Efficacy of Lemon and Lemongrass Essential Oils on Stress among Parents of Children with Intellectual Disabilities

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ABSTRACT

Context: Essential oils act as alternative medicine and have great therapeutic benefits. Oils derived from Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus*) have great importance for stress reduction. No holistic studies compare their chemical composition, essential oil constituents, and efficacy in stress control. Parents who have children with intellectual disabilities (ID) go through the highest levels of stress, which can lead to significant psychological and physical health problems. Therefore, there is a great need for effective stress management interventions that are non-pharmacological. If widely spread interventions work, it can lead to reduced chemical usage rates.

Aim: The study's objective was to assess the effects of Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus*) essential oils, singly and in combination, on stress and biomotor variables among parents of children with ID.

Methods: Quasi-experimental design incorporating a pre-test and post-test control group was conducted. Aromatherapy singly with Lemon, singly with Lemongrass, a blend of both oils individually mixed, a placebo, and the base oil (Sweet almond oil) were given for eight weeks by drops onto an absorbent paper attached to their clothing collar while the parents sat in the shed with fan and fresh air. A purposive sampling method was employed in identifying the participants and community health promoters in identified wards of Kakamega County, Kenya contacted the target households and a simple random formation of groups was employed. Two hundred twenty-eight parents (N=57 per group) completed the study exposures from 250 with a 91.2% response; follow-up rates were maintained at 95%. Stress indicator tools were used to measure stress, and separate blood pressure and heart rate were measured. The essential oils were subject to phytochemical analysis through Gas Chromatography-Mass Spectrometry (GC-MS). Data was analyzed using one-way ANOVA with the Tukey HSD post hoc test (continuous variables).

Results: The three aromatherapy exposures, singly and in combination (Lemongrass, Lemon, and a blend of both Lemon and Lemongrass), significantly reduced physical stress, promoted sleep, and improved the emotion of the parents of children with ID ($p < 0.0001$). A blend of both oils reduced both systolic blood pressure and heart rate. All three aromatherapy interventions (Lemongrass, Lemon, and Blended) demonstrated statistically significant decreases in Systolic Blood Pressure and Heart Rate post-intervention compared to the pre-intervention ($p < 0.0001$ for both outcomes). Significant reduction was highest for systolic blood pressure ($\bar{x}$ -14.0; $p < 0.0001$) and heart rate ($\bar{x}$ -5.3; $p < 0.0001$) for the blend group (a blend of both Lemon and Lemongrass). There were no changes in the control group. ***Conclusion:*** Lemon essential oil and Lemongrass essential oil, singly and combined, reduced stress among parents of children with ID. The blend of both oils offers the best stress reduction benefits and cardiovascular health. This study recommends that parent of children with intellectual disabilities use Lemongrass and Lemon essential oils to reduce stress and improve systolic blood pressure and heart rate since it is natural, safe, cost-effective, and readily available.

Keywords: Children, intellectual disability, Lemon, Lemongrass essential oil, stress

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1. Introduction

Parents of children with intellectual disability report increased stress due to heavier caregiver burden, stigmatization, and financial expenses related to specialized care. Life burdens related to caring for a child with intellectual disability have been associated with caregiver distress, including depression and anxiety *(Kusuma et al., 2024).* Caregiver burden, in particular for parents of children with profound intellectual and multiple disabilities, is associated with higher levels of anxiety and depression as well as increased time spent on caregiving tasks relative to parents of children with typically developing trajectories. Chronic stress can cause surges in pro-inflammatory cytokines and promote inflammation. This surge is linked to poor health, especially when caregiving-related stress is also experienced and compounded by stress in other life domains over time *(López et al., 2017)*

Aromatherapy is a holistic healing treatment based on essential oils that contain volatile plant extracts, often distilled or cold-pressed, for healing and improving overall health, mood, and state of mind. Aromatherapy can help to relieve

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anxiety, depression, and stress *(Perry et al., 2012).* The smell of essential oils can cause changes in the brain by the nerve cell receptors in the nasal epithelium where it is sent to the brain *(Franco et al., 2016)*

This mechanism may explain aromatherapy's potential to reduce stress. Inhaling aromatherapy essential oil blends like Lemon and Lemongrass have shown promising anti-stress effects. Activating multiple brain regions involved in mood and stress regulation leads to an association between essential oil volatiles and the relative perceived physiological reaction *(Franco et al., 2016).*

Aromatherapy provides an alternative or supplementary treatment to help people cope with multiple problems related to their physiological and psychological wellbeing. Due to the blending of these two essential oils, the antidepressant effect may be closer to synergistic associations. Even when small amounts of an active ingredient from one essential oil are added, this effect might still be significant. Unfortunately, few studies have focused on their combined effects, and future research is needed to verify the effective outcomes. Essential oils have also played a role in traditional medicine systems of cultures worldwide. Essential oils have been used orally, inhaled, and applied topically, though rarely ingested. For example, lavender, peppermint, and chamomile are well-known anxiety-calming essential oils *(Boukhatem et al., 2014)*.

Lemon and Lemongrass essential oils too, have been known to help reduce stress. One of the reasons that essential oils are thought to help with health issues is their complexity. Each essential oil is a distillate of hundreds or thousands of chemical compounds and organic constituents, such as terpenes, alcohols, esters, aldehydes, ketones, and phenols. For example, Lemon essential oil's dominant chemical is a monoterpene called limonene. It is well-recognized for its refreshing, energizing effects and as a natural antidepressant *(Karadag et al., 2017).*

Lemongrass essential oil has citral as its main chemical, which is thought to calm the body and mind and is also a natural anti-inflammatory. One of the explanations for the stress-mitigating properties of essential oils is that aromatic compounds might modulate the central nervous system *(Setze, 2009).* Odors of essential oils can affect the emotional part of the brain, which is an organ responsible for regulating emotional state and reactivity to stress *(Goes et al., 2015).* The perception of odor triggers signaling in neurobiological networks interacting with the highest regions in the brain, which consequently changes emotional state by inhibiting, activating, or suppressing behavior *(Bikmoradi et al., 2015)*

The extraction method is a very important point that significantly determines the quality and composition of the obtained essential oils. Various methods are used to extract essential oils, and the few most common are hydro distillation, steam distillation, and cold pressing. Every technique has its own set of advantages, and it can even influence the yield as well as the chemical composition of the ambient oil *(Tongnuanchan & Benjakul, 2014).* For this purpose, the study prefers hydro distillation as an oil extraction method in *Citrus limon* (Lemon) and *Cymbopogon citrates* (Lemongrass) fresh leaves. In hydrodistillation, the essential oils are extracted by immersing the plant material in hot water, vaporized by steam, and then carried away with the steam by condensation into liquid *(Daneshpajooh et al., 2019).*

This method is the most common extraction method of essential oils that is often used, especially for citrus oils. The gas chromatography-mass spectrometry (GC-MS) was applied for analysis of the compounds to analyze the phytochemical compounds. GC-MS is the non-destructive analytical method for identifying and characterizing chemicals in a sample composed of volatile compounds. It is today one of the most used methods for essential oils separation, analysis, and identification *(Matulyte et al., 2019)*

Essential oils have long been appreciated for their therapeutic uses across cultures and systems of traditional medicine. Extracted from aromatic plants, they provide a host of therapeutic properties, including the ability to help with stress management, which has become prominent in the healthcare landscape in recent years (*Ozer et al., 2022*).

2. Significance of the study

Parents of children with intellectual disabilities (ID) experience significantly higher levels of stress, leading to serious psychological and physical health issues, such as an increased risk of cardiovascular diseases and mental health disorders *(Azeem et al., 2013).* Despite the pressing need for effective interventions, there is a noticeable gap in the availability of non-pharmacological strategies specifically targeting stress reduction in this population. Essential oils, particularly those derived from Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus*), are recognized for their therapeutic properties. However, comprehensive studies comparing their chemical composition and effectiveness in stress management remain limited. Conducting this study in Kakamega County, Kenya, where access to conventional stress management resources is constrained, underscores the importance of exploring accessible, cost-effective interventions *(Goes et al., 2015).*

This study can provide empirical evidence on the efficacy of Lemon and Lemongrass essential oils, individually and in combination, in reducing stress and improving cardiovascular health among parents of children with ID. The findings from this quasi-experimental study support the use of these essential oils as a practical, natural alternative to pharmacological interventions, potentially influencing public health strategies designed to support caregivers in similar communities *(Kusuma et al., 2024).*

This study is also significant as it addresses the existing gap in research by comparing the chemical constituents and therapeutic properties of the subjects under investigation. By doing so, it aims to elucidate their potential in alleviating stress among parents of children with intellectual disabilities, thereby contributing valuable insights into effective stress management strategies for children with intellectual disabilities.

3. Aim of the study

The study aimed to assess the effects of Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus*) essential oils, singly and in combination, on stress and bio motor variables among parents of children with ID.

3.1. Research hypothesis

There is no significant difference in stress reduction and cardiovascular health (measured by systolic blood pressure and heart rate) among parents of children with intellectual disabilities when using Lemon (*Citrus limon*) essential oil, Lemongrass (*Cymbopogon citratus*) essential oil, a blend of both oils, a placebo, or base oil (sweet almond oil) over the 8-week intervention period.

4. Subjects & Methods

4.1. Research Design

In our study, the effects of Lemon (Citrus limon) and Lemongrass (Cymbopogon citratus) essential oils alone or in combination on stress reduction in the parents of children with intellectual disabilities (ID) were examined using a quasi-experimental pre-test and post-test control group design. Four groups were created: one was administered with Lemon essential oil, one with Lemongrass essential oil, a third group received a blend of both oils, and one group was the control group and was administered a placebo. The experimental groups inhaled the essential oils thrice daily for eight weeks.

The measurable variables were stress level, blood pressure, and heart rate. Stress level was measured with a stress indicator questionnaire structured test completed before and after the intervention. During the study, systolic and diastolic blood pressure and heart rate were measured by periodically taking the participants' blood pressure as a physiological measure of the aromatherapy intervention. Blood pressure and heart rate were monitored every Tuesday and Friday throughout the 12-week study period. This measurement was done very early in the morning by the trained CHPs totalling the number of blood pressure and heart rate measurements to 24 for each participant.

4.2. Study setting

The study sample was drawn from the general population of four sub-counties in Kakamega County, Kenya: Likuyani, Shinyalu, Khwisero, and Matungu. These sub-counties were chosen to provide a good geographic representation of the county's better and poorer socio-economic conditions.

4.3. Subjects

The study participants were the parents of children with ID in the four selected sub-counties of Kakamega County. Parents were identified with the support from Community Health Promoters (CHPs) at the community level and reached out to eligible study participants to ensure that participants were directly affected by the stress of caring for children with intellectual disabilities.

Purposive sampling was employed to select participants using the following steps: CHPs identified households caring for children with intellectual disabilities, and parents of these children were invited to participate. This approach selected a sample created specifically to focus on parents caring for children with intellectual disabilities. The participants in this study were selected using random sampling.

The researcher randomly selected four sub-counties from the 12 sub-counties in Kakamega County (Matungu, Shinyalu, Khwisero and Likuyani.). From these four runs, every household with birth between 2005 and 2018 with an intellectual disability was invited by investigators to send one caregiver to take part in the study. Initially, the sample numbered 250, which was an equivalent number from each of the four sub-counties. However, 228 participants completed the study, and a final sample size of 228 respondents (91.2% response rate). Every sub-county had 57 respondents proportionate to the total population we aimed to capture.

Inclusion criteria

It also comprised parents of children with intellectual disabilities residing in the selected sub-counties in Kakamega County who could read and write in English and Swahili, aged 18 years and above, and were willing to give informed consent (n = 228). These strata were assessed based on the objectives and purpose of the study. Participants who could complete the 12-week intervention period were included,

Exclusion criteria

Those who could not or were unwilling were excluded. Other participants excluded include parents of children without intellectual disabilities, individuals with a known allergy to essential oils, and those who did not consent to be part of the study. Pregnant women were excluded due to concerns for fetal safety. Participants with bronchial hyperreactivity, migraines, seizures, and epilepsy without a prior history of essential oil use were also excluded from the study. These strata were set to ensure the safety of participants and the safety of the study's data.

4.4. Tools of data collection

4.4.1. Stress Assessment Questionnaire

A validated Stress Assessment Questionnaire was utilized to measure stress levels in the study. This questionnaire is a widely recognized tool adopted without modification from a pre-existing validated stress indicator *(Cohen et al., 1983).* This tool assessed participants' stress levels before and after the intervention. The questionnaire comprises multiple parts, each addressing different aspects of stress, such as emotional, physical, and psychological indicators. It features closed-ended questions, primarily in a Likert scale format, with 45 items in total.

The validity and reliability of the tool have been well-established in prior studies, with a reported Cronbach's alpha greater than 0.80 (0.76), indicating high internal consistency *(Cohen et al., 1983).* The questionnaire was administered twice—pre-intervention and post-intervention—to both the study and control groups. Each response on the Likert scale contributes to a cumulative score, with higher scores indicating greater stress levels.

4.4.2. Parent Assessment Record

This tool was designed by the researcher to record the parents' sociodemographic characteristics, blood pressure, and heart rate. It included the following: sub-county, gender, age group, marital status, education status, employment status, gender of child, birth order of the child, and age group of children.

4.5. Procedures

Ethical permission from Masinde Muliro University's Research Ethics Committee was also sought and granted; permission from the National Commission of Science, Technology, and Innovation (NACOSTI) was sought and obtained (Ref. Number 305897). All the pre-examined eligible participants had to give written authorization to join the study; this ensured that those who accepted to participate were well informed of the study's objectives and procedures, potential risks, study requirements, and prescribed benefits.

This study followed the 1964 Helsinki Declaration and its later amendments, which guide medical research involving human subjects. Participants were made aware of their right to terminate the study at any given moment without any consequence. With a focus on participants' right to privacy and confidentiality, their responses were stored securely and were only accessible to the research team, thus protecting the identity of all those involved.

Validity and Reliability: In the pre-test phase, the researcher used a stress indicator tool and other data collection instruments on a sample group to refine the data collection process, clarify and test the instruments for appropriateness, and answer the participants' questions before the main study took place. The researcher made sure the instruments used were valid. Literature review in international and local research work and consultation with experts in the same field took place to ascertain the validity of collected data.

The stress indicator tool and other data collection instruments underwent a pre-test and validation process to determine their reliability and make necessary adjustments for validity and appropriateness. Cronbach's alpha coefficient was used to check the reliability of the data collection instruments to ensure strong internal consistency that could be treated as a reliable indicator of the multi-item subscale. Cronbach's alpha coefficient was used to check the reliability of the stress indicator tool = 0.760 for 30 participants among the total sample size of almost one thousand; the alpha coefficient was strong or high, indicating good reliability, and the test was valid and acceptable for the study. Cronbach's Alpha is used when the researcher calls for more than one item to measure one phenomenon and wants to assess the reliability of the measurement tool based on the participant's responses.

The data collection procedures for this study involved a systematic approach to measure the effects of Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus)* essential oils on stress levels, blood pressure, and heart rate among parents of children with intellectual disabilities. Initially, participants were recruited through a structured process where Community Health Extension Workers (CHEWs) and Community Health Assistants (CHAs) helped identify eligible parents. These participants were purposively selected and randomly assigned to one of four groups: three treatment groups receiving different concentrations of essential oils (Lemon, Lemongrass, or a blend) and a control group receiving a placebo (sweet almond oil).

A clinically validated Blood Pressure Monitor was employed to monitor blood pressure. This device is commercially available and has been extensively validated for accuracy, with an error margin of less than five mmHg. The tool was used to measure both systolic and diastolic blood pressure, serving as a key indicator of cardiovascular health in the participants. The device features an inflatable cuff, a pressure sensor, and a digital display that provides readings after each measurement. Blood pressure readings were taken twice during each session, both pre-and post-intervention, for all participants. Lower post-intervention readings were indicative of a successful stress reduction intervention.

A validated Heart Rate Monitor was used for heart rate monitoring, offering continuous measurements during the intervention period. This device, known for its high accuracy with an error margin of less than two beats per minute (BPM), recorded heart rates at 30-second intervals, with readings taken every three minutes. The heart rate monitor provided critical data on the participants' physiological responses to the stress reduction interventions. These readings were used to assess the effectiveness of the intervention, with a particular focus on reducing heart rate as a marker of decreased stress levels.

In addition to physiological measurements, the chemical composition of the essential oils used in the study was analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). This analytical technique is highly regarded for its precision and accuracy in profiling chemical constituents. The GC-MS system, a standard laboratory tool, was used to provide a detailed breakdown of the chemical makeup of the Lemon and Lemongrass essential oils. This analysis was conducted once per oil sample and provided crucial data on the compounds responsible for the observed therapeutic effects. The results from the GC-MS analysis were essential for interpreting the efficacy of the essential oils in stress reduction, adding a robust scientific basis to the study's findings *(Ozer et al., 2022)*

Before the intervention, each participant's baseline stress levels, blood pressure, and heart rate were measured. The essential oils, diluted with sweet almond oil, were filled into sealed aromatherapy bottles to ensure that administration was solely through inhalation. Participants were instructed to apply 2-3 drops of their assigned oil onto absorbent paper attached to their clothing collars three times daily over eight weeks. Blood pressure and heart rate measurements were taken twice weekly by trained Community Health Promoters (CHPs), resulting in 18 readings per participant. The stress levels were reassessed using a validated stress indicator tool at the end of the intervention period.

Throughout the study, each participant was identified using a unique code to maintain confidentiality, and all data were recorded in a secure Excel spreadsheet. The comprehensive data collection process ensured the accurate monitoring of the intervention's impact on stress reduction and cardiovascular health in this population.

4.6. Data analysis

To analyse the pattern of the attained data from the stress indicator tool and blood pressure and heart rate, descriptive statistics, Analysis of Variance (ANOVA), T-test, and Analysis of Covariance (ANCOVA) methods were used for the analysis. By randomly selecting the case file identification number in the final sample, the Statistical

Analysis System (SAS) laboratory complements calculated frequency distribution and percentage to organize the obtained information and give an overview of the data. These records help to answer the question raised in the study. These tables shed light on the findings and cover descriptive statistical measures, percentages, and mathematical trend line, respectively. The results will be considered significant at a $p \leq 0.05$.

5. Results

Participant Demographics are presented in Table 1. Of the 228 participants, 72.4% were females, while 27.6% were male caregivers. The PCID was over 33 years old (79.3% or above), while only 20.7% were younger than 33. Most participants (68.4%) were married while others (31.6%) were unmarried. The majority of the parents with children with intellectual disability (74.6%) had primary education, while 25.4% had secondary education.

In general, 59.7% of the caregivers of children with intellectual disability were unemployed, while the employed accounted for 40.3% of the population. The children with intellectual disability sample included slightly more males (55.3%) than females (44.7%), and slightly more third-born or later (53.9%) children than the first-born or second-born (46.1%). The age profile of the children with intellectual disability was split almost equally into two groups: under five years (52.2%) and five years or older (47.8%).

Table 2 illustrates the number of subjects in the treatment groups. In the Lemongrass group, most participants were females, representing 71.9% (n=41), while males constituted 28.0% (n=16) of the group. Similarly, in the Lemon group, females dominated the sample, accounting for 80.7% (n=46) of the participants, compared to 19.3% (n=11) who were males. The Blended group also reflected a higher proportion of female participants, with 73.7% (n=42) females and 26.3% (n=15) males. Lastly, the control group displayed a relatively more balanced distribution, though females still represented the majority at 63.2% (n=36), while males accounted for 36.8% (n=21).

Table 3 represents whether or not there are significant associations between the treatment groups and all the sociodemographic characteristics. The gender distribution shows that males are more represented in the control group (33.3%) compared to the other groups. Still, the association between gender and treatment type is insignificant ($\chi^2 = 4.4$, df=3, p=0.217). Similarly, females are more represented in the Lemon group (27.9%), but this difference is insignificant. Age distribution is divided into two groups: participants younger than 33 years and those 33 years or older. Both age groups show similar distributions across the intervention groups, with no significant differences observed (χ^2=0.5, df=3, p=0.917).

Regarding the age of the children, those under five years are more represented in the control group (30.2%), whereas children aged five years or older are more prevalent in the blended group (28.4%). However, the association between the child's age and treatment type is insignificant (χ^2=4.0, df=3, p=0.262). When considering the child's gender, a relatively even distribution is observed across the treatment groups, with no significant association found (χ^2=1.9, df=3, p=0.590). Similarly, birth order does not significantly affect the interventions, although participants with three or more children are slightly more prevalent in the control group (28.5%) (χ^2=3.7, df=3, p=0.293). Marital status, divided into "Married" and "Others," shows no significant difference across the treatment groups (χ^2=0.5, df=3, p=0.922). Similarly, educational level and employment status also do not show significant associations with the type of treatment received, with p-values of 0.510 and 0.900, respectively.

Findings from aromatherapy interventions noted statistical changes. Table 4 shows the mean difference scores between Pre-test and Post-test by intervention group. The three aromatherapy interventions, Lemongrass, Lemon, and Blended, show statistically significant Chi-Square differences in reducing physical stress and improving sleep and emotional wellbeing ($p < 0.0001$ for all outcomes). The mean differences (Post & Pre) scores were always in the negative for Lemongrass, Lemon, and blended aromatherapy treatment groups, indicating that at Post-test, all three aromatherapy interventions showed significant reductions in physical stress levels, improved sleep, and better emotional states compared to the Pre-test. The control group did not show statistically significant ($p>0.05$ for all outcomes) improvements in any outcome, with mean differences close to zero. Lemongrass shows the most significant reduction in stress levels with mean differences of -2.1 for the physical stress domain, -2.0 for the sleep domain, and -1.6 for the emotional domain, all highly significant ($p<0.0001$). The findings on Blended also indicate similar changes with mean differences all in negative for all the outcome measures: Physical (-2.0), sleep (-2.1), and emotional (-1.5). Lemon also shows statistical difference in reducing stress levels between pre and post; however somewhat less obvious with mean differences in physical (0.0), sleep (0.0), and emotional (0.1). Changes in the Control group did not signify statistically significant.

The difference in the effects of aromatherapy on stress reduction in different outcomes across the three main factors was tested by ANOVA Tukey. Table 5 below shows the differences in mean scores of the three outcome variables of physical, sleep, and emotional wellbeing between groups and respective p-values for each post-test. No statistical significance was found between the Lemongrass and Blended groups ($p>0.05$). All other pair comparisons, that is, Lemongrass vs. Lemon, Lemongrass vs. Control, blended vs. Lemon, blended vs. Control, and Lemon vs. Control, were statistically significant ($p<0.05$).

Table 6 summarizes the differences in blood pressure and heart rate of the participants who participated in the aromatherapy intervention and were categorized into four groups: Lemongrass, Lemon, Blended, and Control. The results below show that all three aromatherapy interventions show a statistically significant decrease in (SBP) systolic blood pressure and (HR) heart rate after the intervention when their BP rate was measured against before (p-value <0.0001 for both outcomes). The highest decrease in SBP was recorded for the Blended group with a value of 14.0 (p-value <0.0001) and the lowest for Control. The blended group also recorded the highest decrease in heart rate value at -5.3 (p-value <0.0001). However, the control group's systolic blood pressure increased statistically significantly

0.2 after the intervention, with no significant changes recorded for their diastolic blood pressure value of 0.109.

Table 7 examines the two-way interaction in this study design; we utilized ANCOVA, with the post-test measure as the dependent variable, pre-test measures as covariates, and intervention groups as the independent variable. The findings indicate that the blended group significantly impacted all variables. The blended group had a highly significant effect for physical stress, with an F-value of 1043.98 ($p<0.0001$). The covariate, the pre-test physical stress score, also significantly influenced the post-test outcomes, as indicated by an F-value of 31.91 ($p<0.0001$). This finding suggests that the initial levels of physical stress and the intervention significantly contributed to the observed changes in post-test physical stress scores.

Regarding sleep, the Blended Group again demonstrated a significant effect, with an F-value of 978.54 ($p<0.0001$). However, the covariate for pre-test sleep scores did not significantly affect the post-test sleep outcomes, with an F-value of 0.40 ($p=0.530$). This result suggests that the intervention's impact on sleep was significant, independent of the initial sleep levels.

Regarding emotional stress, the blended group also shows a significant effect with an F-value of 599.38 ($p<0.0001$). The covariate for pre-test emotional stress scores did not reach statistical significance ($F=1.85$, $p=0.175$), indicating that while the intervention strongly reduced emotional stress, the initial emotional stress levels did not significantly predict the post-test outcomes.

Table (1): Frequency and percentage distribution of sociodemographic profile of the study participants caregivers (n-228).

Characteristic	N	%
Sub-county		
Matungu	57	100.0
Shinyalu	57	100.0
Khwisero	57	100.0
Likuyani	57	100.0
Gender of PCID		
Male	63	27.6
Female	165	72.4
The age group of PCID		
<33 years	47	20.7
≥33 years	181	79.3
Marital status of PCID		
Married	156	68.4
Unmarried	72	31.6
Education status of PCID		
Primary	170	74.6
Secondary	58	25.4
Employment status of PCID		
Employed	92	40.3
Unemployed	136	59.7
Gender of ID child		
Male	126	55.3
Female	102	44.7
Birth order of the child		
1st or 2nd	105	46.1
3rd and above	123	53.9
The age group of child		
<5 years	119	52.2
≥5 years	109	47.8

Table (2): Frequency and percentage distribution of PCIDs who used each intervention (n-228).

Characteristic	Lemongrass (n=57)		Lemon (n=57)		Blended (n=57)		Control (n=57)	
	No.	%	No.	%	No.	%	No.	%
Gender								
Male	16	28.0	11	19.3	15	26.3	21	36.8
Female	41	71.9	46	80.7	42	73.7	36	63.2

Table (3): Association between sociodemographic characteristics of study participants and the interventions (n-228).

Characteristic	Lemongrass (n=57)		Lemon (n=57)		Blended (n=57)		Control (n=57)		χ^2	df	p-value
	No.	%	No.	%	No.	%	No.	%			
Gender											
Male	16	25.4	11	17.5	15	23.8	21	33.3	4.4	3	0.217
Female	41	24.8	46	27.9	42	25.4	36	21.8			
Age group											
<33 years	13	27.7	10	21.3	12	25.5	12	25.5	0.5	3	0.917
≥33	44	24.3	47	26.0	45	24.9	45	24.9			
Age of child											
<5 years	28	23.5	29	24.4	26	21.8	36	30.2	4.0	3	0.262
≥5 years	29	26.6	28	25.7	31	28.4	21	19.3			
Gender of child											
Male	33	26.2	33	26.2	33	26.2	27	21.4	1.9	3	0.590
Female	24	23.5	24	23.5	24	23.5	30	29.4			
Birth order											
1 or 2	26	24.8	32	30.5	25	23.8	22	20.9	3.7	3	0.293
≥ 3	31	25.2	25	20.3	32	26.0	35	28.5			
Marital status											
Married	39	25.0	38	24.4	38	24.4	41	26.3	0.5	3	0.922
Others	18	25.0	19	26.4	19	26.4	16	22.2			
Education											
None/Primary	43	25.3	46	27.1	42	24.7	39	22.9	2.3	3	0.510
Secondary and above	14	24.1	11	19.0	15	25.9	18	31.0			
Employment											
Unemployed	36	26.5	34	25.0	34	25.0	32	23.5	0.6	3	0.900
Employed	21	22.8	23	25.0	23	25.0	25	27.2			

Table (4): Mean stress difference between pre and post-aromatherapy intervention among intervention groups.

Treatment group	Outcome	Mean difference (Post and pre-test) ±SD	t-test	p-value
Lemongrass	Physical	-2.1±0.52	-30.18	< 0.0001
	Sleep	-2.0±0.54	-28.66	< 0.0001
	Emotional	-1.6±0.54	-22.51	< 0.0001
Lemon	Physical	-1.0±0.42	-17.46	< 0.0001
	Sleep	-1.1±0.50	-17.33	< 0.0001
	Emotional	-0.7±0.47	-11.43	< 0.0001
Blended	Physical	-2.0±0.56	-26.98	< 0.0001
	Sleep	-2.1±0.60	-26.31	< 0.0001
	Emotional	-1.5±0.52	-21.99	< 0.0001
Control	Physical	0.0±0.10	1.20	0.236
	Sleep	0.0±0.55	0.58	0.564
	Emotional	0.1±0.71	1.10	0.277

6. Discussion

Aromatherapy has established itself to treat various arrays of complications and conditions. A literature survey reveals that this therapy gained much attention in the late 20th century and is very popular in the 21st century. Due to its importance, popularity, and widespread use, it is recognized as aroma science therapy *(Esposito et al., 2014)*. The study aimed to assess the effects of Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citratus*) essential oils, singly and in combination, on stress and bio motor variables among parents of children with ID. This discussion delves into the effectiveness of Lemon (*Citrus limon*) and Lemongrass (*Cymbopogon citrates*) essential oils in alleviating stress among parents of children with intellectual disabilities (ID); findings align with existing literature on the therapeutic benefits of these essential oils. The findings reveal that both essential oils significantly improved physical stress reduction, sleep quality, and emotional wellness, both singly and in combination. The findings confirm what is known in the literature about the effectiveness of essential oils for stress management that rejects the null hypothesis.

Their essential oils were studied and backed up by many other studies. Lemon has been reported to have stress-reducing effects. Some studies were conducted on Lemon essential oil, including a study by *(Franco et al., 2016).* They reported that the odor of Lemon essential oil significantly reduced stress-induced behavior and suggested its anxiolytic effects. *Ozer et al. (2022)* also reported that Lemon essential oil has uplifting effects and helps decrease stress, enhancing mood and wellbeing. Although a small difference was found between the two scents in the present study, the significant reduction in stress levels in participants who used Lemon essential oil during the study is consistent with those previous reports.

Table (5): Post-test group differences of aromatherapy concerning stress domains.

Variable	Mean differences between groups	Mean difference	t-test	p-value
	Post-test			
	Lemongrass - Blended	0.003	1.22	>0.05
	Lemongrass - Lemon	-1.107	3.45	<0.05
Physical	Lemongrass - Control	-2.362	4.60	<0.05
	Blended - Lemon	-1.110	3.10	<0.05
	Blended - Control	-2.365	3.73	<0.05
	Lemon - Control	-1.255	2.66	<0.05
	Post-test			
	Lemongrass - Blended	0.056	3.37	>0.05
	Lemongrass - Lemon	-1.067	4.40	<0.05
Sleep	Lemongrass - Control	-2.151	3.21	<0.05
	Blended - Lemon	-1.122	3.53	<0.05
	Blended - Control	-2.207	3.47	<0.05
	Lemon - Control	-1.084	1.42	<0.05
	Post-test			
	Lemongrass - Blended	-0.074	3.77	>0.05
	Lemongrass - Lemon	-0.976	2.68	<0.05
Emotional	Lemongrass - Control	-1.752	3.96	<0.05
	Blended - Lemon	-0.902	3.02	<0.05
	Blended - Control	-1.678	1.22	<0.05
	Lemon - Control	-0.776	3.45	<0.05

Table (6): Mean blood pressure and heart rate difference between pre and post-aromatherapy intervention among intervention groups.

Treatment	Outcome	Mean difference (Post and pre-test) ±SD	t-test	p-value
	Systolic BP (mm Hg)	-4.1±2.05	-15.26	<0.0001
Lemongrass	Diastolic BP (mm Hg)	-0.1±0.54	-1.73	0.0897
	Heart rate (beats/min)	-2.6±1.47	-13.61	<0.0001
	Systolic BP (mm Hg)	0.0±1.93	-16.23	<0.0001
Lemon	Diastolic BP (mm Hg)	-2.7±0.40	0.33	0.742
	Heart rate (beats/min)	-5.3±1.73	-11.87	<0.0001
	Systolic BP (mm Hg)	-14.0±4.32	-24.42	<0.0001
Blended	Diastolic BP (mm Hg)	0.0±0.13	1.00	0.321
	Heart rate (beats/min)	-5.3±1.86	-21.76	<0.0001
	Systolic BP (mm Hg)	0.2±0.41	3.86	0.0003
Control	Diastolic BP (mm Hg)	-0.1±0.49	-1.63	0.109
	Heart rate (beats/min)	-0.5±0.60	6.17	<0.0001

Table (7): Mean differences in the post-test means controlling for pre-test stress scores and intervention.

Variables	F	P value
Blended Group	1043.98	<0.0001
Covariate [Physical (Pre-test)]	31.91	<0.0001
Blended Group	978.54	<0.0001
Covariate Sleep (Pre-test)	0.40	0.530
Blended Group	599.38	<0.0001
Covariate Emotional (Pre-test)	1.85	0.175

Similarly, Lemongrass essential oil has been extensively studied for its calming effects. Inhaling Lemongrass essential oil reduced anxiety and improved mood in human subjects, as *Karadag et al (2017)* reported. The significant improvements in sleep quality and psychological wellbeing in the present research further support these findings. Additionally, in line with the current study findings revealing a significant reduction in stress among participants using Lemongrass essential oil, *Karadag et al. (2017)* showed that its major ingredient, citral, is a possible sedative with anti-anxiety activity.

The most significant declines in stress, sleep, and emotional wellbeing occurred for those who took part in the treatment group who inhaled the blend of Lemon and Lemongrass essential oils. Similar synergistic effects were found in other studies, including one by *McCaffrey et al., (2009)* that explored the effects of blending versus single essential oils, using a balanced back rub to encourage relaxation. They reported that blends of essential oils often exhibited more synergistic therapeutic effects than individual essential oils. Combining oils to re-balance and develop synergistic benefits is also suggested to be more

appropriate for changing mood and reducing blood pressure and pulse rate. The higher systolic blood pressure and heart rate reductions for those in the 'blended' group support this idea.

The results of this study largely replicate what another research in the field has found. A couple of issues that need to be mentioned include that the controls were also found to have increased systolic blood pressure post-intervention. Other research in the stress reduction intervention literature has found a placebo effect. This finding may be attributed to the nature of the stress experienced by the study population, parents of children with intellectual disabilities, intensifying the stress during the study period.

Furthermore, as only minimal mean differences were found at the end of the Lemon treatment group for all physical, sleep, and emotional dimensions, differences were smaller than what could be predicted from some other studies showing larger effects from Lemon essential oil to reduce stress. One explanation for the inconsistency is in the context, such as cultural and climate factors specific to the participants in Kakamega County that could lead to differences in the effectiveness of Lemon essential oil *(Chaudhry & Sidhu, 2022).*

Given the bioactive compounds of the oils used in the two (Lemongrass and blended) experimental groups, the improvements in stress levels, sleep quality, and emotional wellbeing make sense. For instance, the limonene in Lemon oil and the citral in Lemongrass oil have all been observed to exhibit anti-anxiety effects through their interactions with the central nervous system in this way; they influence the activity of neurotransmitters, thereby reducing stress *(Karadag et al., 2017; Ganjewala & Luthra, 2009).* The synergistic effect observed with the blended group might be from a combined action of these compounds, which might further enhance their therapeutic effects *(McCaffrey et al., 2009)*

The low efficacy of Lemon essential oil in the current study might be due partly to individual differences in response to aromatherapy, variation in pharmacogenomics, chemogenomics, odor preferences, and differential exposure to essential oils. Differences in stressors between parents of children with and without intellectual disability—particularly the relentless caregiving demands and intense social stigma—may also have warranted more potent interventions than have typically been investigated in the general population *(Cuzzocrea et al., 2013).*

The outlier findings for systolic blood pressure in the Control group suggest that the participants in the study were more exposed to external stress and may have experienced this during the study. Parents of children with intellectual disability tend to be chronically stressed, which is associated with elevated physiological responses, including raised blood pressure. Leaving the control group without an active intervention may have left parents more exposed to stressors and could be responsible for the increase in blood pressure observed.

7. Conclusion

These findings suggest that lemon and lemongrass essential oils may improve the wellbeing of parents of children with intellectual disabilities. The number of females was more than males in the study, and around three-quarters of the participants were older than 33. Most participants were married, with only less than a third being single parents; most were educated up to the primary level. Regarding to employment status, more than half were unemployed. The treatment groups were homogenous, with approximately the same number of participants in each arm. Hence, it had minimal effects of selection bias on the study.

Aromatherapy interventions significantly improved perceived life stressors, sleep patterns, and emotions/behaviors of parents of children with intellectual disability. The Lemongrass and blended group show a stress reduction, while the Lemon group showed a lesser reduction. However, the control group remained unaltered.

Further comparisons were done to see participants' mean values and differences in homogenous demographic characteristics and treatment groups. The mean value of sociodemographic variables such as marital status, education, and age of the participants showed no statistical significance between the treatment groups. This finding indicated an even distribution of the target population across all the study groups. Mean systolic and diastolic blood pressure readings in treatment groups show a significant decrease among aromatherapy groups. All participants' heart rate significantly decreased from before to after the aromatherapy intervention. Those in the blended group shows the highest decrease in systolic blood pressure. Mean heart rate from before to after aromatherapy intervention shows a significant reduction. The blended group had the lowest mean value among the treatment groups.

8. Recommendations

Based on the study findings, it is recommended that lemon and lemongrass essential oils be incorporated into stress management programs for parents of children with intellectual disabilities. The study demonstrated significant reductions in stress levels, improved sleep quality, and enhanced overall emotional wellbeing among participants who used these essential oils. This finding suggests that lemon and lemongrass essential oils can be effective natural stress-reduction alternatives, particularly in this challenging population. Healthcare providers and support organizations should consider incorporating aromatherapy sessions using these essential oils into routine care plans to promote tranquility and relaxation. Additionally, further research is needed to explore the long-term effects of these essential oils on stress levels, sleep quality, and emotional wellbeing and to understand the mechanisms through which they exert their beneficial effects.

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