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Research Article

Investigation of the Impact of Inhalation Aromatherapy on Relaxation and Wellbeing in a Young Adult Population

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Abstract

Background and Purpose: Aromatherapy is the systematic use of essential oils extracted from plants to support health and wellbeing. Recent clinical studies have shown that aromatherapy has potential benefits as a non-pharmacological approach to alleviate stress and anxiety. The aim of this project was to evaluate the impact of inhalation aromatherapy on relaxation and wellbeing in a young adult population. **Methods:** Two double-blind randomised controlled pilot studies were conducted in 2021 and 2022, one using room diffusion (Study 1) and one study using an aromastick (Study 2) to measure the effect on wellbeing, stress and anxiety in a young healthy adult population. Test and control formulations with essential oils were assessed for one week and four weeks, respectively. Both studies employed validated measurement tools (DASS-42, WEMWBS). **Results:** The results for Study 1 showed that participants in the test group reported reduced levels for stress and depression compared to the control group in 87.5% of participants ($p = 0.0291$ and $p = 0.04$, respectively). A trend was seen for anxiety, which was not significant ($p = 0.25$). In the second study, analysis of the wellbeing scores indicated a significant improvement for the test group in a paired t-test ($p = 0.002$). **Conclusion**: In these small pilot studies ($n = 17$ and $n = 33$), statistically significant effects were observed in favour of the test interventions. The robust design of the studies and the use of validated quantitative measurement tools were a good foundation on which to build future research.

Keywords: Inhalation aromatherapy; Stress and anxiety; Relaxation and wellbeing; Essential oil; Complementary therapy

Introduction

In recent years, Complementary and Alternative Medicine (CAM) has become integrated into clinical settings and been the subject of a growing number of clinical studies examining its impact and benefit on patient care [1,2]. The practice of aromatherapy (within CAM) uses essential oils extracted from plant material for therapeutic purposes via inhalation or in topical treatments through touch therapy.

Stress and anxiety continues to be a major global health concern and this has been heightened in recent times due to the COVID-19 pandemic [3]. Studies utilising aromatherapy have examined the positive impact it can have on stress and anxiety [4,5], cognitive performance [6], insomnia [7,8] and in situations that induce anxiety [9-11].

Increased levels of stress and anxiety in patients can have a negative effect on treatment outcomes, recuperation and quality of life. This is a matter of concern amongst clinicians who are exploring the use of inhalation aromatherapy as a non-pharmacological adjunct to patient care. Clinical trials and pilot studies have investigated the potential benefit of inhalation aromatherapy administered to patients via a range of modalities including essential oil infused cloth, patches, nasal inhalers (aromasticks), or in room diffusion [12-15].

Dental anxiety affects between 54% and 92% of dental patients and has been the focus of recent systematic reviews investigating its impact on the treatment itself and subsequent recovery of the patient [16,17]. Aromatherapy has had a positive impact on dental anxiety in clinical trials using room diffusion and inhalation aromatherapy as an intervention for anticipatory anxiety, in oral surgery and in paediatric dentistry with positive results [18-21].

Research into the use of inhalation aromatherapy has grown exponentially in the last 20 years to investigate its effect on the levels of stress and anxiety experienced by patients in clinical settings. A majority of the studies report a positive impact from the intervention but in some cases, evidence is limited by the quality of study design, lack of blinding, uniformity in dosage and low sample size [16,22-24]. Lavender (*Lavandula angustifolia*) essential oil is the most frequently used oil in aromatherapy research to examine its efficacy in alleviating anxiety with many clinical studies employing lavender as an intervention yielding positive results [12,23,25,26]. Anticipating the benefits of a familiar scent can introduce an element of bias whereas the aroma derived from a blend of essential oils is less recognisable to the participant, and can help avoid negative odour association that may arise from a single essential oil [27]. In addition, research is ongoing into the potential of a synergistic effect of the essential oils within a blend [28].

Mindful of these limitations, the current study was well structured in its design and methodology with a clinical aromatherapist formulating both the control and test blend formulations.

The aim of the research was to measure the impact of using an aromatherapy product to promote wellbeing and aid relaxation in a young, healthy adult population (aged 18-35 years).

Primary outcome

- Measure the effect of an aromatherapy intervention on relaxation and wellbeing.

Secondary outcomes

- The olfactory response from participants on initial use of the aromatherapy intervention using an organoleptic scent profile at baseline.
- Feedback from participants on the effect of the aromatherapy intervention on memory and mood.

Materials and Methods

Following ethical approval, two double-blind randomised controlled pilot studies were conducted in Trinity College Dublin (TCD) in 2021 and 2022.

Intervention

The aromatherapy intervention used in Study 1 was a room diffusion product and in Study 2, a nasal aromastick. The formula was developed for the test and control products by F.H., one of the authors of this study, who is a certified and experienced clinical aromatherapist.

The essential oils in the test formulation were supplied by AYRUS GmbH, Germany and were supported by gas chromatography analysis and safety data documentation: frankincense (*Boswellia carterii*) [batch no. 1018883 (Study 1), 1020020 (Study 2)] at 29%; lavender (*Lavandula angustifolia)* [batch no. 1019405 (Study 1), 1020057 (Study 2)] *at 15%;* red orange (*Citrus sinensis*) [batch no.106045 (Study 1), 1020114 (Study 2)] at 35% and neroli (*Citrus aurantium var. amara*) [batch no. 1018517 (Study 1), 1018517 (Study 2)] at 4%. Vetiver (*Vetiveria zizanioides*) [batch no. 1016090 (Study 1), 1018506 (Study 2)] essential oil accounts for 17% of the test formulation

The test room diffusion product in Study 1 contained 3 ml of the pure essential oil test blend. The control product was a single essential oil (grapefruit – *Citrus paradisi*) [batch no. N1011], diluted at 3% in jojoba oil producing a faint citrus aroma [Supplier: Bomar Aromatherapy Ltd, Ireland].

The test aromastick used in Study 2 contained 0.18 g of the pure essential oil blend described above. The control aromastick contained an undiluted single essential oil, Juniper (*Juniperus communis)* [batch no. P0748] at very low dosage (0.06 g) [Supplier: Bomar Aromatherapy Ltd, Ireland].

Study design

Study 1 was conducted from March to May 2021 with a cohort of undergraduate students from the School of Pharmacy and Pharmaceutical Sciences (TCD) using a room diffusion product as the intervention for a one-week period. The study was conducted during the Covid-19 pandemic and was the questionnaires were designed to be completed via an online platform.

The second pilot study (Study 2) was conducted from February to December 2022. It was a collaboration between the School of Pharmacy and Pharmaceutical Sciences, and the School of Dental Science, Trinity College Dublin (TCD) with a cohort of students from both schools, using a nasal aromastick over a four-week period.

The inclusion criteria for both studies were as follows:

- Young adult aged 18-35 years.
- Current registered students in the School of Pharmacy and Pharmaceutical Sciences (Study 1+2) and expanded to include the students from the School of Dental Science in Trinity College (Study 2).
- Willing & able to provide online informed consent.

Those excluded from the studies were pregnant women and those on medication for anxiety and/or depression.

Measurement tools

Study 1 used the validated Depression, Anxiety and Stress Scale (DASS-42) questionnaire which is a psychological assessment tool that measures the intensity of symptoms relating to depression, stress and anxiety. It consists of a series of 42 questions using a four-point Likert scale. It is frequently used as part of clinical assessment and is considered a validated, reliable and effective measurement tool [29-32].

Study 2 used The Warwick, Edinburgh Mental Wellbeing Scale (WEMWBS), a series of positively worded questions on a self-reporting 4-point Likert scale that is sensitive to change and suitable for comparing a test and control intervention. It has been used in clinical studies and is considered a validated and reliable measurement tool to measure relaxation and wellbeing [33-35].

Methodology

The methodology was similar for both Study 1 and Study 2. The studies were conducted online and all responses to both of the questionnaires were completely anonymous. Computer-generated randomisation schedule (test vs. control) were produced to number each product. The ID number facilitated the unblinding of the test and control data on completion of the study.

In Study 1 the participants were asked to complete the 1st DASS-42 questionnaire online and to use the room diffusion product every evening for one hour over one week. At the end of the week, the participant was asked to complete the 2nd DASS-42 questionnaire online. The participants were given three options to use the product: 6-8 drops of the product into either, a bowl of hot water, a water vaporiser room diffuser or on to a tissue placed near a warm radiator.

In Study 2 the participants were asked to complete the WEMWBS online questionnaire over a four week period at three timepoints: at the start (T=0), after two weeks (T=2) and the end of the fourth week (T=4). Each participant was asked to use the aromastick at stressful moments during the day and every evening for 4 weeks. To use the product, the participant was instructed to place the aromastick under the nostrils and to breathe in deeply 3-4 times.

In both studies the first questionnaire included an organoleptic profile after initial use of the product and questions regarding age, gender and academic year. The final questionnaires included feedback on the aroma and the participant experience over the period.

The studies were completely voluntary and no incentives or compensation was offered to the participants.

Data Analysis

Statistical analysis of Study 1 was performed as a 2-way repeated measures analysis of variance (2-way ANOVA) model. In addition, the breakdown of the participant responses and DASS-42 scores were analysed in Microsoft Excel to examine the effect of the test and control intervention group at the two different times (see Table 1).

DASS (42) Scoring	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34+

Table 1: DASS-42 Scores for Depression, Anxiety and Stress.

In Study 2 the data obtained was analysed using the statistical programme designed for the WEMWBS questionnaire in Microsoft Excel. The Wilcoxon signed rank test and a paired t-test were part of the WEMWBS statistical analysis. Following consultation

with a statistician, further analysis was conducted using Mixed Method Model analysis in GraphPad Prism. A delta analysis was considered the most suitable approach to assess changes overtime in the wellbeing scores of the participants.

Any differences were regarded as statistically significant if $p < 0.05$.

Results

Study 1 - Room Diffusion

In total, 203 students from the School of Pharmacy and Pharmaceutical Sciences were invited to participate in the study. Of these, 48 students consented to participate and 37 students collected the room diffusion product. The majority of participants taking part in the study were female (83%), and the remaining 17% were male. Those aged between 18-24 years of age accounted for 93% of the participants with the remaining 7% aged between 25-34 years of age. 27 students completed the first DASS-42 questionnaire and a final total of 18 participants completed both the first and second DASS-42 questionnaires. Only the fully completed responses from both questionnaires were used in the final analysis. Of these, two responses were removed due to the absence of a participant ID number and only one questionnaire completed, resulting in a total of 17 responses for the final analysis. The unblinding of participants revealed 8 test products and 9 control products (Fig. 1).

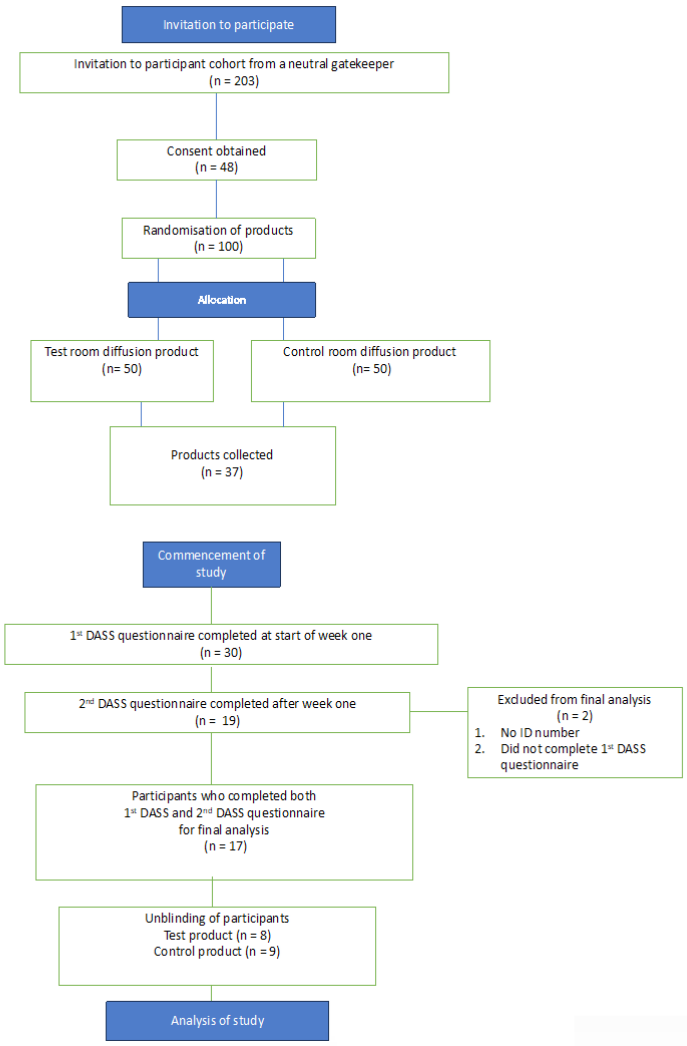

Figure 1: Participant flow diagram for Study 1 (Room Diffusion).

Initial analysis of the DASS-42 questionnaire scores at the end of the one-week intervention showed that the participants in the test group were reporting a more positive response for both, depression and stress, in 87.5% of participants vs 55% in the control group for depression and 87.5% vs 33.3% for stress. This difference between test and control group was observed to a lesser degree for anxiety, where 75% of participants reported improvements in their anxiety levels vs 44% in the control group (see Table 2 - summary of results).

	Depression		**Anxiety**		**Stress**	
	No. of Participants	**% change**	**No. of Participants**	**% change**	**No. of Participants**	**% change**
Test						
Improvement	7	87.5%	6	75%	7	87.5%
No Change	0	0%	0	0%	0	0%
Disimprovement	1	12.5%	2	25%	1	12.5%
Total	8	100%	8	100%	8	100%
Control						
Improvement	5	55.6%	4	44.4%	3	33.3%
No Change	1	11.1%	2	22.2%	1	11.1%
Disimprovement	3	33.3%	3	33.3%	5	55.6%
Total	9	100%	9	100%	9	100%

Table 2: Room Diffusion Study 1

Percent change for depression, anxiety and stress in test vs control groups.

The individual scores for each of the participants in both the test and control groups from the baseline to the end of the one week period show the changes in scores for each participant (Fig. 2). There is a clear reduction in depression, stress and anxiety scores for all but one participant in the test group. No participant in the test group scored in the extremely severe or severe range over all three categories after one week. In the control group, the scores show a reduction in anxiety after the one week period. While some scores improved in the control group, the reduction in values for a majority of participants remained within the range of values for the extremely severe, severe and moderate categories. Only one participant improved scores to mild levels of anxiety (Fig. 2).

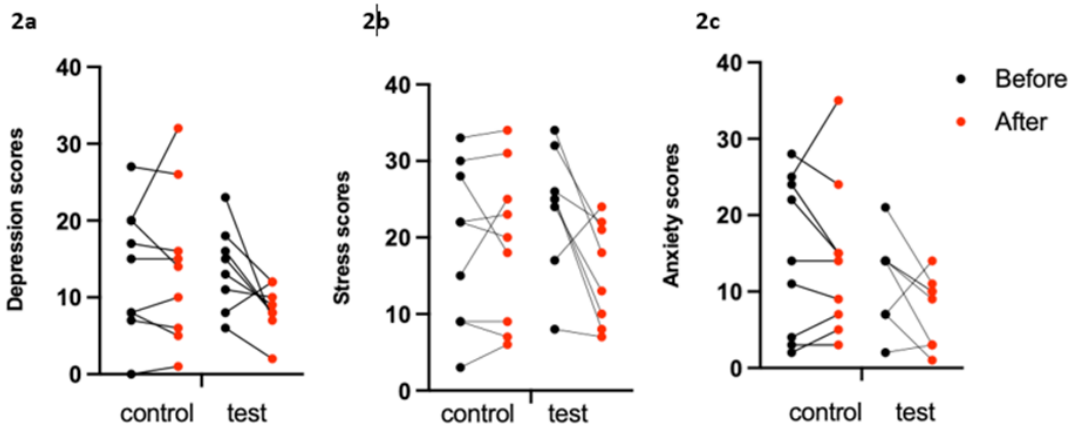

Figure 2: Study 1 – Data analysis of DASS-42 individual scores for test vs control at the start and the end of the week.

DASS-42 Scores:

Depression: normal = 0-9, mild = 10-13, moderate = 14-20, severe = 21-27, extremely severe = 28+Stress: normal = 0-14, mild = 15-18, moderate = 19-25, severe = 26-33, extremely severe = 34+Anxiety: normal = 0-7, mild = 8-9 moderate = 10-14, severe = 15-19, extremely severe = 20+.

Further statistical analysis using a repeated measures 2-way ANOVA model showed that improvement in stress levels in the test group over the control group was statistically significant ($p = 0.029$) as well as the levels of depression ($p = 0.04$), where $p < 0.05$ was considered to be of statistical significance. For anxiety, improvements were not considered to be of statistical significance ($p = 0.25$) (see Fig. 3). It is also interesting to note that 'no change' was only reported in the control group (Table 2).

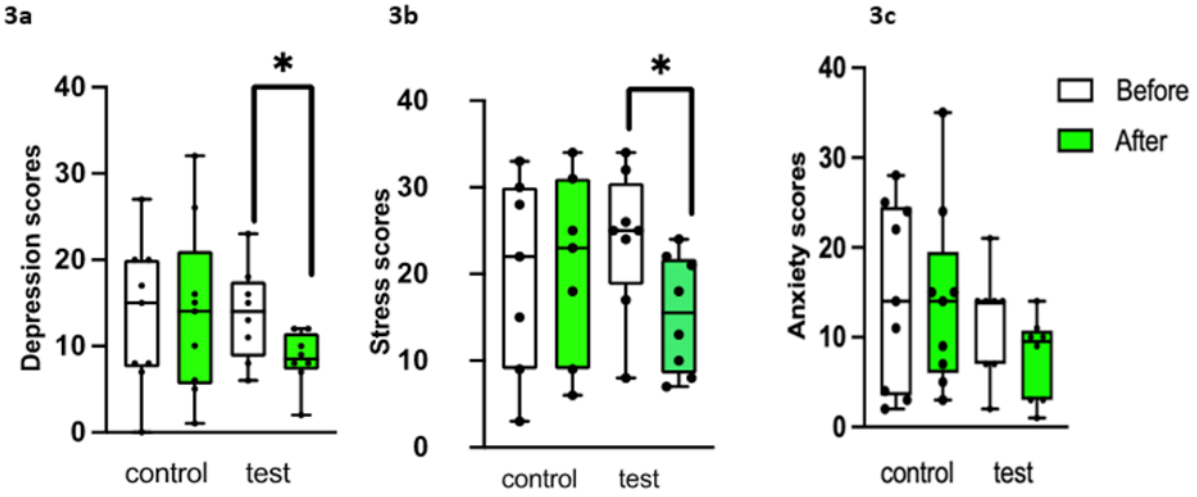

Figure 3: Study 1 – Data analysis (2-ANOVA) test vs control at the start and the end of the week.
3a: Changes in depression scores by participant in the control and test group at the start and after one week. ($p = 0.04$).
3b: Changes in stress scores by participant in control and test group at the start and after one week. ($p = 0.0291$).
3c: Changes in anxiety scores by participant at the beginning and after one week. ($p = 0.25$).
(Score chart in Figure 2).

Study 2 - Aromastick

In total, 500 students were invited to participate in the study, 138 students consented to participate and 85 participants collected the aromastick pack. 58 participants completed the first questionnaire at the start of the study, 44 completed the second questionnaire after two weeks, and 41 participants completed the final questionnaire at the end of the four-week period. The final number analysed was further reduced to 33 as four participants had completed a questionnaire twice, three had not given a participation ID number, and one did not complete the final questionnaire correctly. When unblinded, of the 33 participants included in the analysis, 18 had used the test blend and 15 the control (Fig. 4). The majority of participants taking part in the study were female (85%) and 15% were male. Dental students accounted for 27% of the participants with the remaining 73% from pharmacy.

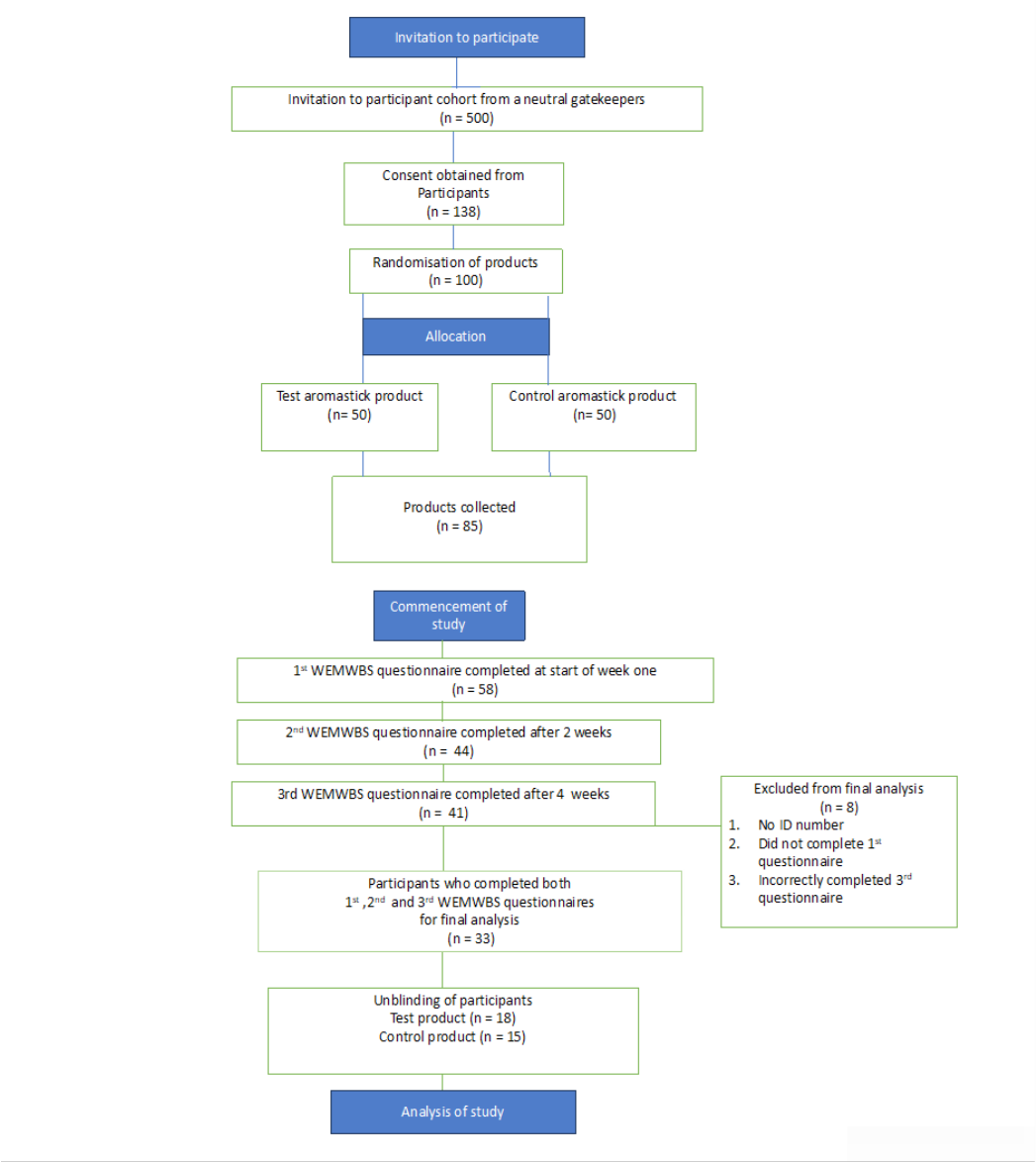

Figure 4: Participant flow diagram Study 2 – Aromastick.

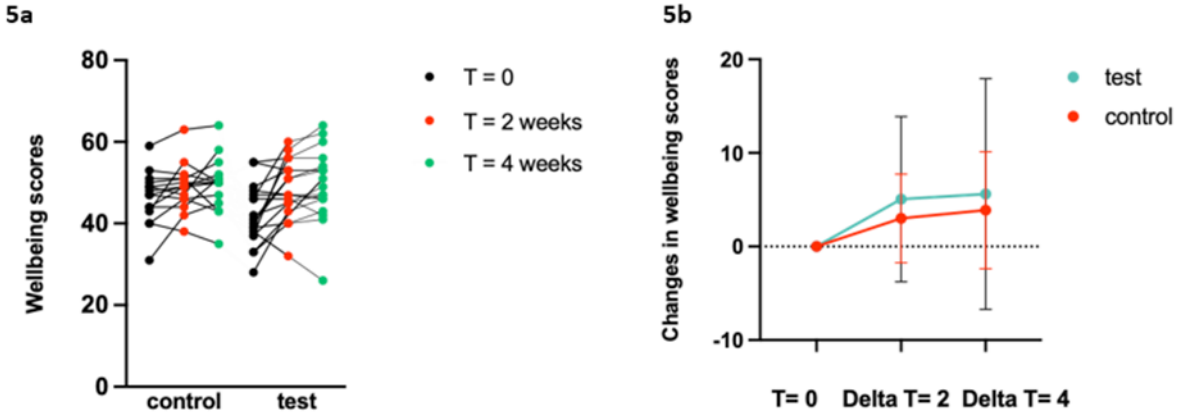

Figure 5: Study 2 - Data analysis test vs control for all 3 timepoints over the 4 week period.

Fig. 5a: Individual WEMWBS wellbeing scores.

Fig. 5b: Delta analysis of WEMWBS scores - changes normalised at baseline for test and control ($p = 0.0058$).

Wellbeing scores: poor = 14-40, below average = 41-44 (low wellbeing), normal = 45-59 (moderate wellbeing), above average = 60-70 (high wellbeing).

A delta analysis was deemed necessary due the higher wellbeing scores of participants in the control group at the start of the study (80% moderate wellbeing, 20% low wellbeing) compared with the test group (39% moderate wellbeing, 61% low wellbeing). The wellbeing scores were normalised at baseline and showed a statistical significance for the test intervention ($p = 0.0058$) (see Fig. 5b). Analysis of the data in a paired t-test comparing the wellbeing scores at the beginning of the study (T=0) and after the four-week period (T=4) indicated a statistically significant increase in wellbeing for the test group intervention ($p = 0.002$).

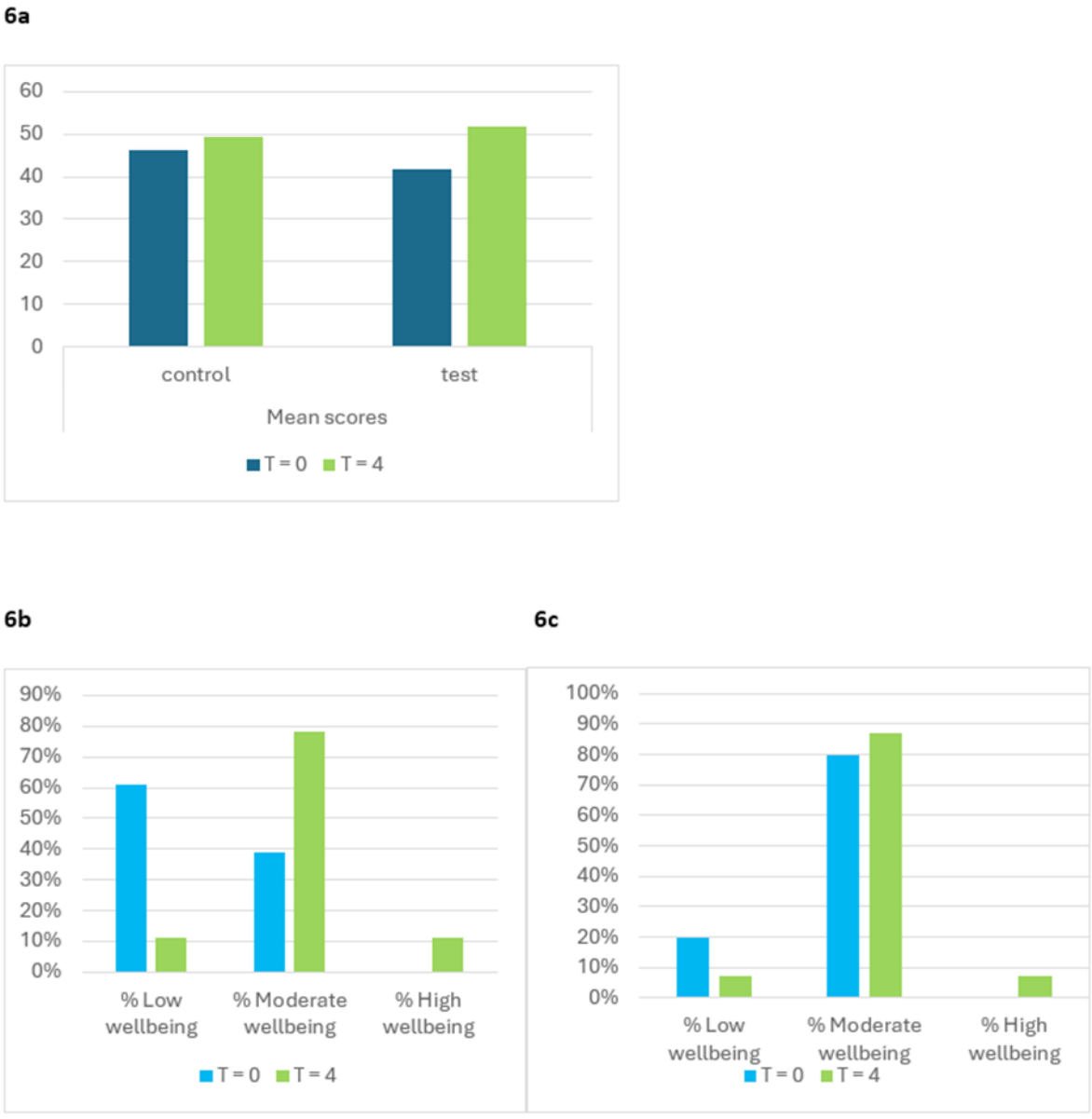

Figure 6: Data analysis of WEMWBS wellbeing scores over the 4 week period.

6a: Changes in the mean scores for control and test from T=0 to T= 4.

6b: Test group changes in wellbeing scores at start and end of 4 weeks.

6c: Control group changes in wellbeing scores at start and end of 4 weeks.

The wellbeing scores for the test group improved significantly from a 61% low wellbeing (T=0), to a 78% moderate wellbeing and 11% high wellbeing at the end of the four week study. There was little change in the scores for the control group during the 4-week period (Fig. 6). This was reflected in the mean scores which showed a small change in the control group (46.3 to 49.3) compared with the test group which reported a significant change (41.8 to 51.9), from week one (T=0) to the end of the 4th week (T=4) (Fig. 6a).

Discussion

Two double blind randomised controlled studies were conducted using validated measurement tools to determine the potential benefit of using aromatherapy products to aid relaxation and promote wellbeing in a young adult student population. The studies took place in Trinity College Dublin in 2021 and 2022, one study using room diffusion and one using an aromastick. A test and control formulation using essential oils was prepared by a clinical aromatherapist for each study. The duration of the interventions was one week and four weeks, respectively. In Study 1 the results showed a statistically significant reduction in the test group intervention in both the stress ($p = 0.0291$) and depression ($p = 0.04$) levels of the participants and to a lesser degree in anxiety ($p = 0.25$) (Fig. 3). In Study 2, the results were in favour of the test group intervention with the level of wellbeing increasing over the 4-week period achieving statistical significance ($p = 0.0058$) (Fig. 5). There was no evidence of adverse effects.

Recent studies have shown that the aromatic compounds in specific essential oils can produce an anxiolytic effect [24,25]. The most frequently used essential oils to reduce anxiety are; lavender (*Lavandula angustifolia*), rose (*Rosa damascena*) and the fruit, flowers and leaves from the orange trees (*Citrus sinensis* and *Citrus aurantium* L) [12,22,36-41]. The primary pharmacological effect of Lavender (*Lavandula angustifolia*) essential oil, with its calming and sedative properties, may be attributed to its key components, linalool and linalyl acetate [25]. Similar therapeutic effects have been shown for monoterpene compounds such as limonene, which is the dominant constituent in *Citrus aurantium* L, *Citrus sinensis* and *Boswellia carterii* [42]. Furthermore, these volatile molecules within essential oils have also been investigated for their potential effect on the central nervous system (CNS). Linalool has been shown to act as an inhibitor on the glutamate binding in the CNS to produce anxiolytic effects [24,43-45]. Based on the presence of these specific components, and supported by clinical studies, the essential oils of lavender, orange, neroli and frankincense (*Boswellia carterii*) were used in the essential oil blend of the current study [42,46,47]. Vetiver (*Vetiveria zizanioides*) an essential oil noted for its mildly sedative and relaxing properties [48], was the final essential oil added to the blend. It also balanced the aroma and acted as a natural fixative.

There are various validated questionnaires used to measure levels of stress and anxiety using a Likert scale. The Depression, Anxiety & Stress Scale (DASS-42) questionnaire was designed to evaluate levels of depression, anxiety and stress, and was chosen for Study 1 due to its comprehensive range of forty-two questions and the fact that it is a commonly used and validated measurement tool for stress and anxiety in clinical studies [49-51]. Other tools considered were: The Spielberger's State-Trait Anxiety Scale (STAI); [52,53] and the Hospital Anxiety and Depression Scale (HADS) [54,55]. While psychological measurement tools are largely self-reporting, an increasing number of studies are including physiological measurements including salivary cortisol, vital signs and heart rate variability. Such additional measures strengthen the validity of a study and lead to more convincing evidence [18,31,47,56,57].

The analysis of Study 1 highlighted the fact that the DASS-42 questions were highly sensitive and might be better employed as indicators of clinical anxiety rather than to gauge the impact of an aromatherapy intervention on levels of relaxation and wellbeing. For example, questions such as: "*I felt that life was meaningless" / "I felt that life wasn't worthwhile*" do not seem well aligned to the aim of the study. On that basis, a more appropriate questionnaire was chosen for Study 2. The Warwick, Edinburgh Mental Wellbeing Scale (WEMWBS) has been used in clinical studies and is considered a reliable and valid measurement tool to measure wellbeing and relaxation [33-35].

Despite the low sample size in these pilot studies (17 and 33 participants, respectively), thereby limiting their statistical significance, a notable statistical significance was observed in favour of the aromatherapy test intervention. While feasibility and pilot studies can overestimate positive outcomes, they do provide an opportunity to investigate the potential for the introduction of a new treatment into clinical practice without the costly investment of a larger scale clinical trial [58,59]. A pilot study with a well-designed and methodologically sound approach, even with a limited sample size, can yield compelling results to power subsequent larger-scale studies [47,60,61].

Traditionally, aromatherapy research has been largely anecdotal with poor design and methodology impacting the quality of the results. Clinical studies investigating the impact of aromatherapy have improved in recent times with an increase in double blind clinical trials that employ quantitative measurements to evaluate the patient experience. This was evidenced by a recently published systematic review by the authors of this current study [22].

In the current studies, the formulations for the test and control products were prepared by a clinical aromatherapist. To ensure consistency, the specific plant species of essential oil and a precise dosage was used for both the test and control products. This was supported by source of supply, batch numbers and safety data documentation. No adverse reactions were reported by the participants. The response to aroma is subjective and personal to an individual who may also have expectations to a recognisable aroma such as lavender (*Lavandula angustifolia*). To minimise such potential bias, the test aroma contained a blend of five essential oils not easily recognisable to the participants. In aromatherapy research, control interventions frequently involve the use of an odourless vegetable oil or the provision of standard

care only. Nevertheless, it was considered essential in both studies that the control groups have an aroma to help maintain participant engagement and reduce potential bias. In order to assess the olfactory function for each participant, which was especially important as the study took place during the COVID-19 pandemic, an organoleptic profile was completed by each participant at the beginning of the study. No apparent evidence of anosmia was observed for any of the participants.

Clinical studies have explored the role played by the olfactory response to aroma and the influence that positive odour-associated memories can exert on health and well-being [62,63]. In the first questionnaire and after the initial use of the product, participants were asked if the aroma conjured up any memory for them. The responses from the participants evoked largely positive memory associations, such as, *"Reminds me off a wellness centre or spa" / "When I used to use lavender oil on my pillow when I couldn't sleep" / "Fresh, sunny, carefree walks next to lemon trees in Italy"* (Text box).

Text box: Feedback on Use of the Aromatherapy Product and Memory Association.

Study 1: Test group

"Reminds me off a wellness centre or spa"

"Oranges"

"My Granny's house"

"Eating oranges at summer camps"

Control group

"Fresh, sunny, carefree walks next to lemon trees in Italy"

"A relaxing massage in a spa"

"It reminds me of the smell of my auntie's car. When I visit my family back in the Philippines"

"Summer time and baking"

Study 2: Test group

"The smell has reminded me of my grandmother's home. There was always the small bag of lavender on the wall. The memory brought up happy memories".

"The smell of the woods where I do a lot of running"

"When I used to use lavender oil on my pillow when I couldn't sleep"

"Spa day, massage oil"

Control group

"The smell of my grandmother's medicine cabinet "

"Feelings of being in a deep forest control"

"Woods in autumn"

In Study 1 the test intervention reported statistically significant results in both studies. In Study 1, there was a statistically significant improvement in the test group for depression ($p = 0.04$) and stress ($p = 0.0291$) and to a lesser degree for anxiety but a trend was observed in favour of the test intervention ($p = 0.25$), Fig. 3.

In the first DASS questionnaire which was completed before the intervention, the scores for extremely severe and severe were alarming for depression (12%), anxiety (30%) and stress (35%). The DASS-42 scores were divided into normal, mild, moderate, severe, or extremely severe for each of the three categories: depression, anxiety and stress (see Methods for DASS-42 score chart). However, these scores were reduced in most cases after using the products at the end of the one week of intervention. For participants who completed the second DASS questionnaire, the control group scores for depression, anxiety and stress decreased slightly in both the severe and extremely severe categories. The test group reported a greater reduction across all categories to be within the moderate, mild and normal ranges of depression stress on completion of the one week intervention. Those participants who showed a disimprovement in the test group were within the normal to mild range (see Fig. 2 for changes in individual results).

In Study 2 the control group comprised of 20% of participants with low wellbeing and 80% at moderate wellbeing at the beginning of the study (T=0) as opposed to the test group whose wellbeing was much lower with 61% with low wellbeing and only 39% moderate wellbeing. A delta analysis was conducted to normalise the wellbeing scores at baseline reporting a statistical significance for the test intervention ($p = 0.0058$) (see Fig. 6b). A paired t-test analysis indicated a statistically significant improvement in wellbeing for the test group ($p = 0.002$). The mean scores in the completion of the WEMWBS questionnaire reported a significant change in the test group from before (T=0) and after the four-week period (T=4) (41.8 to 51.9) compared with a slight change in the control group (46.3 to 49.3). While the control group wellbeing scores changed very little over the four week period, the test group improved dramatically to 78% moderate wellbeing and 11% high wellbeing at the end of the four week study. No group scored a high level of wellbeing at the start of the study (see Fig. 6 b+c).

Limitations

Level of Participation

The level of participation was low amongst the student cohort across both studies. When students are participants, identifying a low stress period during the academic year becomes challenging. A contributory factor in Study 1 may have been that it was conducted during the Covid-19 pandemic when students faced a time of uncertainty and increased mental health challenges. It was also conducted prior to examinations, a potentially anxiety-inducing time for students. This was reflected in the high scores at baseline for depression, anxiety and stress in Study 1. The experience gained in Study 1 informed the design of Study 2 and the collaboration with the School of Dental Science provided the opportunity to expand the cohort of potential participants to 500. While 58 participants started the study, 33 fully completed the 4 week study. To mitigate the level of attrition in both studies, future research could offer an incentive such as a raffle prize to those participants who complete the study.

Mode of application

Clinical studies investigating the efficacy of an inhalation aromatherapy intervention frequently employ room diffusion, oil infused gauze or a nasal aromastick yielding positive results. In room diffusion, the essential oils are placed in a water vapourised diffuser, for example to measure the impact on the levels of stress and anxiety on patients undergoing stress-inducing medical procedures [14,57]. In the present study (Study 1, room diffusion), the product was used every day by 58% of the participants and on most days by a further 37% of participants. A bowl of hot water (63%), a room diffuser (32%) or a tissue (5%)were used by the participants. However, the use of a bowl of hot water was reported to be cumbersome by participants. This may have contributed to the low level of participation amongst the student cohort ("*Bowl of hot water was not the best way to use the product as it became cold quickly and the aroma became much less noticeable*"/ "*Difficult to get an aroma using a bowl of hot water").*

Following the experience gained on room diffusion in Study 1, a decision was made to use a different mode of application in Study 2. Aromasticks have been used for over 15 years in UK cancer hospitals where the complementary therapy team of aromatherapists offer patients a choice of a single essential oil or a blend of oils, which is then sealed in a portable nasal stick for individual use [64-66]. These aromasticks have shown to alleviate the distressing side effects of chemotherapy and radiation treatments and are an empowering tool for patients to use in symptom management [27]. In the current study 7% of participants used the aromastick many times a day, 22% every day and a further 61% reported to have used them most days. "*Enjoyed using the product & taking deep breaths"/* "*I enjoyed using it very much and I feel like during stressful moments it helped me take a step back and just breathe and realise everything would be okay*" / "*I think the product definitely calmed me in the moment but its effects were short term*"). A growing number of pilot clinical studies in the USA and Germany have reported a positive improvement on stress levels when using commercially manufactured aromastick brands to measure their effects on stress, anxiety, cognitive performance and post-procedural nausea. These commercial products contain

a blend of oils and have the added advantage of containing a consistent and precise dose for each test intervention [59,67-69].

Duration of Study

To fully evaluate the potential benefits of the aromatherapy intervention, the appropriate length of the study was considered. In previous studies, the period of exposure to the essential oils varies considerably. It can range from a short burst of inhalation over a few seconds or minutes using an aromastick or oil infused cloth [13,68] to room diffusion overnight when investigating sleep quality [70]. A recent study reported room diffusion for two hours every night over a six month period examining the effect on cognitive function [71]. An aromatherapy product used for an extended period may yield more significant data and facilitate a more comprehensive assessment of its efficacy. The period of intervention in Study 1 was one week and Study 2 is was extended to a four week period. However, the individual scores from week 2 to the end of week 4 did not change much. The largest increase was from baseline (T=0) to week 2 of the study. A follow up longitudinal study would be worthy of consideration to evaluate the sustainability of the observed effects.

Pre-screening of participants

Ten of the thirty respondents in Study 1 who completed the first DASS questionnaire received scores of less than 10 for depression, anxiety and stress which would be considered 'normal'. Although all products were selected through randomisation, a similar situation emerged from the analysis of Study 2 as the control group reported a higher level of wellbeing at the start of the four-week study compared to the test group whose wellbeing scores were considerably lower (Fig. 6 b-c). In future studies, a pre-screening questionnaire to identify and exclude those in the 'normal' category, and include those within the mild to moderate categories would benefit the quality and significance of the results.

Conclusion

The results of both these pilot studies demonstrated that a test formulation of essential oils increased wellbeing and reduced depression, stress and anxiety levels in a young adult population. Both studies reported a statistical significance in favour of the test intervention for depression ($p=0.04$) and stress in Study 1 (room diffusion) ($p=0.0291$) and in increased levels of wellbeing in Study 2 (aromastick) ($p=0.002$). While the studies were small in sample size ($n=17$; $n=33$), a clear trend was observed in favour of the test group for the duration of both studies. The findings were encouraging and indicated that the use of aromatherapy had a positive impact on the mental health of the student cohort.

The robust design of these double-blind studies and the use of validated measurement tools strengthened the results. Unlike other clinical investigations using aromatherapy, the formulations of both test and control had a precise dosage of the essential oils, used a specific plant species and were prepared by a clinical aromatherapist. It is recommended that in future aromatherapy research studies this methodological approach be integrated into an aromatherapy protocol that forms part of evidence based research.

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Ethical Considerations: Both pilot studies were granted ethical approval by the School of Pharmacy and Pharmaceutical Sciences Research Committee (Study 1) and the Dental Science Research Ethics Committee (Study 2), at the University of Dublin, Trinity College.

Conflict of Interest: Fiona Hedigan is also employed by Fiona Hedigan & Associates Limited. She is conducting her postgraduate research as part of a collaboration agreement between the Enterprise Partner (Fiona Hedigan & Associates Limited) and Trinity College Dublin.

References

1. Dyer NL, Surdam J, Srinivasan R, Agarwal A, Dusek JA (2022) The Impact of Individualized Complementary and Integrative Health Interventions Provided in Clinical Settings on Quality of Life: A Systematic Review of Practice-Based Research. Journal of Integrative and Complementary Medicine 28:618-640. [https://doi.org/10.1089/jicm.2021.0413].
2. Farrar AJ, Farrar FC (2020) Clinical Aromatherapy. Nursing clinics of North America 55:489-504. [https://doi.org/10.1016/j.cnur.2020.06.015].
3. Shah SMA, Mohammad D, Qureshi MFH, Abbas MZ, Aleem S (2021) Prevalence, Psychological Responses and Associated Correlates of Depression, Anxiety and Stress in a Global Population, During the Coronavirus Disease (COVID-19) Pandemic. Community Ment Health J 57:101-110. [https://doi.org/10.1007/s10597-020-00728-y].
4. Gong M, Dong H, Tang Y, Huang W, Lu F (2020) Effects of aromatherapy on anxiety: A meta-analysis of randomized controlled trials. J Affect Disord 274:1028-1040. [https://doi.org/10.1016/j.jad.2020.05.118].
5. Schneider R (2016b) There is something in the air: Testing the efficacy of a new olfactory stress relief method (AromaStick®). Stress and Health 32:411-426. [https://doi.org/10.1002/smi.2636].
6. Schneider R (2021) Natural Odor Inhalers (AromaStick®) Outperform Red Bull® for Enhancing Cognitive Vigilance: Results From a Four-Armed, Randomized Controlled Study. Percept Mot Skills 128:135-152. [https://doi.org/10.1177/0031512520970835].
7. Lee MK, Lim S, Song JA, Kim ME, Hur MH (2017) The effects of aromatherapy essential oil inhalation on stress, sleep quality and immunity in healthy adults: randomized controlled trial. European Journal of Integrative Medicine 12:79-86. [https://doi.org/10.1016/j.eujim.2017.04.009].

8. Polonini H, Mesquita D, Lanine J, Dijkers E, Gkinis S, et al., (2020) Intranasal use of lavender and fennel decreases salivary cortisol levels and improves quality of sleep: A double-blind randomized clinical trial. European Journal of Integrative Medicine, 34:101015. [https://doi.org/10.1016/j.eujim.2019.101015].

9. Huang L, Capdevila L (2017) Aromatherapy improves work performance through balancing the autonomic nervous system. Journal of Alternative and Complementary Medicine 23:214-221. [https://doi.org/10.1089/acm.2016.0061].

10. Kerr D, Hegg M, Mohebbi M (2021) Effects of diffused essential oils for reducing stress and improving mood for clinical nurses: An interventional time series study. Nursing Forum 56:305-312. [https://doi.org/10.1111/nuf.12548].

11. Schneider R (2020) Essential oil inhaler (AromaStick®) improves heat tolerance in the Hot Immersion Test (HIT). Results from two randomized, controlled experiments. Journal of Thermal Biology 87:102478. [https://doi.org/10.1016/j.jtherbio.2019.102478].

12. Arslan I, Aydinoglu S, Karan NB (2020) Can lavender oil inhalation help to overcome dental anxiety and pain in children? A randomized clinical trial. European Journal of Pediatrics 179:985-992. [https://doi.org/10.1007/s00431-020-03595-7].

13. Baskran RNR, Lakshmanan R (2019) Assessment of effect of chamomile oil on dental anxiety for patients undergoing extraction – A randomized controlled trial. Drug Invention Today 11:1875-1879.

14. Dagli R, Avcu M, Metin M, Kiymaz S, Ciftci H (2019) The effects of aromatherapy using rose oil (rosa damascena mill.) on preoperative anxiety: A prospective randomized clinical trial. European Journal of Integrative Medicine 26:37-42. [https://doi.org/10.1016/j.eujim.2019.01.006].

15. Trambert R, Kowalski MO, Wu B, Mehta N, Friedman P (2017) A randomized controlled trial provides evidence to support aromatherapy to minimize anxiety in women undergoing breast biopsy. Worldviews Evid Based Nurs 14:394-402. [https://doi.org/10.1111/wvn.12229].

16. Cai H, Xi P, Zhong L, Chen J, Liang X (2020) Efficacy of aromatherapy on dental anxiety: A systematic review of randomised and quasi-randomised controlled trials. Oral Diseases 27:829-847. [https://doi.org/10.1111/odi.13346].

17. Jimson S, Malathi L, Devi GN, Sankari SL (2016) Aromatherapy in dentistry - A review. Biomedical and Pharmacology Journal 9:827-828. [https://doi.org/10.13005/bpj/1010].

18. Ghaderi F, Solhjou N (2020) The effects of lavender aromatherapy on stress and pain perception in children during dental treatment: A randomized clinical trial. Complementary Therapies in Clinical Practice 40:101182. [https://doi.org/10.1016/j.ctcp.2020.101182].

19. Karan NB (2019) Influence of lavender oil inhalation on vital signs and anxiety: a randomized clinical trial. Physiology & behavior, 211:112676. [https://doi.org/10.1016/j.physbeh.2019.112676].

20. Kritsidima M, Newton T, Asimakopoulou K (2010) The effects of lavender scent on dental patient anxiety levels: a cluster randomised-controlled trial. Community Dentistry and Oral Epidemiology 38:83-87. [https://doi.org/10.1111/j.1600-0528.2009.00511.x].

21. Lehrner J, Marwinski G, Lehr S, Johren P, Deecke L (2005) Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office. Physiol Behav 86:92-95. [https://doi.org/10.1016/j.physbeh.2005.06.031].

22. Hedigan F, Sheridan H, Sasse A (2023) Benefit of inhalation aromatherapy as a complementary treatment for stress and anxiety in a clinical setting - A systematic review. Complementary Therapies in Clinical Practice 52:101750. [https://doi.org/10.1016/j.ctcp.2023.101750].

23. Kang HJ, Nam ES, Lee Y, Kim M (2019) How strong is the evidence for the anxiolytic efficacy of lavender?: Systematic review and meta-analysis of randomized controlled trials. Asian Nurs Res (Korean Soc Nurs Sci) 13:295-305. [https://doi.org/10.1016/j.anr.2019.11.003].

24. Mannucci C, Calapai F, Cardia L, Inferrera G, D'Arena G, et al. (2018) Clinical pharmacology of citrus aurantium and citrus sinensis for the treatment of anxiety. Evid Based Complement Alternat Med 2018:3624094. [https://doi.org/10.1155/2018/3624094].

25. Donelli D, Antonelli M, Bellinazzi C, Gensini GF, Firenzuoli F (2019) Effects of lavender on anxiety: A systematic review and meta-analysis. Phytomedicine 65:153099. [https://doi.org/10.1016/j.phymed.2019.153099].

26. Stanley PF, Wan LF, Karim RA (2020) A randomized prospective placebo-controlled study of the effects of lavender aromatherapy on preoperative anxiety in cataract surgery patients. Journal of perianesthesia nursing 35:403-406. [https://doi.org/10.1016/j.jopan.2019.12.004].

27. Dyer J, Cleary L, Ragsdale-Lowe M, McNeill S, Osland C (2014) The use of aromasticks at a cancer centre: a retrospective audit. Complement Ther Clin Pract 20:203-206. [https://doi.org/10.1016/j.ctcp.2013.11.006].

28. Rai M, Paralikar P, Jogee P, Agarkar G, Ingle AP, et al. (2017) Synergistic antimicrobial potential of essential oils in combination with nanoparticles: Emerging trends and future perspectives. International Journal of Pharmaceutics 519:67-78. [https://doi.org/10.1016/j.ijpharm.2017.01.013].

29. Antony MM, Bieling PJ, Cox BJ, Enns MW, Swinson RP (1998) Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. Psychological Assessment 10:176-181.

30. Brown TA, Chorpita BF, Korotitsch W, Barlow DH (1997) Psychometric properties of the Depression Anxiety Stress Scales (DASS) in clinical samples. Behaviour Research and Therapy 35:79-89. [https://doi.org/10.1016/S0005-7967(96)00068-X].

31. Hasheminia D, Kalantar Motamedi MR, Karimi Ahmadabadi F, Hashemzehi H, Haghighat A (2014) Can ambient orange fragrance reduce patient anxiety during surgical removal of impacted mandibular third molars? J Oral Maxillofac Surg 72: 1671-1676. [https://doi.org/10.1016/j.joms.2014.03.031].

32. Vajpeyee M, Tiwari S, Jain K, Modi P, Bhandari P, et al. (2021) Yoga and music intervention to reduce depression, anxiety, and stress during COVID-19 outbreak on healthcare workers. Int J Soc Psychiatry 68:798-807. [https://doi.org/10.1177/00207640211006742].

33. Espie CA, Emsley R, Kyle SD, Gordon C, Drake CL, et al. (2019) Effect of Digital Cognitive Behavioral Therapy for Insomnia on Health, Psychological Well-being, and Sleep-Related Quality of Life: A Randomized Clinical Trial. JAMA Psychiatry 76:21-30. [https://doi.org/10.1001/jamapsychiatry.2018.2745].

34. Maheswaran H, Weich S, Powell J, Stewart-Brown S (2012) Evaluating the responsiveness of the Warwick Edinburgh Mental Well-Being

Scale (WEMWBS): group and individual level analysis. Health Qual Life Outcomes 10:156. [https://doi.org/10.1186/1477-7525-10-156].

35. Riaz W, Khan ZY, Jawaid A, Shahid S (2021) Virtual Reality (VR)-Based Environmental Enrichment in Older Adults with Mild Cognitive Impairment (MCI) and Mild Dementia. Brain Sci 11:1103. [https://doi.org/10.3390/brainsci11081103].

36. Abbaszadeh R, Tabari F, Asadpour A (2020) The effect of lavender aroma on anxiety of patients having bone marrow biopsy. Asian Pacific Journal of Cancer Prevention 21:771□775. [https://doi.org/10.31557/APJCP.2020.21.3.771].

37. Babatabar Darzi H, Vahedian-Azimi A, Ghasemi S, Ebadi A, Sathyapalan T, et al. (2020) The effect of aromatherapy with rose and lavender on anxiety, surgical site pain, and extubation time after open-heart surgery: A double-center randomized controlled trial. Phytotherapy Research 34:2675-2684. [https://doi.org/10.1002/ptr.6698].

38. Dehkordi AK, Tayebi A, Ebadi A, Sahraei H, Einollahi B (2017) Effects of aromatherapy using the damask rose essential oil on depression, anxiety, and stress in hemodialysis patients: A clinical trial. Nephro-Urology Monthly 9. [https://doi.org/10.5812/numonthly.60280].

39. Ebrahimi A, Eslami J, Darvishi I, Momeni K, Akbarzadeh M (2021) An overview of the comparison of inhalation aromatherapy on emotional distress of female and male patients in preoperative period. J Complement Integr Med 19:111-119. [https://doi.org/10.1515/jcim-2020-0464].

40. Jodaki K, Abdi K, Mousavi M.-S, Mokhtari R, Asayesh H, et al. (2021) Effect of rosa damascene aromatherapy on anxiety and sleep quality in cardiac patients: A randomized controlled trial. Complementary Therapies in Clinical Practice 42:101299. [https://doi.org/10.1016/j.ctcp.2020.101299].

41. Namazi M, Amir Ali Akbari S, Mojab F, Talebi A, Alavi Majd H, et al. (2014) Aromatherapy with citrus aurantium oil and anxiety during the first stage of labor. Iran Red Crescent Med J 16: e18371. [https://doi.org/10.5812/ircmj.18371].

42. Vieira AJ, Beserra FP, Souza MC, Totti BM, Rozza AL (2018) Limonene: Aroma of innovation in health and disease. Chemico-Biological Interactions 283:97-106. [https://doi.org/https://doi.org/10.1016/j.cbi.2018.02.007].

43. Hartley N, McLachlan CS (2022) Aromas Influencing the GABAergic System. Molecules (Basel, Switzerland) 27: 2414. [https://doi.org/10.3390/molecules27082414].

44. Kiecolt-Glaser JK, Graham JE, Malarkey WB, Porter K, Lemeshow S, et al. (2008) Olfactory influences on mood and autonomic, endocrine, and immune function. Psychoneuroendocrinology 33:328-339. [https://doi.org/10.1016/j.psyneuen.2007.11.015].

45. Wang ZJ, Heinbockel T (2018) Essential Oils and Their Constituents Targeting the GABAergic System and Sodium Channels as Treatment of Neurological Diseases. Molecules (Basel, Switzerland) 23: 1061. [https://doi.org/10.3390/molecules23051061].

46. Jafarzadeh M, Arman S, Pour FF (2013) Effect of aromatherapy with orange essential oil on salivary cortisol and pulse rate in children during dental treatment: A randomized controlled clinical trial. Adv Biomed Res 2: 10. [https://doi.org/10.4103/2277-9175.107968].

47. Watanabe E, Kuchta K, Kimura M, Rauwald HW, Kamei T, et al. (2015) Effects of bergamot (citrus bergamia (risso) wright & arn.) essential oil aromatherapy on mood states, parasympathetic nervous system activity, and salivary cortisol levels in 41 healthy females. Forsch Komplementmed 22:43-49. [https://doi.org/10.1159/000380989].

48. Lunz K, Stappen I (2021) Back to the Roots-An Overview of the Chemical Composition and Bioactivity of Selected Root-Essential Oils. Molecules (Basel, Switzerland) 26: 3155. [https://doi.org/10.3390/molecules26113155].

49. Bikmoradi A, Seifi Z, Poorolajal J, Araghchian M, Safiaryan R, et al. (2015) Effect of inhalation aromatherapy with lavender essential oil on stress and vital signs in patients undergoing coronary artery bypass surgery: A single-blinded randomized clinical trial. Complementary Therapies in Medicine 23:331-338. [https://doi.org/10.1016/j.ctim.2014.12.001].

50. Fauzi MF, Anuar TS, Teh LK, Lim WF, James RJ, et al. (2021) Stress, Anxiety and Depression among a Cohort of Health Sciences Undergraduate Students: The Prevalence and Risk Factors. Int J Environ Res Public Health 18: 3269. [https://doi.org/10.3390/ijerph18063269].

51. Kianpour M, Moshirenia F, Kheirabadi G, Asghari G, Dehghani A, et al. (2018) The effects of inhalation aromatherapy with rose and lavender at week 38 and postpartum period on postpartum depression in high-risk women referred to selected health centers of yazd, iran in 2015. Iran J Nurs Midwifery Res 23:395-401. [https://doi.org/10.4103/ijnmr.IJNMR_116_16].

52. Franco L, Blanck TJJ, Dugan K, Kline R, Shanmugam G, et al. (2016) Both lavender fleur oil and unscented oil aromatherapy reduce preoperative anxiety in breast surgery patients: A randomized trial. Journal of Clinical Anesthesia 33: 243-249. [https://doi.org/10.1016/j.jclinane.2016.02.032].

53. Hu P.-H, Peng Y.-C, Lin Y.-T, Chang C.-S, Ou M.-C. (2010) Aromatherapy for reducing colonoscopy related procedural anxiety and physiological parameters: a randomized controlled study. Hepatogastroenterology 57:1082-1086.

54. Graham PH, Browne L, Cox H, Graham J (2003) Inhalation aromatherapy during radiotherapy: Results of a placebo-controlled double-blind randomized trial. Journal of Clinical Oncology 21: 2372-2376. [https://doi.org/10.1200/jco.2003.10.126].

55. Pasyar N, Rambod M, Araghi F (2020) The effect of bergamot orange essence on anxiety, salivary cortisol, and alpha amylase in patients prior to laparoscopic cholecystectomy: A controlled trial study. Complementary Therapies in Clinical Practice 39:101153. [https://doi.org/10.1016/j.ctcp.2020.101153].

56. Hosseini S, Heydari A, Vakili M, Moghadam S, Tazyky S (2016) Effect of lavender essence inhalation on the level of anxiety and blood cortisol in candidates for open-heart surgery. Iran J Nurs Midwifery Res 21:397-401. [https://doi.org/10.4103/1735-9066.185582].

57. Ni CH, Hou WH, Kao CC, Chang M., et al. (2013) The anxiolytic effect of aromatherapy on patients awaiting ambulatory surgery: A randomized controlled trial. Evid Based Complement Alternat Med 2013:927419. [https://doi.org/10.1155/2013/927419].

58. Lindgren V, McNicholl L, Friesen MA, Barnett S, Collins F (2019) Effects of aromatherapy on pain and anxiety scores in adult patients admitted to a community hospital on the medical unit or telemetry unit a pilot study. Holistic Nursing Practice 33:346-353. [https://doi.org/10.1097/hnp.0000000000000352].

59. McIlvoy L, Richmer L, Kramer D, Jackson R, Shaffer L, et al. (2015) The efficacy of aromatherapy in the treatment of postdischarge nausea in patients undergoing outpatient abdominal surgery. Journal of PeriAnesthesia Nursing, 30:383-388. [https://doi.org/10.1016/j.jopan.2014.10.004].

60. Eldridge SM, Lancaster GA, Campbell MJ, Thabane L, Hopewell S, et al. (2016) Defining Feasibility and Pilot Studies in Preparation for Randomised Controlled Trials: Development of a Conceptual Framework. Plos One 11: e0150205. [https://doi.org/10.1371/journal.pone.0150205].

61. Loscalzo J (2009) Pilot trials in clinical research: of what value are they? Circulation 119: 1694-1696. [https://doi.org/10.1161/circulationaha.109.861625].

62. Herz RS (2009) Aromatherapy facts and fictions: a scientific analysis of olfactory effects on mood, physiology and behavior. Int J Neurosci 119:263-290. [https://doi.org/10.1080/00207450802333953].

63. Herz RS (2016) The role of odor-evoked memory in psychological and physiological health. Brain Science 6: 22. [https://doi.org/10.3390/brainsci6030022].

64. Dyer J, Cleary L, McNeill S, Ragsdale-Lowe M, Osland C (2016) The use of aromasticks to help with sleep problems: A patient experience survey. Complement Ther Clin Practice 22:51-58. [https://doi.org/10.1016/j.ctcp.2015.12.006].

65. Stringer J, Donald G (2011) Aromasticks in cancer care: An innovation not to be Sniffed at. Complement Ther Clin Practice 17:116-121. [https://doi.org/10.1016/j.ctcp.2010.06.002].

66. Tyrer E (2021) Space to Breathe: The use of essential oil aroma sticks in an NHS complementary therapy service's response to a socially distanced world. International Journal of Clinical Aromatherapy, 16 ISSN 1961-7623.

67. McCaffrey R, Thomas DJ, Kinzelman AO (2009) The effects of lavender and rosemary essential oils on test-taking anxiety among graduate nursing students. Holist Nurs Pract 23:88-93. [https://www.embase.com/search/results?subaction=viewrecord&id=L354368489&from=export].

68. Schneider R (2016a) Direct application of specially formulated scent compositions (AromaStick®) prolongs attention and enhances visual scanning speed. Applied Cognitive Psychology 30:650-654. [https://doi.org/10.1002/acp.3237].

69. Wotman M, Levinger J, Leung L, Kallush A, Mauer E, Kacker A (2017) The efficacy of lavender aromatherapy in reducing preoperative anxiety in ambulatory surgery patients undergoing procedures in general otolaryngology. Laryngoscope Investigative Otolaryngology 2:437-441. [https://doi.org/10.1002/lio2.121].

70. Ko LW, Su CH, Yang MH, Liu SY, Su TP (2021) A pilot study on essential oil aroma stimulation for enhancing slow-wave EEG in sleeping brain. Sci Rep 11: 1078. [https://doi.org/10.1038/s41598-020-80171-x].

71. Woo CC, Miranda B, Sathishkumar M, Dehkordi-Vakil F, Yassa MA, et al. (2023) Overnight olfactory enrichment using an odorant diffuser improves memory and modifies the uncinate fasciculus in older adults. Front Neurosci 17: 1200448. [https://doi.org/10.3389/fnins.2023.1200448].