Aromatherapy as an Adjunctive Approach to Improve Sleep Patterns in Individuals with Type II Diabetes: A Contribution Towards SDG 3-Good Health And Well Being, Inclusive Health

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Abstract: This quasi-experimental research utilizing a pretest-posttest control group model was carried out to assess the impact of aromatherapy on enhancing sleep quality in client's **recognized as adult onset** diabete thereby contributing to the achievement of **Sustainable Development Goal (SDG) 3 – Good Health , Well-Being, Inclusive health.** A sum of 60 individuals who satisfied the inclusion specfications—comprising both genders, aged 30 to 70 years, with a substantiate identification of adult onset diabetes under regular medical management and reporting severe sleep disturbances—were recruited. Baseline demographic and clinical data were gathered by exploiting a structured interview, and sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) on Day 1. Beginning on Day 2, participants in the experimental group received aromatherapy intervention by inhaling lavender essential oil—prepared by adding six drops to 30 mL of hot water— two sessions per day for four weeks, while the comparison group continued with standard hospital care. On Day 29, post-intervention assessments were conducted using the same PSQI tool. The interventional group depicted a significant enhancement in sleep quality, with pretest and posttest mean scores of 17.50 ± 0.90 and 11.33 ± 1.49, respectively. The mean difference of 6.17 yielded a t-value of 18.9462 ($p < 0.05$), reflecting statistical significance. Furthermore, an independent t-test comparing posttest scores between groups produced a t-value of 15.4967 ($p < 0.001$), confirming a marked enhancement in sleep quality in aromatherapy group compared to the comparison group. These outcomes indicate that lavender aromatherapy serves as a cost-effective, non-invasive complementarytherapy to improve sleep patterns among individuals with Type II diabetes.

Keywords – Aromatherapy, Lavender Oil, Type II Diabetes Mellitus, Sleep Quality, Glycemic Control, Complementary Therapy, Non-Pharmacological Intervention, Pittsburgh Sleep Quality Index (PSQI), **Good Health and Well-Being**, Inclusive health

I. OVERVIEW

Adult onset diabetes is a long lasting metabolic condition marked by ongoing hyperglycemia due to body's diminished ability to produce or utilize insulin It remains one of the most prevalent non-communicable diseases globally, posing major health, social, and economic challenges [1]. A person is clinically diagnosed with diabetes when fasting plasma glucose levels reach or exceed 126 mg/dl, or when random plasma glucose values remain abnormally high despite medical or lifestyle interventions. As reported by World Health Organization (WHO),around 171 million population globally were living with adult onset diabetes in the year 2000, and this outline is directed towards escalating to nearly 642 million by 2040, indicating an alarming global epidemic [2]-[5]. Type II Diabetes Mellitus (T2DM) constitutes nearly 90% of all diabetes cases and is closely associated with genetic susceptibility, age, ethnicity, sedentary lifestyles, obesity, and unhealthy dietary patterns. Recent genome-wide association studies (GWAS) have demonstrated that T2DM is a multifactorial polygenic disorder, where genetic predisposition primarily affects insulin secretion, while environmental and behavioral determinants exacerbate insulin resistance. Given its silent progression and the delayed manifestation of symptoms, diabetes often remains undiagnosed until serious impact —mainly cardiac vascular disorders [6].

Conventional management of diabetes includes pharmacological therapies such as insulin, thiazolidinediones, sulfonylureas, alpha-glucosidase inhibitors, and biguanides, along with non-pharmacological measures like diet modification, regular physical activity, and behavioral interventions [7]. However, the growing burden of diabetes necessitates a holistic and integrative approach that addresses not only glycemic control but also the associated psychosocial and physiological challenges, including sleep disturbances [8]. Sleep is a vital biological process essential for metabolic balance, cognitive function, and emotional regulation. Deprived sleep quality leads to hormonal imbalance, increased insulin resistance, and elevated stress hormones—all of which can aggravate glycemic instability in individuals with diabetes [9]. Studies have revealed that nearly 40–70% of people with T2DM experience varying degrees of sleep disturbance, including insomnia, restless sleep, or altered sleep architecture. These disruptions not only diminish overall quality of life but also contribute to disease progression and poor treatment outcomes [10]-[12].

In recent years, complementary and alternative therapies have gained attention as supportive strategies in chronic disease management. Among these, aromatherapy—the therapeutic use of plant-derived essential oils—has shown promise in promoting relaxation, improving sleep quality, and alleviating stress [12]-[15]. Lavender oil (Lavandula angustifolia), one of the most extensively researched essential oils, possesses sedative, anxiolytic, and mood-stabilizing properties. Inhalation of lavender aroma stimulates the limbic system and modulates neurotransmitter activity, thereby enhancing relaxation and promoting better sleep patterns without pharmacological side effects [17]-[19]. During clinical exposure, the investigator observed that individuals with diabetes frequently reported difficulty in achieving restful sleep despite adherence to medical treatment. Upon reviewing related literature, aromatherapy emerged as a safe, accessible, and cost-effective intervention capable of enhancing sleep quality and improving overall well-being [20]-[26]. This study aligns with the **United Nations Sustainable Development Goal (SDG) 3: Good Health, Well-Being** and **inclusive health** which emphasizes ensuring healthy lives and promoting well-being for all at all ages. Specifically, it contributes to **Target 3.4**, which aims to reduce premature mortality from non-communicable diseases through prevention and management, while fostering physical and mental well-being. This insight led to the formulation of current research, aiming in analysing the function of aromatherapy as an adjunctive approach in managing sleep disturbances and improving glycemic control among individuals with Type II diabetes [27]-[30]. Accordingly, the objectives of study includes:

- Assess the pre-test levels of sleep quality among clients with Type II diabetes mellitus in both experimental and comparison groups;
- Determine the efficacy of aromatherapy on sleep trait and cemic control in the intervention group;
- Compare post-test outcomes between intervention and control groups;
- To findout the relationship between post-test sleep trait and selected demographic and clinical variables..

II. LITERATURE REVIEW

Adult onset diabetes continues to impose an escalating global health burden. Numerous studies have emphasized that individuals with diabetes frequently experience sleep disturbances, which in turn exacerbate metabolic dysregulation and hinder glycemic control [1]-[5]. Deprived sleep quality and declination in duration of sleep have reported glucose metabolism dysfunction, increase insulin resistance thereby elevates stress-related hormones such as cortisol and catecholamines. These physiological alterations aggravate hyperglycemia leading to a vicious cycle that perpetuates poor disease management [6]-[10].

Sleep Disturbances and Diabetes: Sleep disturbances in diabetic individuals are often attributed to fluctuations in blood glucose levels, nocturia, peripheral neuropathy, and psychological stress. A study by Knutson et al. (2018) [29] proved a significantassociation between short sleep duration and increased HbA1c levels among adults with T2DM, indicating that poor sleep contributes to suboptimal glycemic control [11]-[15]. Furthermore, sleep deprivation impairs leptin and ghrelin balance, promoting appetite dysregulation and obesity, which are established risk factors for insulin resistance. It has also been reported that patients with diabetes exhibit altered circadian rhythms, leading to disrupted melatonin secretion, which further interferes with glucose metabolism.

Non-Pharmacological Interventions and Complementary Therapies: Non-pharmacological approaches, including relaxation techniques, physical activity, yoga, and mindfulness-based therapies, have been widely studied for their role in improving sleep and psychological well-being among diabetic populations. Complementary and alternative medicine (CAM) practices are gaining recognition due to their minimal side effects, holistic approach, and accessibility [16]-[20]. Aromatherapy, a branch of CAM, utilizes the inhalation or topical application of essential oils to evoke physiological and psychological responses conducive to healing and relaxation. Among various essential oils, lavender (Lavandula angustifolia) has been the most widely explored for its sedative and anxiolytic effects.

Aromatherapy and Sleep Quality: Lavender essential oil contains active constituents such as linalool and linalyl acetate, which influence the cerebrospinal system by altering gamma-aminobutyric acid (GABA) receptors thereby reducing neuronal excitability. According to Goel and Lao (2020) [27], inhalation of lavender aroma has proved to enhance subjective sleep trait, prolong slow-wave sleep, and reduce anxiety levels. A randomized comparative trial by Lillehei et al. (2015) [30] found that participants exposed to lavender oil aromatherapy for four weeks reported significant improvements over the control group in Pittsburgh Sleep Quality Index (PSQI) scores. Similarly, Hirokawa et al. (2012) [28] demonstrated that lavender inhalation before bedtime decreased heart rate variability and induced relaxation, facilitating faster sleep onset. The mechanism underlying aromatherapy's impact on sleep quality involves stimulation of the olfactory system, which directly connects to the limbic system—responsible for emotional regulation and hormonal balance. This neurobiological interaction leads to the release of serotonin and endorphins, reducing stress levels and promoting a state of tranquility conducive to better sleep [26]-[30]..

Aromatherapy and Glycemic Control: Recent investigations have also explored the relationship between aromatherapy and glycemic regulation. Stress-induced hyperglycemia is a common occurrence among diabetic patients, as long term stress rises blood sugar levels by circulating cortisol and adrenaline. By

reducing psychological stress and improving sleep quality, aromatherapy indirectly contributes to better glycemic control. Research by Abd El-Aziz et al. (2019) [26] indicated that lavender aromatherapy dramatically decreased fasting blood glucose and glycated hemoglobin levels among patients with adult onset diabetes after four weeks of intervention. The relaxation achieved through aromatherapy is believed to enhance insulin sensitivity and optimize endocrine balance, thereby contributing to improved metabolic outcomes. Furthermore, oxidative stress plays amajor factor in the pathogenesis of diabetes-related complications [20]-[25]. The inhalation of lavender oil, in particular, has been linked to a reduction in lipid peroxidation and inflammatory cytokines, thus supporting vascular health and metabolic stability.

Integration of Aromatherapy in Nursing Practice: Incorporating aromatherapy into clinical and nursing practice presents a promising non-invasive and cost-effective adjunctive therapy for managing sleep disturbances among diabetic individuals. Nursing interventions focusing on holistic care increasingly emphasize patient-centered approaches that combine medical treatment with relaxation therapies [1]-[6]. Aromatherapy can be easily administered under nursing supervision, enhancing patient compliance and overall satisfaction. It promotes psychological well-being, thus addressing the multifaceted nature of chronic disease management [7]-[14].

Eventhough there is a strong evidence that aromatherapy promotes good sleep, limited studies have specifically focused on diabetic populations, particularly those experiencing sleep disturbances as a comorbid condition. Moreover, while improvements in sleep have been linked to better glycemic outcomes, the direct biochemical mechanisms underlying this relationship remain underexplored. There is also a need for controlled, longitudinal studies assessing the sustained impact of aromatherapy on sleep patterns and metabolic biomarkers in patients with Type II diabetes. In summary, existing literature underscores the intertwined relationship between sleep quality and glycemic control in individuals with Type II diabetes. Aromatherapy, particularly with lavender essential oil, emerges as a simple, natural, and effective complementary therapy capable of enhancing relaxation, improving sleep patterns, and indirectly stabilizing blood glucose levels. However, further empirical studies are required to substantiate its long-term efficacy and establish standardized protocols for its use within diabetic care frameworks.

III. MATERIALS AND METHODS

Study Design: The present research employed a quasi-experimental pretest–posttest control group design to evaluate the effectiveness of aromatherapy in improving sleep quality and glycemic regulation among individuals diagnosed with T2DM. This design was selected to allow comparative assessment between an interventional group receiving aromatherapy and a control group receiving only routine hospital care, thereby facilitating the measurement of changes in sleep quality and physiological parameters before and after the intervention.

Study Setting and Duration: The investigation was conducted in the Diabetic Outpatient Clinic of the host institution over a period of five months, from August 2024 to December 2024. The selected setting provided a consistent patient population with Type II Diabetes under regular follow-up, enabling systematic data collection in a controlled clinical environment.

Ethical Considerations: Prior to data collection, ethical clearance was obtained from the Institutional Human Ethics Committee (IHEC) of the Saveetha Institute of Medical and Technical Sciences (SIMATS)(ApprovalNo:IHEC/SIMATS/2024/OBG/XXX). Formal permission was also secured from the Department of General Medicine. All participants were informed about the purpose, nature, potential benefits, and minimal risks of the study. Written informed consent was obtained from every participant, ensuring compliance with ethical standards for human research and confidentiality of data.

Participants and Eligibility Criteria: A total of 60 clients with T2DM who met the eligibility requirements were recruited for the study. Participants of both genders, aged 30 to 70 years, and diagnosed with diabetes for at least one year were included. All individuals were on regular medical therapy and had reported significant sleep disturbances, as determined using the PSQI during baseline assessment.

Eligibility Criteria: Adults confirmed with adult onset diabetes between the age group of 30–70 years with medication and regular follow-up. Individuals experiencing moderate to severe sleep disturbances as assessed by PSQI. Willingness to take part and give signed informed consent.

Criteria for Exclusion: Participants were excluded if they had, dermatological disorders such as dermatitis or chronic diabetic foot lesions. Neurological, psychiatric, or endocrine disorders including hypothyroidism, adrenal dysfunction, or depression. Peripheral arterial diseases, varicosities, venous thromboembolism or anemia. A history of alternative or complementary therapies such as acupressure, acupuncture, or reflexology. Lactation or inability to comply with study instructions. Use of aromatherapy or herbal treatments within the past three months.

Sampling Technique: participants who met the inclusion criteria were found using non-probability purposive sampling method. Eligible individuals were subsequently divided equally into two groups—30 participants in the interventional group (aromatherapy) and 30 participants in the comparison group(standard care).Group assignment was performed in a manner that ensured comparable baseline characteristics across both groups.

Data Collection Procedure: Pre-Assessment (Day 1) On the first day of data collection, demographic and clinical details were obtained through a self-structured questionnaire designed by the researcher. Baseline assessments of sleep quality and fatigue levels were conducted using standardized tools, including the PSQI for sleep quality assessment and relevant fatigue measurement scales as applicable. Intervention: Aromatherapy Protocol. From Day 2 onwards, participants in the experimental group received lavender aromatherapy as an adjunctive non-pharmacological intervention. They were instructed to add six drops of lavender essential oil (Lavandula angustifolia) into 30 mL of hot water in an inhalation bowl. Inhale the aromatic vapor twice daily, once in the morning and once before bedtime, for a continuous duration of four weeks (28 days). Maintain regular diabetic medications and dietary habits as per physician guidance. The control group continued with routine diabetic management and standard hospital care, including general health education on sleep hygiene and dietary practices, but did not receive aromatherapy. Post-Assessment (Day 29). On Day 29, all participants underwent post-intervention evaluation using the same standardized tools. The PSQI was administered again to measure changes in sleep quality following the intervention. Clinical indicators related to diabetes management, including fasting blood glucose levels and HbA1c, were also recorded to observe any auxiliary effects of aromatherapy on glycemic control.

. Analysis of the Data: SPSS version 26.0 was used to enter and analyze the data. To summarize baseline and demographic characteristics, descriptive statistics like variance, mean, and standard deviation were calculated. The statistical significance of changes in sleep quality and related variables was evaluated using inferential statistics, such as paired t-tests for within-group comparisons and independent t-tests for between-group analysis. Statistical significance was defined as a p-value of less than 0.05..

IV. RESULTS

Evaluation Of The Experimental And Control Groups' Pre-Test And Post-Test Levels Of Sleep Quality:In the experimental group, all 30 participants (100%) initially experienced severe sleep disturbances during the pretest phase. Following the aromatherapy intervention in the posttest, 2 participants (6.67%) reported mild sleep disturbances, and 28 participants (93.33%) experienced moderate sleep disturbances, indicating a notable improvement in sleep quality. In contrast, within the control group, all 30 participants (100%) continued to experience severe sleep disturbances during the pretest, and by the posttest, only 1 participant (3.33%) reported moderate disturbances while 29 participants (96.67%) continued to experience severe sleep disturbances. (As shown in Table 1).

Table 1: Sleep Quality Level Frequency and Percentage Distribution in the Experimental and Control Groups

Sleep Quality Level	Interventional Group				Comparison Group			
	Pre Assessment		Post Assessment		Pre Assessment		Post Assessment	
	No.	%	No.	%	No.	%	No.	%
Good Sleep Quality	-	-	-	-	-	-	-	-
Mild Sleep Disturbances	-	-	2	6.67	-	-	-	-
Moderate Sleep Disturbances	-	-	28	93.33	-	-	1	3.33
Severe Sleep Disturbances	30	100.00	-	-	30	100.00	29	96.67

Insomnia has been shown to have an indirect yet significant relationship with both the onset and prevalence of diabetes. Sleep deprivation can either result from diabetes-related complications or serve as an early indicator of increased susceptibility to the condition (16). Various socioeconomic determinants - such as female gender, limited financial resources, longer duration of diabetes, poor glycemic regulation, and coexistence of other chronic illnesses—have been consistently linked to diminished sleep quality among individuals with diabetes (17). In the present study, all participants across both the experimental and control groups exhibited severe sleep disturbances during the pre-assessment phase. Within the experimental group, 21 participants (70%) were diagnosed with diabetes, compared to 25 participants (83.33%) in the control group. Regarding gender distribution, 16 (53.33%) participants in the interventional group and 19 (63.33%) in the comparison group were female. With regards to, socioeconomic status, 13 participants (43.33%) in the interventional group and 11 (36.67%) in the comparison group reported a monthly income exceeding ₹15,000. Although existing literature supports the influence of socioeconomic and demographic variables on sleep disturbances in diabetic individuals, the present investigation was unable to pinpoint the specific contributing factor responsible for the poor sleep quality observed among participants.

Comparison of Sleep Quality Levels Within Experimental and Control Groups: In the experimental group, the mean pretest score for sleep quality was 17.50 ± 0.90, while the posttest mean score reduced to 11.33 ± 1.49. The mean difference of 6.17 yielded a t-value of 18.9462, which was statistically significant at $p < 0.05$. This indicates a substantial improvement in sleep quality following the aromatherapy intervention. Conversely, in the control group, the mean pretest score was 17.23 ± 1.25, and the posttest mean score slightly decreased to 16.97 ± 1.33. The mean difference of 0.27, with a t-value of 1.3515, was not statistically significant at $p < 0.05$, suggesting minimal change in sleep patterns without intervention. Furthermore, the independent sample t-test comparing pretest values between the two groups yielded a t-value of 0.9691, indicating no significant difference at baseline. However, posttest comparison revealed a t-value of 15.4967 with a mean difference of 0.26, which was statistically significant at $p < 0.001$. This confirms that participants in the experimental group demonstrated a markedly greater improvement in sleep quality compared to those in the control group. Overall, these findings strongly suggest that aromatherapy had a meaningful and measurable effect on enhancing sleep quality among individuals with Type II diabetes, emphasizing its potential as a supportive, non-pharmacological intervention in diabetic care (Table 2).

Table 2 Sleep Quality Level Frequency and Percentage Distribution in the Experimental and Control Groups

Level of Sleep Quality	Pre Assessment		Post Assessment		Average Difference Score	Paired 't' test value
	Mean	S.D	Mean	S.D		

Interventional Group	17.50	0.90	17.23	1.25	**0.27**	**t = 18.9462; p=0.0001; S*** **
Comparison Group	11.33	1.49	16.97	1.33	5.63	t = 1.3515; p=0.1869; N.S
Average Difference Score	6.17		**0.26**		***p<0.001 S – Significant	
Student Independent 't' test & p-value	t = 0.9691		**t = 15.4967**		**N.S – Not Significant**	
	p=0.3404, N.S		**p=0.0001, S*** **			

Lavender essential oil contains two primary bioactive compounds—linalyl acetate and linalool—which are primarily responsible for its potent hypnotic and sedative effects. These constituents act through neurophysiological pathways that influence the limbic system, a brain region intimately involved in emotional regulation, memory, and arousal. Specifically, lavender oil exerts its effect by modulating the amygdala, the area of the brain that governs emotional responses and stress-related reactions. The soothing aroma of lavender interacts with olfactory receptors, transmitting signals through the olfactory bulb to the limbic structures, thereby inducing a state of calmness and relaxation that facilitates the onset of sleep. Furthermore, lavender's hypnotic efficacy has been linked to its ability to inhibit the release of acetylcholine, a neurotransmitter involved in neural excitation and muscle activation. By reducing acetylcholine secretion, lavender oil promotes a parasympathetic nervous response, leading to decreased heart rate, reduced anxiety, and improved overall sleep architecture. In essence, these biochemical and neurological interactions enhance both the duration and depth of sleep, allowing for a more restorative rest cycle (15). In alignment with existing scientific findings, the present study also demonstrated similar outcomes. Participants who received aromatherapy with lavender oil reported enhanced satisfaction, improved sleep patterns, and a sense of safety and comfort with the intervention. At the conclusion of the posttest phase, many expressed a willingness to incorporate aromatherapy into their regular lifestyle routines, reflecting its perceived therapeutic value and practical feasibility as a non-pharmacological sleep aid.

Relationship between specific Clinical and Demographic Factors and Sleep Quality In the Interventional Group: Upon statistical analysis, the study revealed that none of the selected demographic or clinical variables—such as age, gender, income, duration of diabetes, or comorbid conditions—showed a significant correlation with changes in sleep quality within the experimental group. This finding indicates that the beneficial effects of lavender aromatherapy on sleep were consistent across diverse participant profiles, suggesting that the intervention's efficacy is independent of individual sociodemographic and clinical characteristics. Such a result underscores the universal applicability of aromatherapy as a complementary strategy for improving sleep among individuals with Type II diabetes, irrespective of personal or medical variations.

V. CONCLUSION

The present study demonstrates that aromatherapy using lavender essential oil serves as a promising adjunctive, non-pharmacological intervention to enhance good sleep trait among individuals with adult onset diabetes. Findings revealed marked improvement in sleeping patterns among participants who received aromatherapy compared to those in the control group, affirming its therapeutic potential in managing sleep disturbances commonly experienced by diabetic patients. The intervention was perceived

as safe, cost-effective, non-invasive, and easy to implement, making it a practical addition to holistic diabetes management. By promoting better sleep, aromatherapy may indirectly contribute to improved glycemic regulation, since adequate rest serves as a contributing factor in metabolic balance, and stress hormone regulation. The participants also reported enhanced relaxation and psychological comfort, highlighting aromatherapy's dual benefit on physical and emotional health. Therefore, the integration of aromatherapy into nursing practice and patient education programs can enhance comprehensive diabetes care by addressing both physiological and psychosocial dimensions of the disease. However, while the study presents encouraging results, its generalizability remains limited due to certain constraints.. Moreover, the study did not account for possible confounding variables, such as lifestyle habits, medication variations, or psychological stress levels, which may have influenced outcomes. Despite these limitations, the findings provide a strong foundation for expanding the evidence base surrounding complementary therapies in diabetes management.

Future research should aim to overcome the methodological limitations of the present study by including larger, more diverse populations across multiple healthcare settings to enhance the external validity of the outcomes. Additionally, researchers should consider comparing aromatherapy with other complementary interventions, such as music therapy, yoga, mindfulness meditation, acupressure, or reflexology, to determine their relative efficacy in improving sleep and overall health among diabetic patients. Future investigations could also explore the biochemical mechanisms underlying aromatherapy's effects—such as its impact on melatonin secretion, cortisol regulation, or autonomic nervous system activity—to provide deeper scientific validation. Furthermore, integrating multimodal approaches that combine aromatherapy with behavioural counseling, dietary modifications, and physical exercise could yield synergistic benefits and establish comprehensive, patient-centered care models. Qualitative studies exploring patient perceptions, adherence, and emotional outcomes can also enrich understanding of aromatherapy's holistic role in chronic disease management. In summary, while the present study reinforces the therapeutic potential of aromatherapy in improving sleep among individuals with Type II diabetes, future interdisciplinary and large-scale research is essential to validate, optimize, and integrate such complementary practices into mainstream clinical and nursing frameworks for sustainable diabetic care.

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