

Effect of Inhaled Ylang-Ylang Essential Oil on Respiratory Rate, Heart Rate, Blood Pressure, and Short-term Memory of Medical Students in a Private Medical Institution in Malaysia: A Randomized Control Trial

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ABSTRACT

Lately, the usage of essential oil has been rising in popularity and is becoming a new trend. A randomised controlled trial from June to July 2022 among medical students in a private medical institution in Malaysia was conducted to determine the effect of Ylang-Ylang oil on respiratory rate, heart rate, blood pressure, and short-term memory. A total of 70 participants were randomly assigned into intervention and control group. The respiratory rate, heart rate, and blood pressure of our participants were measured before they entered the intervention or control room and were recorded in a form. The intervention group participants were exposed to the Ylang-Ylang essential oil, whilst the control group participants were exposed to water vapour without any Ylang-Ylang scent. After respective exposure in both intervention and control groups, the outcome parameters (respiratory rate, heart rate, blood pressure and short-term memory) were recorded in the same form as before. The study data was analysed using Epi Info software version 7.2.5.0. The changes in blood pressure, heart rate and respiratory rate were analysed using a paired t-test, while the short-term memory test was analysed using an unpaired t-test. No statistically significant association in outcome measures were found between the participants in the intervention and control group. Further studies should explore different doses of Ylang-Ylang, with different duration & repeated measures of vital signs and memory.

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INTRODUCTION

Essential oils are aromatic, volatile liquids obtained from plant material through steam distillation and named after the plant from which they are derived [1]. As there is a vast variety of plants available, there are diverse types of essential oils available in the market. Essential Oils can be classified based on the aroma/smell of the oil, namely Citrus, Herbaceous, Medicinal/Camphorous, Floral, Resinous oils and Woody, Earthy, Minty and Spicy oils, according to Richard Herman [2]. The predominantly produced essential oils for industry purposes are from orange, corn mint, eucalyptus, citronella, peppermint, and lemon [3]. Still, the more commonly domestically used ones include lavender, chamomile, peppermint, tea tree oil, eucalyptus, geranium, jasmine, rose, lemon, orange, rosemary, frankincense, and sandalwood [3]. The action of essential oils begins by entering the human body via three possible different ways, including direct absorption through inhalation, ingestion, or diffusion through the skin tissue [4]. Other possible methods include aromatherapeutic massages, aromatherapeutic baths and sauna [5].

The oils are frequently used for their therapeutic, odoriferous, and flavour properties in an extensive selection of products like cosmetics, foods, and medicines [6]. Some of the essential oils possess antimicrobial, antiviral, antibiotic, anti-inflammatory, and antioxidant properties as well as purported psychogenic effects such as relieving stress, treating depression, and aiding with insomnia [7]. Aromatherapy is one of the complementary therapies which use essential oils as the major therapeutic agents to treat several diseases [8]. Aromatherapy has been recognised for its potential therapeutic effects in various contexts. It may help reduce pain during labour and childbirth, lower blood pressure in hypertensive patients, alleviate stress, enhance mood and sleep quality in individuals undergoing haemodialysis, and decrease stress levels in healthy adults. It has been shown to reduce anxiety in perioperative patients and improve sleep quality across diverse populations [9]. Essential oils influence the cardiovascular system, as shown in a study that investigated the short-term effects of essential oils on the cardiovascular health of young spa workers. The study results showed that essential oil exposure for one hour reduces the heart rate and blood pressure [10]. Another study has shown inhaling lavender oil significantly reduces participant's anxiety levels [11]. One study also showed that essential oils were effective in reducing the respiratory rate of the participants [12].

Some studies have investigated the effect of essential oil on memory and cognition. To understand the concept of memory better, one study showed that acetylcholine (ACh) may enhance the encoding of memory by enhancing the influence of feedforward afferent input to the cortex, making cortical circuits respond to features of sensory stimuli while decreasing excitatory feedback activity mediating retrieval [13]. Interestingly, not all essential oils have the same effect on memory; for example, inhalation of rosemary essential oil increases the memorisation of numbers, and inhalation of lavender essential oil weakens this process [14]. Rosemary essential oil improves mood, memory, and cognitive performance and helps to lift spirits; Rosemary oil also increases memory recall speed in older persons as well [15,16]. The essential oil that was applied in our study was Ylang-Ylang scented oil, as it is a new essential oil available in the market. Ylang-Ylang oil has been described as possessing a medium to strong initial aroma with a fresh, floral,

slightly fruity yet delicate fragrance [17]. Furthermore, the flower is also described as producing an intensely sweet scent, which is like jasmine [18]. It is effective in treating depression, high blood pressure, and anxiety [17]. Inhalation of Ylang-Ylang oil significantly decreased the systolic and diastolic blood pressure levels [19]. It also significantly increased the subjective attentiveness and alertness [20]. Ylang-Ylang oil seems to affect short-term memory as well. Peppermint was found to enhance memory, whereas Ylang-Ylang impaired it [21]. However, the data available for the effects of Ylang-Ylang on memory is very limited.

Stress in medical school can be quite a common phase every medical student goes through in their day-to-day lives. Stress in an academic situation can have both positive and negative consequences. Stress can inhibit and suppress learning, which is called 'unfavourable stress' and is associated with inhibition of students' academic performance [22]. A study carried out in 2009 showed that a pronounced working memory deficit was associated with exposure to stress [23]. One study conducted to find the prevalence of stress among medical students found it to be 41.9% in a Malaysian Medical School [24]. A high prevalence of stress among medical students is a cause of concern as it may impair the behaviour of students, diminish learning, and ultimately affect patient care after their graduation [25]. Even though stress may not directly cause hypertension, it can lead to repeated blood pressure elevations, which eventually may lead to hypertension [26]. Therefore, stress was shown to affect both blood pressure and memory. Interestingly, a study regarding awareness of essential oils among Malaysian students showed that 51% of the respondents rarely used essential oils [27]. Studies of the usage of essential oils, especially about the scent of Ylang-Ylang and its effects on medical students in Malaysia, are extremely limited. Hence this research aimed to study the effect of Ylang-Ylang essential oil on respiratory rate, heart rate, blood pressure, and short-term memory among medical students.

METHODS

Study design and setting

The study was a randomised controlled trial conducted from May to July 2022 among undergraduate medical students in a private medical institution in Malaysia.

Sample size and sampling

The sample size (n) was calculated below using "Open Epi" version 3, an open-source calculator, based on a previous study done at the University of Lynchburg [28]. According to the sample size calculation, the minimum sample needed was 66 participants.

Inclusion criteria

Undergraduate medical students, both female and male and local and international students, were recruited. Students were recruited for research regardless of their gender, age, and ethnicity. Students were recruited for research regardless of their current or past essential oil usage.

Exclusion criteria

Students with cardiac or respiratory problems, allergies to fragrances, recent COVID symptoms, or a running nose on the day of the experiment were not recruited for the study.

We sent out our invitations and recruited the first 70 participants who volunteered to participate in our study.

INTERVENTION

The intervention was the inhalation of essential oil (Ylang-Ylang-scented essential oil).

1. Pre-intervention procedure

Before carrying out the experiment, we titrated the blood pressure monitor by practising it on the investigators. This was to minimise interpersonal and inter-device variations. Apart from that, we referred to the latest edition of MacLeod's textbook to measure all the variables except for short-term memory, which was assessed with "Memory for image". We sent an invitation letter along with the consent form to the participants, and those who agreed to participate will receive a questionnaire on trial day. Before assigning the participants to different classrooms (Classroom A and Classroom B), their heart rate, blood pressure, and respiratory rate were measured. Precaution measures such as a first aid kit, standby healthcare professionals and transport were prepared should there be any emergencies during the study.

The two diffusers used were Young Living brand diffusers, and the essential oil used was Ylang-Ylang oil. Fifteen drops of essential oil were added to the diffuser per session. The blood pressure cuffs were all digital blood pressure devices. All participants used the same brand and the same model digital BP cuff to prevent inter-instrumental variations during data collection.

2. Randomization and blinding procedure

The sample size of the study was 70 participants (50 Females and 20 Males). Females and male students were evenly divided into intervention and control group for every session by stratified randomisation. During the day of the experiment, at the start of each session, the participant's blood pressure, heart rate, and respiratory rate were measured before randomisation. Randomisation was done at the beginning of each session. For example, session 1 had 10 participants (8 females & 2 males), and the participants were randomly assigned to room A and room B, where each room consisted of 4 females and 1 male. Allocation concealment was done with the help of pre-prepared envelopes with the name of the room in it, where the participants were blinded, meaning that they did not know whether they were assigned to an intervention group or a control group. The investigators were blinded to the randomisation status except for one of them who put the essential oil into one of the diffusers in classroom A or B. There were 7 sessions and 7 times randomisation using the envelopes, and the same researcher took care of the essential oil to maintain the blinding. There was a switch in the room for intervention and control to maintain blinding of the participants. Each time before switching, the handler of the diffuser opened rooms for adequate time between each session to clear the air and wash the diffuser.

3. Intervention

The intervention group was a group of participants whose room was diffused with Ylang-Ylang essential oil for 10 minutes. Then, participants were instructed to stay in their specified classroom for 10 minutes before assessing their outcomes and were allowed to leave the room at the same time after all the outcomes of all participants were measured.

4. Control

The control group was a group of participants whose room was diffused with water for 10 minutes. Then, participants were instructed to stay in their specified classroom for 10 minutes before assessing their outcome and were allowed to leave the room at the same time after all the outcomes of all participants were measured.

5. Outcome assessment

Outcome measurements were the same for room A and room B, meaning that outcome measurements for intervention and control groups were the same. Outcomes such as heart rate and blood pressure of the participants were taken using digital blood pressure measurement devices. Each session had 10 participants, who were randomised into room A and room B. All of them were given BP cuffs; thus, they measured their blood pressure under the supervision of the researchers. Another outcome, respiratory rate, was also self-monitored by counting the breaths (observing the movement of the chest) of the participant for a full minute, which was timed by the timer from the phone. The last

outcome, short-term memory, was assessed using the "Memory for image" method. Picture 1, as shown below, was displayed via projector onto the front screen with adequate exposure of light and in an appropriate size frame, and participants had to memorise the given pictures within 20 seconds. After which, all participants wrote whatever they could remember as specific as possible on a given paper within 1 minute. Two investigators graded their papers independently based on the list of accepted answers, as shown in Table 1.

DATA COLLECTION

Questionnaires/proformas were prepared to collect the data. It included record number, session time, day of participation, room label (A or B), demographic data such as age, gender, weight, height, participants' past experiences of the essential oil therapy, and the impressions of participants on the essential oil. The proforma prepared had places to note down participants' heart rate, blood pressure, and respiratory rate before entering the room and after exposure. A blank paper was given to the participants to note down their answers for the short-term memory test, and a place was prepared to record the score of the short-term memory test on the proforma. We also prepared a list of accepted answers to grade the participants' answers to the short-term memory questions on the pictures.

DATA ANALYSIS

Data was analysed by using Epi Info software version 7.2.5.0. The main outcome variables in this study were respiratory rate, heart rate, blood pressure and short-term memory. Descriptive statistics such as frequency and percentage were calculated for the qualitative variables such as age, gender, ethnicity, BMI, previous usage of essential oils and familiarity with Ylang-Ylang oil before our study. Mean and standard deviation were calculated for the quantitative outcome variables. Hypothesis testing, such as paired T, was performed on the heart rate, respiratory rate, and blood pressure, and unpaired T-tests were performed on short-term memory to compare the intervention and control group. The chi-squared test was used for categorical data, such as no change/change in RR, HR, or BP difference. The association of measures used for this study was a relative risk (RR), and a p-value less than or equal to 0.05 (5%) was considered statistically significant.

ETHICAL CONSIDERATIONS

A consent form consisting of all the important and relevant particulars of the study was given to the participants so that written informed consent was obtained before the intervention started and before answering the questionnaire. The participants were informed regarding the use of essential oil as our intervention and were given full freedom of choice to participate in this study. Participation was solely voluntary, and no incentives were offered to encourage participation. Moreover, the participants were not coerced or forced into taking part in this study. Any information that the participants in this study provided was kept confidential and strictly served only the purpose of this study. Maintenance of the anonymity and privacy of the participants was ensured. This research was approved by the Research Ethics Committee, Manipal University College Malaysia (MUCM), Malaysia.

RESULTS

Table 1 shows the demographic characteristics of the study participants, including gender, age, ethnicity, and nationality. Out of the 70 participants, 71.43% were females. 80.0% of our participants were from the age group of 21-23. For ethnicity, 35.71% were Indians, 27.14% were Chinese, 8.57% were Malays, and 28.57% were of other ethnicities. As for the experience of using essential oil, 51.43% of them had used it before (Table 1).

Table 1. Demographic characteristics of the respondents (n=70)

Respondent characteristics	Frequency (n)	Percentage (%)
Gender		
Male	20	28.57
Female	50	71.43
Age (Years)		
18-20	9	12.86
21-23	56	80.00
24-26	5	7.14
Ethnicity		
Malay	6	8.57
Chinese	19	27.14
Indian	25	35.72
Other	20	28.57
Nationality		
Malaysian	55	78.57
Non-Malaysian	15	21.43
Previous use of essential oil		
Yes	36	51.43
No	34	48.57
Perspective about essential oil		
Beneficial/Good	30	42.86
Neutral	32	45.71
I don't know	3	4.29
No opinion	5	7.14
Familiarised with Ylang-Ylang scent before		
Yes	12	17.14
No	58	82.86

Table 2 shows the memory scores of both the intervention and control group. The mean values of the intervention and control groups were 9.54 and 8.94, respectively, which resulted in a mean difference of 0.6. The p-value was 0.190. Hence, there is no significant association between Ylang-Ylang EO and short-term memory. In other words, Ylang-Ylang EO did not decrease nor improve short memory.

Table 2. Short-term memory score among the intervention and control groups (n=70)

	Intervention Group	Control Group	Mean difference (95%CI)	p-value
Memory Score mean (SD)	9.54 (2.28)	8.94 (1.41)	0.6 (-0.30, 1.5)	0.190

Table 3 shows the differences in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) among the intervention and control groups. The control group decreased the average SBP to 1.97. However, this was not a significant finding (P 0.414). For DBP, the intervention group increased the average DBP less than the control group by 0.029. However, it was not a significant finding (P 0.990). The heart rate of the intervention group decreased the average HR by 1.20 more than that of the control group. However, this was not a significant finding (p = 0.630) (Table 3).

Table 3. Differences in systolic and diastolic blood pressure and heart rate among the intervention and control groups (n=70)

Differences in BP, HR before and after exposure to intervention vs control	Intervention Group (Ylang-Ylang essential oil) Mean (SD)	Control Group (water vapour) Mean (SD)	Mean difference (95%CI)	p-value
Systolic Blood Pressure	0.14 (11.39)	2.11 (8.47)	-1.97 (-6.76, 2.82)	0.414
Diastolic Blood Pressure	-1.49 (8.48)	-1.51 (10.79)	0.029 (-4.60, 4.66)	0.990
Heart Rate	4.06 (9.32)	2.86 (11.32)	1.20 (-3.75, 6.15)	0.630

Table 4 shows the differences in respiratory rates among the intervention and control groups. Both groups showed a reduction in respiratory rate. However, it was not a significant finding (P 0.211) (Table 4).

Table 4. Differences in systolic and diastolic blood pressure and heart rate among the intervention and control groups (n=70)

Differences in respiratory rate before and after exposure to intervention vs control	Intervention Group (Ylang-Ylang essential oil) Mean (SD)	Control Group (water vapour) Mean (SD)	Mean difference (95%CI)	p-value
Respiratory Rate	0.09 (3.65)	1.09 (2.94)	-1.00 (-2.58, 0.58)	0.211

DISCUSSION

The objective of this randomised control trial was to observe the effect of Ylang-Ylang scented essential oil on respiratory rate, heart rate, blood pressure and short-term memory among medical students in a private medical institution in Malaysia. Interestingly, in our RCT, we found out that Ylang-Ylang essential oil exposure decreased the respiratory rate of our intervention participants, but our findings were not significant. However, a similar, although non-randomized, control trial found that aromatherapy exposure to inpatients in the internal medicine intensive care unit of a hospital in Southeastern Turkey decreased the respiratory rate significantly but had no effect on the other vitals [12].

Our study observed that there was no significant difference in SBP and DBP before and after exposure to Ylang-Ylang oil. However, a similar randomised control trial carried out on healthy males at Hanseo University Korea revealed that after Ylang-Ylang oil inhalation, there was a significant decrease in the systolic and diastolic blood pressure values [19]. Another research objective in our study was to find out the effect of Ylang-Ylang oil on heart rate; we observed that there was a decrease in the heart rate among our participants, although the same study carried out at Hanseo University Korea showed that it significantly decreased the heart rate of the healthy males [19].

The last objective of our study was the effect of Ylang-Ylang oil on memory. We observed a slightly increased mean score for short-term memory in our intervention group participants compared to the control group, but the findings were not significant. However, a randomised control trial carried out at the University of Northumbria revealed that exposure to Ylang-Ylang oil compared to peppermint and no essential oil exposure impaired memory and slowed the processing speed in their participants who were undergraduate students and members of the general public [21]. The mean findings of our study were almost the same as before and after exposure, but this could be because our participants were too excited while doing the “image for memory” test, as we assessed the outcome vitals after the memory test was done.

We have encountered a few limitations whilst conducting this study Ylang-Ylang. There was a time restriction when conducting our analysis. If the time exposure of Ylang-Ylang oil had been longer, we could have gathered more accurate results, and we couldn't have followed up with our participants; hence, we couldn't study any long-term effects of Ylang-Ylang oil on respiratory rate, heart rate, blood pressure and short-term memory. In our study, we tried our best to blind the participants throughout the experiment. Still, since the intervention group would be inhaling the Ylang-Ylang essential oil, the exposed participants would know they were in the intervention. However, this did not affect the results as the investigators were properly blinded and were only informed about the classroom arrangements after the analysis. Lastly, our study population was limited to an institution, and therefore, the generalizability of the findings to medical students in different settings might be limited.

CONCLUSION

In conclusion, 51.43% of participants used essential oils in their day-to-day lives, and 42.86% believed that it is beneficial to health. In our study, in assessing the effects of Ylang-Ylang essential oil, it showed that there was no significant change in the respiratory rate, heart rate, blood pressure and short-term memory of our participants. These findings contradict our reference articles. Still, it may be due to the limitations of our randomised control trial but also the students' mental and emotional aspects, which we cannot control. Hence, we neither encourage nor discourage the usage of Ylang-Ylang essential oil to our medical students. We recommend that research in the future study different doses of Ylang-Ylang, with different durations & repeated measures of vital signs and memory.

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