes and companies after obtaining prior permission from administrators of the buildings concerned.

The selection criteria were: adults aged 20–60; post-COVID-19 patients within 7–45 days from infection onset discharged from isolation treatment; those with aggravated respiratory symptoms but not hospitalised at a government-designated hospital; those who are capable of communication, understood the purpose of the study, and gave written consent to participate in the study. Excluded from enrolment were those taking medications for hypertension, hypotension and sleep disorders, night shift workers, pregnant women and individuals with contraindications to aromatherapy essential oils. Sample size was determined using G*power 3.1.9.4.[14] The target effect size was set to 0.25, considering that there are only a very limited number of previous studies. A total required sample size of 54 was calculated by applying F-tests based on effect size =0.25, significance level =0.05, power (1-β) =0.95, number of groups =2, and number of repeated measurements =4. Considering the duration of study of five days, the minimum required sample size was increased by 10 % to 60 participants. Participants were recruited through convenience sampling using recruitment posters to select those who meet the selection criteria. During the experimental treatment and data collection process, a total of 60 participants' data were used for analysis, with no dropouts, and 30 participants in the aromatherapy group (AG) who applied essential oil inhalation and 30 participants in the control group (CG) who received usual care were analyzed (Fig. 1).To ensure randomization and concealment of participants, a total of 60 copies of questionnaire were prepared prior to recruitment, which were randomly distributed by drawing lots when participation was determined. During the study, information about the group identification was not provided(HK and HA), but concealment was impossible due to the nature of the experimental treatment.

2.3. Experimental setup

2.3.1. Selection of essential oils for aromatherapy

For the experimental treatment in this study, oils effective against respiratory symptoms, pain, fatigue, stress and sleep disorders were selected and blended, relying on the information available in the aromatherapy-related literature and the advice given by internationally renowned aromatherapists.[11]

Eucalyptus is rich in 1,8-cineole and is a representative oil for relieving respiratory symptoms, while lemon is rich in limonene and is known to be effective in strengthening immunity. Lavender is rich in linalyl acetate and is an essential oil recommended for bronchitis, colds, etc., and is an oil that stabilizes the nervous system. Peppermint is rich in menthol and is recommended for colds, flu, fever and headaches, while tea tree is rich in terpinen-4-ol and has antimicrobial effects. Ylang ylang is an oil that contains benzyl acetate and has a stabilizing effect.[11] Thus, aroma oils for experimental treatment were blended from a selection of essential oils from eucalyptus, lemon, lavender, peppermint and tea tree that are reported to be effective against respiratory tract infection, pain, fatigue and stress for day treatment, and for night treatment, a blend from a selection of lavender and ylang-ylang essential oils was prepared.

2.3.2. Experimental treatment

Two aroma essential oils were provided to the AG: (i) aroma diffuser necklaces to reduce respiratory tract infection, pain, stress and fatigue and (ii) aroma stone to improve sleep quality. The aroma oil for the diffuser necklace was blended from a selection of essential oils of eucalyptus, lemon, lavender, peppermint and tea tree mixed at the ratio of 3:3:2:2:1

Each participant was provided with a necklace with a diffuser with 1-cc aroma oil blend attached to it. The aroma diffuser necklace was worn during the daytime, and the participants were instructed to inhale the oil for 1 min, holding the diffuser within 10 cm of their nose in the time slots determined by the researcher: in the morning (9:00-10:00), in the early afternoon (13:00-14:00) and in the evening (18:00-19:00). The aroma oil for the aroma stone was blended from lavender and ylang-ylang essential oils at the ratio of 8:2, of which 3 cc was put in an empty bottle and provided to each participant of the AG together with an aroma stone. The participants were instructed to prepare their own aroma stones by dropping three drops of aroma oil on the stone before going to bed and place it within a 30 cm-radius around the head. The experiment was ended upon finishing data collection from the intended number of participants.

The CG was allowed to receive usual care during the 4 days of the trial. Upon completion of data collection of the CG, an aroma necklace with a diffuser containing oil was additionally given to those who wanted to try aroma essential oil inhalation therapy.

2.4. Outcomes

The primary outcome variables of this study were sore throat and nasal symptoms, while the secondary outcome variables included perceived stress, fatigue, and sleep quality. All instruments employed in this study were used after obtaining approval from the original authors and translators.

2.4.1. Sore throat

The intensity of perceived pain from sore throat was measured using a numerical rating scale (NRS) by instructing the participant to select the number corresponding to the intensity of perceive pain on a straight-line scale from zero to 10, with a higher number indicating a higher pain intensity.

2.4.2. Nasal symptoms

Nasal symptoms were assessed using the Total Nasal Symptom Score (TNSS)[15] developed by Linder and translated into Korean provided gratis by the Korea Allergy Association.

2.4.3. Perceived stress

Perceived stress was measured using the NRS. The participant was asked to select the number corresponding to the level of perceived stress on a straight-line scale from zero to 10, with a higher number indicating a higher level of perceived stress.

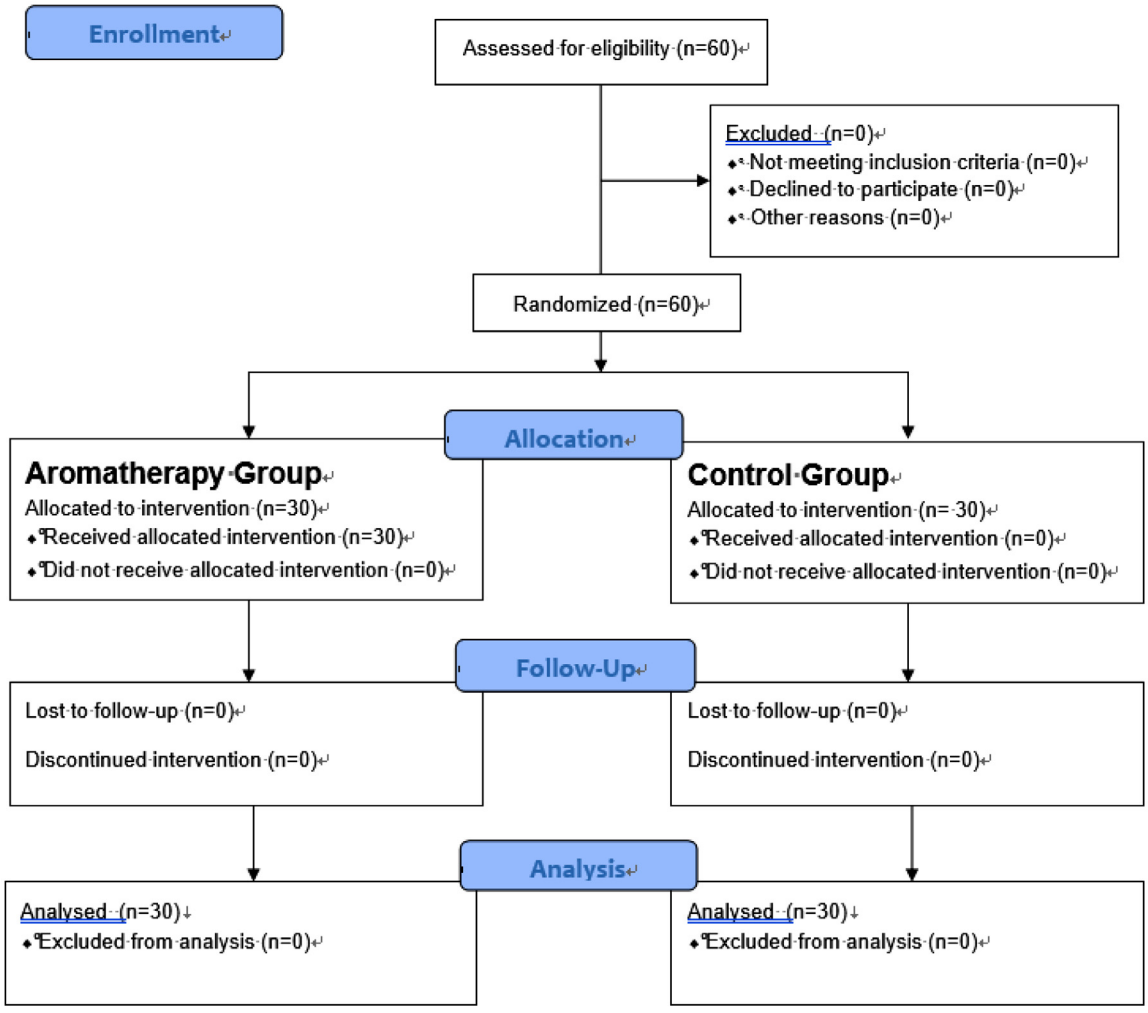

Fig. 1. Flow diagram.

2.4.4. Fatigue

Perceived fatigue was measured using the NRS. The participant was asked to select the number corresponding to the level of perceived fatigue on a straight-line scale from zero to 10, with a higher number indicating a higher level of perceived stress.

2.4.5. Sleep quality

Quality of sleep was assessed using the Leeds Sleep Evaluation Questionnaire (LSEQ)[16] developed by Parrott and Hindmarch and adapted/modified by Kim et al. into the Korean Version of Modified Leeds Sleep Evaluation Questionnaire (KMLSEQ).[17]

2.5. Data collection

Data were collected from 25 August 2022 to 18 September 2022. The detailed data collection process is described below. The questionnaire, aroma diffuser necklace filled with aroma oil and aroma stone with an empty bottle were handed over in person in a venue agreed upon, where the research method, trial procedure, side-effects and aroma oil storage and handling methods were explained and a signed written consent to participate in the study was obtained from each participant. A questionnaire pack was provided to be filled out from day 0 (D_0) through day 4 (D_4). To rule out the possibility of confusing the order of the days, the five copies of questionnaire were distinguished through the index of different color on the first page of each questionnaire. The participants were given detailed instructions as to how to fill out the questionnaire.

Pre-test (D_0): The researcher distributed the questionnaire after giving instructions about special precautions and trial procedure to the participants. In the pre-test conducted using the questionnaire, the participants' general characteristics, sore throat (NRS), nasal symptoms (TNSS), perceived stress (NRS), fatigue (NRS), and sleep quality (KMLSEQ) were measured. Upon completing the pre-test, the AG was provided with an aroma diffuser necklace to wear during the daytime and showed how to prepare the aroma stone before going to bed. The CG, which received usual care, was instructed to complete the questionnaire according to the given schedule. Both groups were instructed to measure the five assessment items before 9 am to complete the questionnaire after waking up, and the AG was instructed to wear the aroma diffuser necklace after completing the questionnaire.

Experimental treatment (D_0–D_4)

- AG: The AG participants were instructed to wear the aroma diffuser necklace after waking up throughout the day, inhaling three times a day for one minute each, holding the diffuser within 10 cm from their nose during the time slots in the morning (9:00-10:00), in the early afternoon (13:00-14:00) and in the evening (18:00-19:00). They were instructed to measure the five assessment items (sore throat, nasal symptoms, perceived stress, fatigue and sleep quality) using their respective tools and fill them out before 9 am after waking up, i.e., end of inhalation of the nighttime aroma oil using the aroma stone, and to respond to the assessment items before waring the aroma diffuser necklace and going for their daily lives.

- CG: The CG participants received usual care and were given the questionnaire pack to fill out every morning before 9 am after waking up, responding to the same five assessment items after measuring them using their respective tools.

Completion of the trial (D_4): After waking up on D_4 of experimental treatment, the aroma essential oil inhalation procedure was completed, upon which sore throat, nasal symptoms, perceived stress, fatigue and sleep quality were measured using the questionnaire. The CG was also instructed to measure the same assessment items using the questionnaire. The researcher asked the participants to notify them upon completion of the questionnaire, and collected all questionnaires directly from each participant. When collecting the questionnaires, a sealed envelope was used to prevent personal information from being exposed to the outside. When the questionnaires were collected after the end of the trial, additional oil was provided to the AG participants who wanted to continue the aromatherapy, and an aroma diffuser necklace filled with aroma oil to the CG participants who wanted to try aroma essential oil inhalation therapy.

2.6. Ethical considerations

Ethical considerations made in conducting this study are as follows. The study protocol was submitted to the IRB of the institution the researcher is affiliated with, and IRB approval (EU22-47) was obtained, and the study was registered with Clinical Research Information Service (CRIS) (KCT 0008029). A recruitment announcement was posted on bulletin boards to induce potential participants to voluntarily decide the participate in the study. Prior to filling out and signing a written consent, participants were given sufficient explanations about the purpose and procedure of the study, and written consents were collected from those who volunteered to participate in the study. In the information sheet for the participants, detailed explanations were given regarding the side-effects that may occur in the course of participation in the study and treatment and coping methods as well as compensations when side-effects occur. They were also informed of the possibility of participating in and withdrawing from the study at any time without incurring disadvantages. A unique identification number was given to each data point in compliance with the guidelines for personal information protection, and upon completion of data analysis, the files were stored in an encrypted USB to ensure personal information protection. Participants were given a small gift (voucher, hand sanitizer, N95 mask) after completing data collection.

2.7. Data analysis

Data analysis was performed using the SPSS for Window Version 29.0 statistical program. The participants' general characteristics were analysed by frequency/percentage, mean, X^2-test and *t*-test, and the homogeneity of dependent variables between the two groups at the baseline was verified using *t*-test. T-test was used to analyze the between-group difference before and after aroma essential oil inhalation treatment. The *p*-value for hypothesis testing was set to 0.05.

3. Results

3.1. Demographic characteristics

When comparing general characteristics before experimental treatment, there were no differences between the two groups in gender, age, and infection onset, and no differences were observed in major symptoms between the two groups except for ageusic symptoms (Table 1). As a baseline before experimental treatment, there were no differences between the two groups in sore throat, TNSS, perceived stress, fatigue and quality of sleep (Table 1).

3.2. Primary outcomes

3.2.1. Sore throat

As a result of measuring the subjects' sore throat for 4 days before and after the experimental treatment, there was no significant difference in the sore throat symptoms of the two groups on the 1st and 2nd day after the experimental treatment. However, there was a significant difference between groups on the 3rd day of experimental treatment (D_3) (t=-2.022, p=0.048) and the 4th day of experimental treatment (D_4)(t=-2.450, p=0.017). (Table 2, Supplement 2).

3.2.2. Nasal symptoms

When nasal symptoms were measured after applying the experimental treatment for 4 days, nasal symptoms in both groups decreased, but there was no significant difference between the two groups (Table 2, Supplement 2).

3.3. Secondary outcomes

3.3.1. Perceived stress

When perceived stress was measured between the two groups in each day after applying the experimental treatment for 4 days, there was no significant difference between the two groups in each day (Table 2, Supplement 2).

3.3.2. Fatigue

Before the experimental treatment, there was no significant difference in fatigue between the two groups, and even after 1st day of experimental treatment, there was no significant difference in fatigue between the two groups. However, there was a significant difference in fatigue between the two groups at the 2nd day (t=-2.748, p=0.008), 3rd day (t=-2.948 p=0.005), and 4th day (t=-3.084, p=0.003) of the experimental treatment (Table 2, Supplement 2).

3.3.3. Quality of sleep

There was no significant difference in the sleep quality of the two groups before the experimental treatment, and there was no significant difference between the two groups even 4 days after the experimental treatment (Table 2, Supplement 2).

4. Discussion

4.1. Summary of main findings

As a result of confirming the effect of aromatherapy on sore throat, nasal symptoms, stress, fatigue, and sleep quality in adults infected with COVID-19, sore throat in the experimental group was significantly lower than sore throat in the control group at the 3rd and 4th days after the experimental treatment. Additionally, from the second day after the experimental treatment, the fatigue of AG was found to be significantly lower than that of CG. However, there were no significant differences in nasal symptoms, stress, and sleep quality between AG and CG.

4.2. Agreements and disagreements with other studies

This study confirmed the effectiveness of aromatherapy by applying it to patients who were infected with COVID-19 and were released from quarantine. However, since the COVID-19 pandemic began in 2019, there have not been many studies confirming the effectiveness of aromatherapy applied to patients infected with COVID-19. Related studies include a study applying aromatherapy to female patients more than 5 months after infection,[6] a study on post-vaccination symptom management in subjects who received the COVID-19 vaccine,[18] and a study of rosa damascena on sleep quality.[19] Although a direct comparison was difficult for lack of previous research on aroma oil inhalation therapy

Table 1
Homogeneity tests of general characteristics and dependent variables of participants.

Characteristics	Category	AG (n = 30) Mean±SD or N (%)	CG (n = 30) Mean±SD or N (%)	X^2 or t	P
Gender	Male	8 (27 %)	9 (30 %)	0.282	0.779
	Female	22 (73 %)	21 (70 %)		
Age		31.30 ± 11.03	31.63 ± 8.67	-0.130	0.897
On set	1~14 day	6 (20.0 %)	8 (26.7 %)	-0.434	0.666
	15~25 day	10 (33.3 %)	6 (20.0 %)		
	26~35 day	6 (20.0 %)	4 (13.3 %)		
	36~45 day	8 (26.7 %)	12 (40.0 %)		
Symptom	Sore throat	20 (66.7 %)	25 (83.3 %)	-1.494	0.141
	Nasal Symptom	14 (46.7 %)	16 (53.3 %)	-0.509	0.613
	Fatigue	23 (76.3 %)	21 (70 %)	0.576	0.567
	Ageusic	15 (50 %)	6 (20 %)	2.523	0.015
	Anosmia	10 (33.3 %)	4 (13.3 %)	1.853	0.069
	Pantalgia	11 (36.7 %)	10 (33.3 %)	0.226	0.791
	Fever	17 (56.7 %)	14 (46.7 %)	0.766	0.447
Sore throat (NRS)		3.53 ± 2.70	3.93 ± 2.96	-0.547	0.587
Total nasal symptom (TNSS)		4.67 ± 3.30	4.90 ± 3.30	-0.273	0.785
Perceived Stress (NRS)		6.27 ± 2.55	5.73 ± 2.65	0.430	0.430
Fatigue (NRS)		6.27 ± 1.72	6.07 ± 1.68	0.455	0.650
Quality of sleep (KMLSEQ)		476.17 ± 158.75	483.33 ± 188.15	-0.159	0.874

AG: Aromatherapy group, CG: Control group, KMLSEQ: Korean version of Modified Leeds Sleep Evaluation Questionnaire, NRS: Numeral Rating Scale, SD: Standard Deviation, TNSS: Total Nasal Symptom Scale.

Table 2
Comparison of variables between AG and CG.

Variable		AG (n = 30) Mean±SD	CG (n = 30) Mean±SD	$t(p)$
Sore throat (NRS)	D_0	3.53 ± 2.70	3.93 ± 2.96	-0.547 (0.587)
	D_1	2.90 ± 2.47	4.03 ± 2.94	-1.616 (0.111)
	D_2	2.37 ± 2.46	3.57 ± 2.74	-1.787 (0.079)
	D_3	1.80 ± 2.25	3.03 ± 2.47	-2.022 (0.048)
	D_4	1.20 ± 2.16	2.63 ± 2.37	-2.450 (0.017)
Total nasal symptom (TNSS)	D_0	4.67 ± 3.30	4.90 ± 3.30	-0.273 (0.785)
	D_1	3.93 ± 3.16	4.43 ± 3.21	-0.608 (0.546)
	D_2	2.90 ± 2.59	3.63 ± 3.40	-0.940 (0.351)
	D_3	1.93 ± 2.46	3.17 ± 3.14	-1.692 (0.096)
	D_4	1.50 ± 2.46	2.77 ± 3.17	-1.729 (0.089)
Perceived stress (NRS)	D_0	6.27 ± 2.55	5.73 ± 2.65	0.795 (0.430)
	D_1	5.77 ± 2.03	5.40 ± 2.36	0.646 (0.521)
	D_2	4.83 ± 2.35	5.50 ± 2.30	-1.100 (0.271)
	D_3	4.33 ± 2.41	4.77 ± 2.51	0.563 (0.509)
	D_4	1.20 ± 2.16	2.63 ± 2.37	0.769 (0.769)
Fatigue (NRS)	D_0	6.27 ± 1.72	6.07 ± 1.68	0.455 (0.650)
	D_1	5.63 ± 1.90	6.03 ± 1.86	-0.822 (0.414)
	D_2	4.43 ± 2.08	5.93 ± 2.15	-2.748 (0.008)
	D_3	4.04 ± 2.30	5.77 ± 2.16	-2.948 (0.005)
	D_4	3.23 ± 2.05	5.03 ± 2.46	-3.084 (0.003)
Quality of sleep (KMLSEQ)	D_0	476.17 ± 158.75	483.33 ± 188.15	-0.273 (0.785)
	D_1	539.10 ± 165.46	484.67 ± 194.03	-0.608 (0.546)
	D_2	632.00 ± 139.15	517.93 ± 210.23	-0.940 (0.351)
	D_3	700.67 ± 154.85	561.00 ± 220.71	-1.692 (0.096)
	D_4	737.43 ± 163.46	595.87 ± 238.25	-1.729 (0.089)

AG: Aromatherapy group, CG: Control Group, KMLSEQ: Korean version of Modified Leeds Sleep Evaluation Questionnaire, NRS: Numeral Rating Scale, SD: Standard Deviation, TNSS: Total Nasal Symptom Scale.
D_0: pretest, D_1: 1st day, D_2: 2nd day, D_3: 3rd day, D_4: 4th day.

applied to COVID-19 infection symptoms, the research finding that aromatherapy applied in the form of gargling after surgery was effective on alleviating postoperative sore throat,[20,21] which confirmed that the sore throat, which is a pain caused by a physical stimulus through intraoperative anesthesia, could be alleviated by aroma gargling, may be considered to be in agreement with the finding of this study that aromatherapy is effective on sore throat cause by inflammation response to COVID-19 infection. Since headache, sore throat, and myalgia were the main pain symptoms complained of by COVID-19 patients,[22] this study sought to determine whether aromatherapy was effective in alleviating symptoms of respiratory infections such as sore throat and nasal symptoms by applying aromatherapy.

In this study, eucalyptus, lemon, lavender, peppermint, and tea tree oil were used as essential oils selectively used to relieve respiratory symptoms in COVID-19 patients, and were applied by inhalation.[11] There are no studies that applied aromatherapy to relieve respiratory symptoms in COVID-19 patients, and a study that confirmed the effect of applying aromatherapy to relieve symptoms in upper respiratory infection patients aged 21–66 years old, not COVID-19 patients[23]

The essential oils used in that study[23] were eucalyptus, peppermint, origanum, and rosemary, applied as a spray, and were effective in alleviating respiratory symptoms within 20 min, but were ineffective after 3 days of treatment. The results of this study showed that sore throat was significantly reduced in AG than in CG, and sore throat in AG was significantly lower than that in CG on the 3rd and 4th days of experimental treatment. These results show that aromatherapy is effective in relieving respiratory symptoms. However, there was no significant difference in nasal symptoms between the two groups. Given that there was a significant decrease in nasal symptoms over the 4 days of experimental treatment, the within-group variation appears to be relatively greater than the between-group variation. Therefore, future research on the effect of aromatherapy on nasal symptoms during the acute phase of COVID-19 infection is necessary.

In this study, when looking at the perceived stress of AG and CG after applying aromatherapy, there was no significant difference between the two groups. In a systematic literature review of the effect of aromatherapy on reducing stress in healthy adults,[24] it was found that aromatherapy had a stress-reducing effect, but there was no significant difference between AG and CG in the subjects of this study. However, seeing that the stress of both groups decreased significantly from the start of the experimental treatment to the fourth day of the experimental treatment, it appears that stress decreased relatively significantly after the covid-19 infection quarantine was lifted. As a result, it appears that the within-group variation is quite large and the between-group variation is relatively low. Therefore, future research is needed to confirm the effectiveness of aromatherapy in the acute period after infection.

In this study, fatigue was found to be significantly reduced when aromatherapy inhalation method was applied. When looking at the prevalence of Post-COVID-19 symptoms, it was said that fatigue and dyspnea especially occur 60 and ≥90 days after infection.[25] Therefore, I think it is very meaningful that aromatherapy is effective in reducing fatigue. In a recent study[6] that confirmed the effect on fatigue by applying aromatherapy to adults infected with COVID-19, thyme, orange, clove bud, and frankincense were applied as a method of inhalation to women who complained of fatigue even after more than 5 months of recovery after acute infection. It was said that when aromatherapy was administered, fatigue in the intervention group was significantly lower. Compared to recent study,[6] this study targeted adults who were infected with COVID-19 within 45 days of infection, and the oils applied were eucalyptus, lemon, lavender, peppermint, tea tree, and ylang, so there are differences between the two studies. However, in terms of confirming the effect of alleviating fatigue caused by COVID-19, the results can be seen as similar.

There are many studies on the effects of aromatherapy on sleep,[26] but no studies were found that applied aromatherapy to patients infected with COVID-19. However, during the COVID-19 pandemic, Rosa damascena was applied by inhalation to personnel working in the operating room, and as a result, sleep quality was reported to have improved, but the study was not conducted on patients.[19] In many studies, inhaling aromatherapy essential oils appears to improve the sleep quality of subjects, but in this study, the effect of aromatherapy on improving sleep quality in subjects quarantined after being infected with COVID-19 appears to have a small effect size.

4.3. Implications in clinical practice

As a result of this study, aromatherapy inhalation applied to COVID-19 infected patients has the effect of relieving sore throat and reducing fatigue, so aromatherapy using essential oils can be applied to relieve sore throat and fatigue. Aromatherapy is expected to be particularly effective in alleviating sore throat in the initial infection phase or in the late phase, of which the duration of symptom differs from patient to patient. In particular, the aroma oils used in this study is composed of essential oils from eucalyptus, lemon, lavender, peppermint and tea tree, which are known to be beneficial for respiratory tract and its infection, efficiently relieving and reducing sore throat.

4.4. Implications in research

In the results of this study, because the study subjects were patients who were released from quarantine after COVID-19 infection, there were limitations in confirming the effect of alleviating symptoms in the acute phase before quarantine. Therefore, future research is needed to confirm the effectiveness of aromatherapy by applying it from the beginning of COVID-19 infection.

4.5. Limitations

The first limitation of this study is that the subjects of the study were people who were released from quarantine in a timely manner. There may be limitations in confirming its effectiveness because it is past the acute phase, not when symptoms are most severe. Also, although the information about group assignment was not given to the participants, assignment concealment was impossible by the nature of the intervention. Additionally, the third limitation is that the essential oil was put into the necklace and inhaled during the day. The subjects were people who had been released from quarantine and had to wear masks while working. Since the subjects were released from quarantine after showing symptoms of coronavirus infection, they wore a necklace during their daytime activities. However, wearing a mask interfered with smooth aroma inhalation, so they were asked to inhale for 1 min each three times a day. Therefore, the results of this study may differ from inhaling aroma oil without a mask. Aroma stones were applied at night, and since people were released from quarantine, they did not wear masks at home, and they placed the aroma stones at a 30 cm radius before going to bed.

4.6. Conclusion

Since the trial period of this study was approved by the IRB based on the time of release from quarantine, data were collected from the 7th day of infection, which indicates limitations in examining the effect of aromatherapy on relieving acute-phase sore throat. Nevertheless, it can be confirmed that sore throat was effectively reduced in AG participants. In this study, when eucalyptus, lemon, lavender, peppermint, and tea tree oil were provided through inhalation, sore throat was alleviated and fatigue was reduced in patients with COVID-19 infection. However, since sufficient research evidence is still lacking, repeated studies are needed, but it is believed to have the potential to be effectively used to relieve sore throat and fatigue in patients infected with COVID-19.

CRediT authorship contribution statement

Hye-Young Kang: Methodology, Validation, Formal analysis, Investigation, Writing – original draft. **Hye Young Ahn:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition. **Mi-Jung Kang:** Conceptualization, Methodology, Writing – review & editing, Visualization, Funding acquisition. **Myung-Haeng Hur:** Conceptualization, Formal analysis, Data curation, Writing – original draft, Supervision, Project administration, Funding acquisition.

Conflict of interests

The authors declare that they have no conflicts of interest.

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Ethical statement

This research was reviewed and approved by the institutional review board of Eulji University Hospital (registration number EU22-47) and the study was registered with Clinical Research Information Service (KCT0008029). Informed consent was obtained from all participants.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.imr.2023.101001.

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