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Effects of Combined Sleep Hygiene Education and Lavender Aromatherapy on Sleep Quality and Fatigue in Patients Undergoing Hemodialysis: A Quasi-Experimental Study

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Abstract

Background: Sleep disturbances and fatigue frequently occur in patients undergoing hemodialysis. This study investigated whether a combination of sleep hygiene education and lavender aromatherapy improved sleep quality and fatigue.

Methods: A quasi-experimental, non-equivalent control-group pretest–posttest design, enrolling 84 patients consecutively and allocating them based on pre-existing hemodialysis schedules (42 intervention; 42 control). The intervention group received two sessions of sleep hygiene education and nightly lavender aromatherapy via reed diffuser for four weeks, while the control group received usual care. We measured sleep quality and fatigue using the Pittsburgh Sleep Quality Index (PSQI) and the FACIT-Fatigue Scale. Group-by-time effects were analyzed using generalized estimating equations. In the intervention group, median PSQI scores improved from 19.00 (IQR 17.25–20.00) to 2.00 (IQR 1.00–3.00), while the control group changed from 19.00 (IQR 17.00–20.00) to 18.50 (IQR 17.00–20.00).

Result: Median FACIT-Fatigue scores increased from 25.00 (IQR 20.00–27.00) to 48.00 (IQR 44.00–50.00) in the intervention group and from 22.00 (IQR 20.00–24.00) to 23.00 (IQR 21.00–25.00) in the control group. Significant group-by-time interactions were observed for PSQI ($\beta = -16.44$, 95% CI −17.22 to −15.65; $p < 0.001$) and FACIT-Fatigue ($\beta = 22.26$, 95% CI 20.61–23.91; $p < 0.001$).

Conclusion: The combination of sleep hygiene education and lavender aromatherapy led to greater improvements in sleep quality and fatigue than usual care. However, interpret these findings with caution because the groups were not randomized.

Keywords: Aromatherapy, Hemodialysis, Sleep Hygiene.

BACKGROUND

Chronic kidney disease (CKD) is characterized by progressive kidney damage that diminishes the kidneys' capacity to regulate metabolic, fluid, and electrolyte balance (1). The National Kidney Foundation reports that CKD affects 10% of the global population, impacting approximately 800 million individuals worldwide (2). In Indonesia, the Indonesian Health Survey estimated a CKD prevalence of 0.22%, corresponding to approximately 638,178 individuals (3).

Hemodialysis serves as a primary management strategy for CKD. This kidney replacement therapy circulates blood through an extracorporeal dialyzer to remove metabolic waste and excess fluid, and to correct electrolyte and acid–base imbalances when kidney function is severely compromised (4). Acute complications during or immediately following hemodialysis may include intradialytic hypotension, muscle cramps, nausea, headache, and cardiac rhythm disturbances. In contrast, individuals undergoing long-term hemodialysis often experience a broader range of symptoms, such as anemia-related manifestations, fatigue, sleep disturbances, and reduced quality of life (5, 6).

Fatigue and sleep disorders are prevalent complications among individuals receiving hemodialysis. The prevalence of fatigue in this population has been reported to range from 60% to 80% (6, 7). Prolonged hemodialysis sessions can result in multifaceted fatigue, affecting physical, psychological, and emotional well-being (8). These disturbances may adversely impact health by reducing quality of life, increasing the risk of accidents, causing discomfort, elevating the risk of falls, contributing to cognitive impairment, and potentially leading to mortality (9–11). Sleep disturbances are highly prevalent among hemodialysis patients and are characterized by poor sleep quality, insomnia, sleep apnea, and dependency on hypnotic medications (9). A study conducted by Pawar et al. in hemodialysis patients showed that 66.07% were poor sleepers, 48.21% had insomnia, and 46.43% had excessive daytime sleepiness (12).

Management of sleep disorders and fatigue involves both pharmacological and non-pharmacological interventions. Non-pharmacological approaches include sleep hygiene education, acupressure, and aromatherapy (13,14). Sleep hygiene education focuses on behavioral and environmental modifications that promote healthy sleep patterns (15). The primary objective is to prevent behaviors that disrupt normal sleep and to enhance sleep quality (16, 17). However, as sleep hygiene education primarily addresses behavioral and environmental factors, it may not adequately target physiological or psychological arousal that can also disrupt sleep and contribute to fatigue.

Aromatherapy is another non-pharmacological therapy that utilizes concentrated essential oils derived from herbs, flowers, or plants to address various conditions (18). Application methods include massage, friction, inhalation, compresses, and bathing, with inhalation and cutaneous application considered the safest (19). Aromatherapy has been shown to influence the autonomic nervous system by promoting relaxation and reducing anxiety, heart rate, and blood pressure (20, 21).

Combining sleep hygiene education and aromatherapy exemplifies a holistic nursing approach to enhancing physical and psychological health (22). While sleep hygiene education targets behavioral and environmental contributors to sleep disturbances, aromatherapy may facilitate physiological and psychological relaxation. Integrating these interventions could address multiple mechanisms underlying poor sleep and fatigue more effectively than either intervention alone. Although it is hypothesized that the combined intervention would yield greater improvements in sleep quality and fatigue, evidence supporting this approach, particularly among Indonesian patients undergoing hemodialysis, remains limited. Therefore, this study aimed to determine whether combining sleep hygiene education and lavender aromatherapy is associated with greater improvements in sleep quality and fatigue than routine care in patients undergoing hemodialysis.

METHODS

Study Design

This study used a quantitative, quasi-experimental, non-equivalent control-group pretest–posttest design. Group assignment was based on participants' pre-existing hemodialysis schedules, established as part of routine clinical care before enrolment. The researchers did not generate a random allocation sequence or modify dialysis schedules for study purposes. Therefore, the allocation procedure was non-random. This schedule-based assignment minimized potential contamination between the intervention and control groups. However, because group allocation was not randomized, differences related to dialysis schedules, including time of day, healthcare personnel, treatment environment, fatigue level, and patient characteristics, could have introduced selection bias. Therefore, baseline characteristics and outcome measures were assessed in both groups before the intervention to evaluate group comparability. The outcomes were assessed using self-administered questionnaires. The researcher collecting the post-intervention data was not blinded to group allocation.

Participants /Sample

The study was conducted with a four-week intervention period in the hemodialysis room at Raden Mattaher Regional Hospital in Jambi Province. The study population was patients undergoing hemodialysis at Raden Mattaher Regional Hospital in Jambi Province. Participants were recruited using consecutive sampling. Eligible patients were enrolled sequentially as they met the inclusion criteria. Inclusion criteria were Patients aged 18 years and older, those on hemodialysis for at least 3 months, and those without olfactory, visual, or hearing impairments. Exclusion criteria included respondents who were allergic to lavender aromatherapy and patients who experienced deterioration during hemodialysis. Participants with conditions that could make inhaled aromatherapy inappropriate were additionally screened before enrolment. The research team consecutively screened potential participants against the eligibility criteria. Eligible patients received an explanation of the study and provided written informed consent before enrolment and baseline assessment.

The sample size was calculated using G*Power for a two-tailed comparison of two independent means. The parameters were derived from a previous study that reported a post-test mean fatigue (SD) of 35.4 (15.7) in the intervention group and 45.1 (14.1) in the control group, corresponding to an estimated standardized effect size of 0.65 (23). Using a two-sided significance level of 0.05, 80% statistical power, and a 1:1 allocation ratio, the minimum required sample size was approximately 39 participants per group. To allow for potential attrition, the recruitment target was increased to 42 participants per group, resulting in a total sample of 84 participants.

We assessed 94 patients for eligibility. Of these, four declined to participate, and six did not meet the inclusion criteria. Consequently, 84 participants were enrolled and allocated to the intervention (n = 42) and control (n = 42) groups. No participants withdrew or were lost to follow-up during the study. Therefore, all 84 enrolled participants completed the four-week intervention and were included in the final analysis.

Instruments

The study used the Indonesian-language versions of the Pittsburgh Sleep Quality Index (PSQI) and the Functional Assessment of Chronic Illness Therapy–Fatigue (FACIT-Fatigue) Scale. Demographic data included age, sex, education level, and hemodialysis duration. We administered the questionnaires at baseline before the intervention and again immediately after the four-week intervention in the hemodialysis unit. Participants completed the questionnaires independently; when participants had difficulty reading or understanding an item, a trained researcher provided standardized assistance by reading the item without interpreting or influencing the response. We obtained permission

to use the PSQI from the University of Pittsburgh. Permission to use the FACIT-Fatigue Scale was obtained from FACIT.org.

The PSQI contains 19 self-administered questions summarized into seven sleep components. Each component is scored from 0 to 3, and the global score ranges from 0 to 21. A higher global score reflects worse sleep quality (24). A global PSQI score >5 indicated poor sleep quality. Previous research in Indonesia validated the PSQI, with a Cronbach's alpha of 0.79 and a content validity score of 0.89 (25). The sleep quality questionnaire demonstrated acceptable internal consistency in this study, with a Cronbach's alpha coefficient of 0.719.

The FACIT Fatigue Scale measured fatigue in respondents. It includes 13 questions scored on a Likert scale from 0 (not at all) to 4 (very much). The total score ranges from 0 to 52. Higher scores indicate less fatigue. This instrument has also been validated in Indonesia. Construct validity showed that all questions were valid (0.331–0.636), with a Cronbach's alpha of 0.646 (26). Although the Cronbach's alpha of 0.646 was below 0.70, the validated Indonesian FACIT-Fatigue Scale was retained. Meanwhile, the Cronbach's alpha. In this study, it was 0.748.

This study used a *booklet* as a medium for sleep hygiene education and included a lavender aromatherapy reed diffuser. The booklet explains the definition of sleep hygiene, its benefits, sleep hygiene behaviors, and relaxation techniques to improve sleep quality.

Data Collection

The study was conducted from April 2025 to May 2025. The intervention included structured sleep hygiene education supported by a booklet and lavender aromatherapy delivered via a reed diffuser. The booklet contained information on the definition and benefits of sleep hygiene, recommended sleep hygiene behaviors, relaxation techniques, and strategies for creating a supportive sleep environment. We used a commercially available 50-mL lavender-based reed diffuser containing Lavandula hybrida (lavandin). The diffuser container measured approximately 5.2 cm × 5.2 cm × 7.2 cm, with an overall height of approximately 17 cm when the reed sticks were inserted. The product was registered with the Indonesian Ministry of Health under registration number KEMENKES RI PKL 20601421012. We inserted five fiber reed sticks into each diffuser, which was placed on a stable surface approximately 50–100 cm from the participant's bedside. The diffuser remained in the bedroom throughout the entire sleep period every night for four consecutive weeks. Bedroom dimensions were not standardized because the intervention was conducted in participants' usual sleeping environments. However, participants were instructed to keep the diffuser in the same place throughout the study period to minimize variation in exposure. Participants turned the reeds once weekly to maintain fragrance diffusion and did not replace them during the intervention. Participants did not refill or replace the diffuser during the four weeks. Participants were also instructed to maintain the same number of reeds throughout the study.

The researchers delivered the sleep hygiene education in two sessions during the first week. Session 1 covered sleep, the sleep process, sleep function, sleep quality, and the purpose and safe use of lavender aromatherapy. Session 2 covered sleep hygiene behaviors, including regular sleep and wake schedules, appropriate napping, light exposure, bedroom temperature, noise control, avoidance of caffeine and nicotine, comfortable sleep environments, bathing before bedtime, and physical activity. The two sessions were delivered over two days and totaled 90 minutes. Participants in the intervention group received the booklet after the sessions.

Following the educational sessions, participants received lavender aromatherapy for four weeks before bedtime. The researchers assessed fatigue and sleep quality after four weeks of intervention. Participants' adherence to aromatherapy use was monitored using a daily checklist. No daily checklist entries were missing during the intervention period. The researchers contacted participants weekly to remind them and confirm the use of the reed diffuser before bedtime. Intervention fidelity was

maintained by using the same booklet, standardized educational content, session duration, number of reed sticks, diffuser placement instructions, and weekly follow-up procedure for all participants in the intervention group. Meanwhile, the control group received routine nursing care provided in the hemodialysis unit, including standard monitoring and nursing care during hemodialysis.

Data Analysis

We assessed data distribution using the Shapiro–Wilk test. Because the outcome variables were non-normally distributed, we presented data as medians and interquartile ranges (IQRs), while categorical variables were presented as frequencies and percentages. Baseline categorical characteristics were compared using the chi-square test or Fisher's exact test, as appropriate, whereas continuous characteristics were compared using the Mann–Whitney U test.

We performed the primary analysis using generalized estimating equations (GEE) to evaluate changes in sleep quality and fatigue over time between the intervention and control groups. We fitted separate GEE models for each outcome using a Gaussian distribution with an identity link function, an exchangeable working correlation structure, and robust standard errors. We specified participant identification number as the subject variable and time (baseline and post-intervention) as the repeated factor. Each model included group (intervention vs control), time (pre-intervention vs. post-intervention), and the group-by-time interaction. We included age, sex, and duration of hemodialysis as covariates, along with their interactions with time, to account for their potential influence on changes in outcomes. We reported results as regression coefficients (β), 95% confidence intervals (CIs), and p-values. GEE regression coefficients (β) represent adjusted differences in mean change between groups.

Statistical significance was set at $p < 0.05$ (two-sided). Analyses were performed using SPSS. All 84 participants had complete baseline and post-intervention PSQI and FACIT-Fatigue data. Therefore, no outcome data were missing from the analytic dataset

Ethical Consideration

The Ethics Committee of Raden Mattaher Regional Hospital granted ethical approval before participant recruitment and data collection began. Although the formal approval letter was issued in May 2025 (No. S.179/SPE/V/2025), ethical clearance had already been obtained before the study began in April 2025. The study was conducted in accordance with the Declaration of Helsinki. Before enrolment, all participants received information about the study purpose, procedures, potential risks, and expected benefits and provided written informed consent. Participants were informed that participation was voluntary and that they could withdraw at any time without affecting their hemodialysis treatment or other healthcare services. The research team maintained participant confidentiality by using coded identification numbers, restricting data access to the research team, and securely storing study data. The study monitored, documented, and evaluated any intervention-related adverse events throughout the study, and participants experiencing adverse reactions were withdrawn from the intervention and provided appropriate clinical care.

RESULT AND DISCUSSION

RESULT

Demographic Characteristics of Responden

This study included 84 respondents, evenly split between the intervention and control groups. Respondent characteristics are as follows:

Table 1. Sociodemographic, health-related, and housing environmental characteristics of participants (N = 84)

Characteristics	Intervention Group		Control Group		p-value
	f	**%**	**f**	**%**	
Age					0.891
18-25	6	14.2	5	11.9	
26-35	13	31.0	13	31.0	
36-45	16	38.1	14	33.3	
46-55	7	16.7	10	23.8	
Gender					0.826
Male	20	47.6	19	45.2	
Female	22	52.4	23	54.8	
Education					0.406
Elementary School	6	14.3	9	21.4	
Junior High School	8	19.0	9	21.4	
Senior High School	13	31.0	15	35.7	
College	15	35.7	9	21.4	
Duration of HD					0.450
3-6 Months	12	28.6	9	21.4	
>6 Months	30	71.4	33	78.6	

Note. f = frequency; % = percentage; HD = hemodialysis.

In the intervention group, the largest age category was 36-45 years (38.1%). By gender, most respondents were women, totaling 22 people (52.4%). Most respondents were college graduates: 15 people (35.7%). Most respondents had a duration of> 6 months, totaling 30 people (71.4%).

In the control group, most respondents were aged 36-45 years (14 people, 33.3%). Female respondents were the largest, with 23 people (54.8%). Most respondents had a high school education (15 people, 35.7%). The majority of respondents had undergone hemodialysis for more than 6 months, with 33 people (78.6%). Baseline testing indicated no statistically significant demographic differences between groups ($p > 0.05$).

Table 2. Pre- and Post-intervention Sleep Quality and Fatigue Scores with Adjusted Group by Time Effects

	Intervention group (n=42)		Control Group (n=42)		Adjusted Group x time Effect β	95% CI	p-value
	Pre Median (IQR)	Post Median (IQR)	Pre Median (IQR)	Post Median (IQR)			
Sleep quality	19.00 (17.25 – 20.00)	2.00 (1.00-3.00)	19.00 (17.00-20.00)	18.5 (17.00-20.00)	-16.44	-17.22 - 15.65	<0.001
Fatigue	25.00 (20.00 – 27.00)	48.00 (44.00 – 50.00)	22.00 (20.00 – 24.00)	23.00 (21.00 – 25.00)	22.26	20.61 – 23.91	<0.001

Note. Data are presented as median (interquartile range [IQR]). *b* = adjusted regression coefficient for the group × time interaction; CI = confidence interval. The group × time effect represents the adjusted difference in change from pre- to post-intervention between the intervention and control groups.

The intervention group demonstrated marked improvements in sleep quality and fatigue. Median PSQI scores decreased from 19 (IQR 17.25–20.00) at baseline to 2 (IQR 1–3) post-intervention, while the control group showed minimal change, from 19 (IQR 17.00–20.00) to 18.5 (IQR 17–20). GEE analysis confirmed a significant group-by-time interaction for PSQI ($\beta = -16.44$, 95% CI −17.22 to −15.65, $p < 0.001$), indicating greater improvement in sleep quality for the intervention group.

Similarly, the median FACIT-Fatigue score in the intervention group increased from 25 (IQR 20.00–27.00) to 48.00 (IQR 44.00–50.00), reflecting reduced fatigue. The control group showed only a slight increase, from 22.00 (IQR 20.00–24.00) to 23.00 (IQR 21.00–25.00). A significant group-by-time interaction for fatigue ($\beta = 22.26$, 95% CI 20.61–23.91, $p < 0.001$) confirmed greater fatigue reduction in the intervention group. These results suggest that the combined sleep hygiene education and lavender aromatherapy intervention led to greater improvements in sleep quality and fatigue than the control condition.

DISCUSSION

This study showed that combined sleep hygiene education and lavender aromatherapy were associated with improvements in fatigue and sleep quality among patients undergoing hemodialysis. This finding is consistent with previous studies evaluating sleep hygiene education and aromatherapy in different populations, which reported improved sleep quality and reduced fatigue following these interventions (27, 28). Studies have also shown that sleep hygiene education was associated with improved sleep outcomes among patients undergoing hemodialysis (29). Borzou et al.'s study revealed significant differences in sleep quality and fatigue between the control and intervention groups after sleep hygiene education (27).

Sleep hygiene involves behavioral and environmental practices designed to support the initiation and maintenance of restful, restorative sleep (15, 30). Sleep hygiene education aims to inform individuals about lifestyle and environmental factors that can disrupt or improve sleep and may also reduce fatigue among patients undergoing hemodialysis. This includes practicing regular exercise, maintaining consistent bed and wake times, establishing a pre-bedtime routine, avoiding or limiting stimulants like caffeine several hours before sleep, skipping naps, and reducing alcohol intake. Educating patients about sleep hygiene is very important. This is because many patients do not understand how sleep affects their health. Sleep hygiene education includes training, behavioral strategies, sleep restrictions, and behavioral modifications aimed at improving sleep quality (31). Through sleep hygiene, circadian rhythms can become more stable, support bodily recovery, and strengthen the immune system. These practices may support more stable circadian rhythms and promote restorative sleep (32). Nurses play a pivotal role in addressing this gap by teaching patients sleep hygiene practices.

Meanwhile, aromatherapy can help with physiological self-regulation by enhancing relaxation. These combinations can encourage patients to take a more active role in managing their health and increase self-efficacy and independence. Inhalation aromatherapy, like lavender or sweet orange, has been shown to improve relaxation and sleep quality while reducing fatigue (19). The mechanism works through the olfactory limbic system, which activates the sympathetic and parasympathetic systems and promotes relaxation. Thus, it can reduce anxiety, heart rate, and blood pressure and improve sleep latency and quality (20, 21).

The large improvements observed in the intervention group may reflect the complementary mechanisms of the two intervention components. Sleep hygiene education targeted behavioral and environmental factors that interfere with sleep, whereas lavender aromatherapy provided a relaxation stimulus before bedtime. Together, these strategies may have supported a more consistent sleep routine and a stronger relaxation response than routine care alone. This study also revealed that the control group showed only a small change over time. This is probably due to the routine care they received in

the hemodialysis unit, which may have included general health education, emotional support, and routine monitoring during dialysis sessions. However, the intervention group showed substantially greater improvement than the control group, suggesting that the combined intervention may have contributed to the observed differences beyond routine care alone.

Meanwhile, Lavender constituents have been proposed to influence GABAergic pathways, which may contribute to relaxation and sedation. Lavender aromatherapy may therefore support relaxation and sleep regulation through its effects on the central nervous system (33–35). This combined intervention integrates behavioral cognitive modification and physiological relaxation. By combining aromatherapy with sleep hygiene education, patients receive both a relaxation stimulus and practical guidance to improve their sleep environment and bedtime routines. This combination may have contributed to the greater improvements observed in sleep quality and fatigue.

Based on questionnaire responses, most patients in the intervention group reported sleep issues, including difficulty falling asleep and frequent nighttime awakenings. However, after receiving sleep hygiene education and lavender aromatherapy, patients reported fewer sleep problems and lower fatigue, including earlier sleep onset, greater relaxation during sleep, and fewer nighttime awakenings. These self-reported improvements were consistent with the observed changes in PSQI and FACIT-Fatigue scores.

According to Orem's self-care theory, this intervention represents a supportive–educative nursing system in which nurses act as facilitators to enhance patients' self-care agency (36). Through education, patients gain knowledge and skills to manage their sleep behavior. According to this framework, a supportive education system helps patients take responsibility for their own health. Thus, nurses have a vital role not only as caregivers but also as facilitators who support patients in managing their own disease. Nurses offer guidance to enhance self-efficacy and promote patients' independence in managing chronic conditions (37, 38).

In practical terms, this intervention may be feasible for integration into hemodialysis nursing care because it is low-cost and non-invasive. Nurses can teach patients to maintain consistent sleep and wake times, avoid caffeine or nicotine before bedtime, reduce smartphone use before sleep, control bedroom noise and light, and use relaxation techniques. Consider adequate ventilation and patient preference before recommending reed diffusers (39).

A limitation of this study is that sleep quality and fatigue were assessed through a questionnaire. Therefore, the accuracy of the data depends on respondents' honesty. Additionally, the intervention was relatively short, lasting only four weeks. In addition, because participants were not randomly allocated, selection bias and residual confounding related to dialysis schedules and unmeasured clinical characteristics cannot be excluded. Finally, this single-center study may limit the generalizability of the findings. Future studies should use randomized controlled trials with larger, multicenter samples, extend the intervention period, and include objective physiological markers, such as cortisol levels and heart rate variability, to strengthen the evidence base for nursing practice.

CONCLUSION

The findings indicate that combining sleep hygiene education with lavender aromatherapy improves sleep quality and fatigue more than routine care in patients undergoing hemodialysis. Nurses play a key role in delivering sleep-related education and supporting complementary interventions. Further randomized, multicenter studies with longer intervention and follow-up periods, along with objective physiological measures, are recommended to validate these results.

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YO: Writing- Original Draft, Review & Editing. RNM: Writing-Original Draft, Methodology. VM: Writing-Original Draft. PIS. Manuscript review and Validation. AS: Formal analysis, manuscript review. YIPS: Manuscript review.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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DATA AVAILABILITY
The dataset generated and analyzed during the current study is available from the corresponding author upon request.

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