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Non-invasive acupoint stimulation as a complementary therapy for fatigue in hemodialysis patients: A systematic review

Gunawan Susanto*, Arif Setyo Upoyo

Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman
Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

Abstract

Background: Patients with chronic kidney disease (CKD) undergoing hemodialysis often experience complex and variable fatigue, which significantly impacts their quality of life. Several factors can cause this fatigue, including the dialysis procedure itself and conditions such as depression, anemia, sleep disorders, and restless leg syndrome. Non-pharmacological methods, such as non-invasive acupoint stimulation, have been used to manage fatigue. However, a systematic review of the literature is needed to determine the effectiveness of this approach.
Purpose: To evaluate the effectiveness of non-invasive acupoint stimulation as a complementary therapy in reducing fatigue levels in patients undergoing hemodialysis.
Method: The databases Google Scholar, ResearchGate, and ProQuest were used to identify English-language research publications from 2013 to 2024. These publications included two from Iran, one from Turkey, one from India, one from Korea, and two from Taiwan. The selection of publications followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Quality evaluation was conducted using the Joanna Briggs Institute (JBI) Critical Appraisal Skills Program.
Results: Findings indicate that all evaluated non-invasive acupoint stimulation methods significantly reduced fatigue. Electrical stimulation techniques, including electro-stimulation and Transcutaneous Electrical Acupoint Stimulation (TEAS), demonstrated consistent effectiveness. Manual acupressure and auricular acupressure also showed significant improvements in fatigue levels. Additionally, radiation stimulation using far-infrared light yielded promising results. Variations in the number of stimulation points, session duration, and total intervention length still produced significant reductions in fatigue, suggesting that non-invasive acupoint stimulation methods can be effective despite methodological differences.
Conclusion: Non-invasive acupoint stimulation methods show great potential in managing fatigue in hemodialysis patients. Despite methodological variations, all studies reported significant fatigue reductions, supporting the integration of non-invasive acupoint stimulation methods into clinical practice to improve patients' quality of life. Further research is needed to develop intervention protocols and confirm these findings.

Keywords: Acupoint Stimulation; Chronic Kidney Disease; Fatigue; Hemodialysis; Non-invasive.

INTRODUCTION

Chronic kidney disease (CKD) is a serious global health issue. The prevalence of CKD in Indonesia is estimated at around 0.2%, with the number of patients reaching 70,000 in 2016 and increasing by 10% annually (Nafisah et al., 2021). Hemodialysis (HD) is the primary treatment option for CKD patients.

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Approximately 2.5 million people worldwide require Renal Replacement Therapy (RRT), with around 60% undergoing HD (Elliott et al., 2023; Ho et al., 2021). Although HD is crucial for sustaining the lives of CKD patients, the procedure is often associated with complications that affect patients' quality of life, one of which is fatigue, a major issue (Farragher et al., 2019). Post-dialysis fatigue significantly impacts daily activities and affects patients' adherence to HD therapy, although the clinical causes are not fully understood, and no widely recognized treatment exists to prevent or address it (Liu et al., 2023). In patients with end-stage renal disease (ESRD), untreated fatigue may severely affect the quality of life, leading to increased dependency on others, weakness, loss of physical and psychological energy, social isolation, and depression (Sabouhi et al., 2013).

Fatigue in chronic kidney disease is often complex and varies between individuals, characterized by feelings of weakness, helplessness, and a lack of energy disproportionate to the effort exerted, affecting physical and cognitive abilities (Finsterer & Mahjoub, 2013; Gregg et al., 2021; Liu et al., 2023; Menting et al., 2018). The factors that can influence the level of fatigue include depression, anemia, sleep disorders, and restless leg syndrome (Sabouhi et al., 2013). Additionally, the dialysis procedure also contributes to fatigue. There are two types of dialysis-related fatigue: intradialytic fatigue (IDF) and postdialysis fatigue (PDF). IDF occurs or worsens before and during the hemodialysis session, possibly due to the body's classical conditioning response to the dialysis procedure. Meanwhile, PDF develops after hemodialysis and can last for several hours. The causes of PDF include factors such as inflammation, dysregulation of the hypothalamic-pituitary-adrenal axis, osmotic and fluid shifts, cardiovascular and hemodynamic effects, laboratory abnormalities, depression, and physical inactivity. Although the two types of fatigue occur at different times, some of their causes, such as the metabolic effects of the dialysis procedure, may affect both (Bossola et al., 2023).

Several physical and mental approaches have been proposed to address fatigue related to hemodialysis, including the use of medications for insomnia and depression, social support to reduce depression and anxiety, and exercise to improve physical strength. Although studies have demonstrated the clinical benefits of these approaches for hemodialysis patients, the effectiveness of medications in managing hemodialysis-related fatigue remains incompletely understood. Moreover, fatigue-induced weakness often serves as a barrier to exercise, and exercise-based approaches may not always be feasible, especially for patients with disabilities. Therefore, non-invasive alternatives are needed to address fatigue in hemodialysis patients (Liao et al., 2024).

One promising non-invasive intervention is the non-invasive acupoint stimulation method. Acupoint stimulation, rooted in traditional Chinese medicine principles, aims to modulate the flow of energy (Qi) in the body. In the context of chronic kidney disease and HD, the non-invasive acupoint stimulation method may help reduce the energy imbalances that contribute to fatigue (Hadadian et al., 2016; Kim et al., 2016). Although much literature has documented the potential benefits of non-invasive acupoint stimulation methods in reducing fatigue, there remains a lack of clear consensus regarding their effectiveness in CKD patients, particularly those undergoing HD.

Acupoint stimulation can be performed using non-invasive methods such as manual acupressure, electrical stimulation, or radiation-based techniques. These methods are appealing because they offer a safe, non-invasive approach that is easy to apply, particularly for patients who cannot or do not wish to undergo invasive procedures. However, studies evaluating the effectiveness of non-invasive acupoint stimulation on fatigue in HD patients are still limited and vary in methodology, acupoint selection, treatment duration, and outcome measures.

Therefore, a systematic review is needed to synthesize existing evidence on the effectiveness of non-invasive acupoint stimulation methods in reducing fatigue in HD patients. This review aims to answer the critical question of whether non-invasive acupoint stimulation methods can be considered an effective complementary therapy in managing fatigue in CKD patients undergoing HD. The findings of this review will contribute to the advancement of academic understanding regarding the role of non-invasive acupoint stimulation and provide practical guidance for healthcare professionals in their efforts to holistically improve patients' quality of life.

Gunawan Susanto*, Arif Setyo Upoyo

Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman
Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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RESEARCH METHOD

A systematic review methodology was applied in this investigation. Using specific keywords such "acupressure," "fatigue," "hemodialysis," and "rct," a search for full-text English-language research papers was carried out through the Google Scholar, Research Gate, and Proquest databases between 2013 and 2024. Using the recommended Reporting Items For Systematic Reviews and Meta-Analyses (PRISMA) methods, we chose the papers (Pati & Lorusso, 2017).

The inclusion criteria were based on PICO (Population = hemodialysis patients, Intervention = non-invasive acupressure, Comparison = other non-invasive interventions or standard care, and Outcome = fatigue severity). Observational studies, study protocols, and review articles were the exclusion criteria. The first screening was completed by the first author, and the content analysis screening was completed by the other authors. The table, which includes authors, participants, design, intervention, and outcome, was created by extracting data. To evaluate the calibre of research publications, we employed the Critical Appraisal Skills Programme JBI in quality appraisal (Barker et al., 2023). The data was analysed using a theme analysis, which involved the following steps: 1) comprehension of the data, 2) recognition of codes, 3) extraction of themes from the codes, 4) repeating of the themes, and 5) definition of themes (Braun & Clarke, 2016). The summary of the studies or data extraction is below.

RESEARCH RESULTS

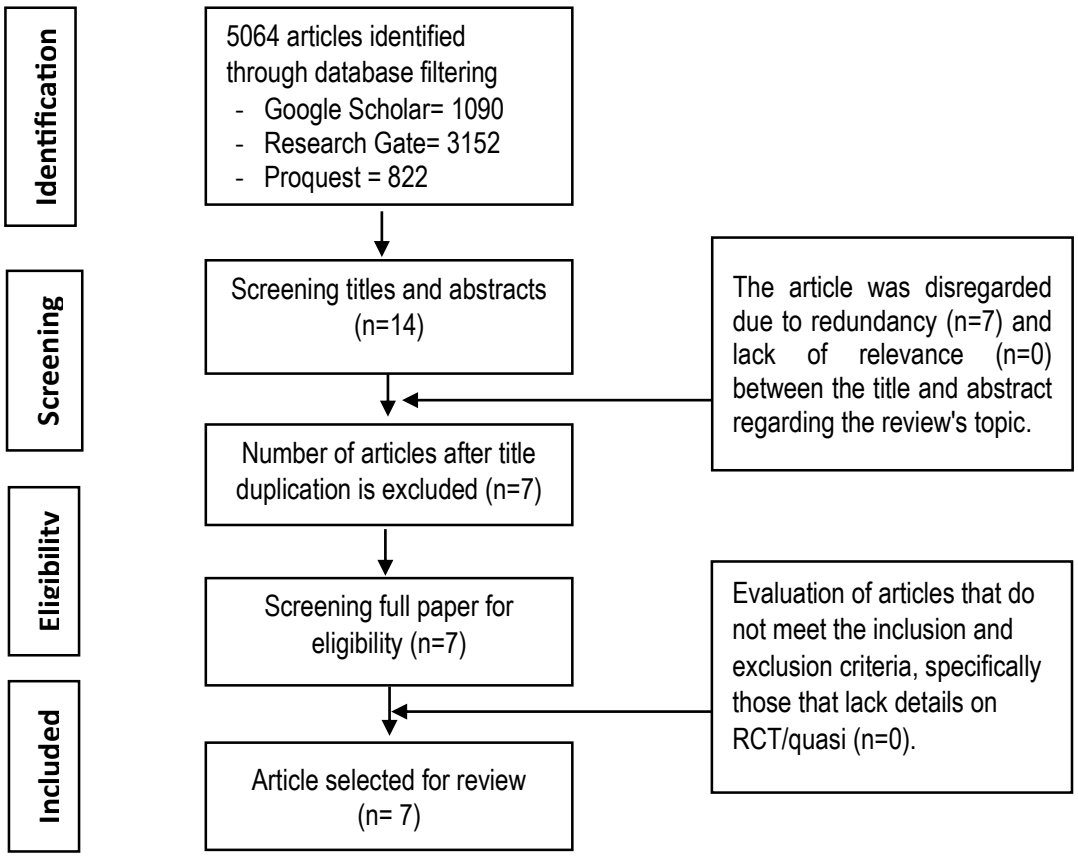

Figure. PRISMA flow diagram

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Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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Table. Summary of Included Studies

(Author, Year) (Country)	Purpose	Method (Number, Intervention and Tools)	Outcome
(Sabouhi et al., 2013) **(Iran)**	to investigate the effectiveness of acupressure on fatigue in hemodialysis patients.	N=96 The intervention group received acupressure at six acupressure points. The control group received routine care without acupressure or placebo. The placebo group received an intervention similar to the acupressure group, but with a distance of 1 cm from the actual acupressure points, so it did not provide the same therapeutic effect. F: 3 times a week for 4 weeks. D: 3 minutes per point, 20 minutes per day. T: First 2 hours of the hemodialysis session. Procedure: The first 2 minutes were used for "superficial stroking," followed by 18 minutes of acupressure on six acupuncture points (K1, GB34, ST36, SP6, BL23, HT7), each point receiving 3-4 kg of pressure for 3 minutes. Tools: Visual analog scale of fatigue Piper Fatigue Scale (PFS)	The results showed that the acupressure intervention significantly reduced total fatigue scores and scores on the emotional, cognitive, and behavioral dimensions ($P < 0.05$) compared to the placebo and control groups. Fatigue scores in the sensory dimension were also lower in the acupressure group compared to the placebo group ($P < 0.05$) and the placebo compared to the control group ($P < 0.05$).
(Chun & Park, 2016) **(Korea)**	to identify the effect of auricular acupressure on pruritus and fatigue in hemodialysis patients.	N=41 The intervention group received auricular acupressure. The control group did not receive acupressure therapy. F: Once a week for 10 weeks. Duration, time, and procedure: Acupuncture stickers were applied to both ears and left for 3 days, then removed on the 4th day. Each therapy cycle consisted of 3 days of sticker use followed by 4 days of rest to prevent the accumulation of "evil qi." During the first 2 weeks, 7 basic acupuncture points were applied: 3 points on the right ear (Newspaper, Endocrine, Pituitary) and 4 points on the left ear (Autonomic	Auricular acupressure showed significant effectiveness in reducing pruritus ($F = 13.93$, $p < 0.001$) and fatigue ($F = 18.33$, $p < 0.001$).

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(Author, Year) (Country)	Purpose	Method (Number, Intervention and Tools)	Outcome
		Nerve, Cortical, Triple Warmer, Brainstem). From the third week onwards, additional points for itching, sleep, and others were added for the remaining 10 weeks. Tools: Multidimensional Fatigue Scale developed by Tack	
(Biçer & Taşci, 2022) **(Turkey)**	this study examines the effect of acupressure performed on this point on blood pressure regulation as well as its effect on symptoms such as hypotension-associated fatigue and pain.	N=135 The intervention group received stimulation with an electrostimulation device at the Neiguan point (P6) during hemodialysis. The placebo group used the same device at the Neiguan point (P6) during hemodialysis, but the battery was removed so it was non-functional. F: Three times a week. D: One hour per session for one month. T: The third hour of each hemodialysis session. Procedure: The electrostimulation device was applied to the Neiguan point (P6) on the wrist and activated. Tools: Visual Analog Scale (VAS) for pain and fatigue, Piper fatigue scale	Acupressure at the Neiguan (P6) point using an electrostimulation device successfully regulated systolic and diastolic blood pressure ($P < 0.05$). At the second follow-up, VAS scores for pain, VAS for fatigue, and Piper Fatigue Scale scores significantly decreased in the intervention group ($P < 0.05$), while no difference was seen at the first follow-up ($P > 0.05$).
(Lobo, 2019) **(India)**	to find effectiveness of acupressure therapy on change in fatigue scores, contributing factors of fatigue and blood parameters	N=80 The intervention group received acupressure therapy. The control group received sham acupressure. F: Twice a week for 8 weeks. D: One minute, followed by massaging the point in a three-centimeter radius around the specific point in a circular motion once per second. T: Pressure and massage were applied using the thumb on specific fatigue points such as K1, GB34, ST36, K3, K6, K7, GB21, H7, and L1. This was followed by	Acupressure significantly reduced fatigue, improved functional ability, and enhanced sleep quality in hemodialysis patients. The results showed a significant decrease in fatigue scores in the intervention group ($p < 0.05$), improved functional ability ($p < 0.05$), and improved sleep quality ($p < 0.05$).

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(Author, Year) (Country)	Purpose	Method (Number, Intervention and Tools)	Outcome
	including oxidative markers among maintenance hemodialysis (MHD) patients in a tertiary care hospital, Udupi district.	massaging the point in a three-centimeter radius around the specific point in a circular motion once per second for three minutes. Tools: Severity of Fatigue Scale Questionnaires on Factors of Fatigue Assessment Tool Functional Ability Assessment Tool Short Inventory Mental wellbeing Scale Sleep Quality Index Blood test	Additionally, acupressure therapy also showed significant improvement in oxidative stress markers such as protein thiols and glutathione, and a reduction in malondialdehyde ($p < 0.05$).
(Suandika et al., 2023) **(Indonesia)**	to investigate the effect of acupressure on fatigue severity, sleep quality, and psychological status in patients with end-stage renal disease (ESRD) receiving hemodialysis (HD) treatment.	N=96 The intervention group received acupressure at 3 points. The control group received sham acupressure at points located 1 cun away from the K1, ST36, and SP6 points. F: 3 times a week for 4 weeks. D: 3 minutes per point, 18 minutes per session. T: First 2 hours of the hemodialysis session. Acupressure therapy procedure: Thumb pressure was applied to points K1, ST36, and SP6 with two rotations per second for 3 minutes per point until reaching the sensation of "de-qi" (pain, tingling, soreness). Tools: Brief Fatigue Inventory (BFI). Pittsburgh Sleep Quality Index (PSQI). Hospital Anxiety and Depression Scale (HADS)	Acupressure significantly reduced fatigue (b=-1.71, 95% CI: -1.90 to -1.51), improved sleep quality (b=-5.81, 95% CI: -6.80 to -4.81), and reduced anxiety (Estimate=-3.213, 95% CI: -4.238 to -2.188) and depression (Estimate=-3.378, 95% CI: -4.432 to -2.325) compared to the control group, with no side effects reported.

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Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman
Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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(Author, Year) (Country)	Purpose	Method (Number, Intervention and Tools)	Outcome
(Liao et al., 2024) **(Taiwan)**	to evaluate whether far-infrared stimulation of the Neiguan acupoint (P6) could effectively reduce fatigue and improve heart rate variability (HRV) in hemodialysis patients.	N=73 The experimental group received far-infrared stimulation at the Neiguan (P6) acupoint. The control group did not receive any intervention. F: 3 times a week for 12 weeks. D: 40 minutes per session. T: During the hemodialysis session. Acupressure therapy procedure: Far-infrared radiation was applied using far-infrared (FIR) radiation on the Neiguan (P6) acupoint on the arm not used for hemodialysis. The procedure was performed at a distance of 20 to 25 cm from the body surface, and the temperature was maintained between 38°C and 40°C Tools: Fatigue scale SA-3000P Analyzer	Far-infrared stimulation at the Neiguan point significantly reduced fatigue (β = 24, $p < 0.001$) and improved HRV (β = 74.36, $p < 0.001$). Fatigue reduction across all aspects and increased autonomic nervous system activity (β = 14.71, $p < 0.01$) were observed by the third month.
(Hadadian et al., 2016) **(Iran)**	To evaluate the effects of Trans Cutaneous Electrical Acupoint Stimulation (TEAS) on fatigue among ESRD patients receiving haemodialysis treatment.	N=56 TEAS group: Received TEAS at three acupuncture points. Control group: Received sham TEAS. F: Twice a week for 8 weeks. D: 30 minutes per session. T: During the first two hours of the hemodialysis session. Procedure: TEAS was applied to points ST36, SP6, and P6 for 30 minutes. Electrode pads were placed on the points and connected to an electrical stimulation device, set at a frequency of 2 Hz and a pulse width of 0.2 ms, with intensity adjusted to achieve the sensation of "de-qi." Tools: Brief Fatigue Inventory (BFI)	TEAS significantly reduced total fatigue (P = 0.004), sensory fatigue (P = 0.015), and behavioral fatigue (P = 0.041) but had no significant effect on emotional or cognitive fatigue compared to the control group.

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Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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Analytical Findings

The results of the literature search found 7 articles that met the criteria in Google Scholar, Reseach Gate, and Proquest. Articles come from publications from 2013 to 2024. Research locations in Iran (2 articles or 28,6%), Taiwan (2 articles or 28,6%), Korea (1 article or 14,3%), India (1 article or 14,3%), and Turkey (1 article or 14,3%). The results of the assessment with the Joanna Briggh Institute (JBI) Critical Appraisal Skills Program (CASP) 2020 found 7 articles of good quality. This review includes a total of 577 patients. Most participants fall into the middle-aged to elderly age groups, with the youngest being 18 years old.

Non-Invasive Acupoint Stimulation Method

In this systematic review, we evaluate various non-invasive acupoint stimulation methods applied to reduce fatigue in hemodialysis patients. We identified three main categories of therapy methods from the reviewed literature: electrical stimulation, manual or physical stimulation, and radiation stimulation. Electrical stimulation consists of two subcategories: electro-stimulation and Transcutaneous Electrical Acupoint Stimulation (TEAS). Two studies, namely those conducted by Biçer & Taşci (2022) and Hadadian et al. (2016), evaluated the effectiveness of electro-stimulation on acupuncture points. The electro-stimulation method was applied periodically for one month to five weeks. The results from Biçer & Taşci's study showed that electro-stimulation significantly reduced fatigue levels in hemodialysis patients, with a p-value < 0.05. On the other hand, Hadadian et al. (2016) investigated the use of TEAS, which was applied to several acupuncture points with specific frequency and intensity. This study also reported a significant reduction in fatigue compared to the sham control group, with a p-value = 0.002.

Manual or physical stimulation includes acupressure on acupuncture points and auricular acupressure. Several studies, including those conducted by Sabouhi et al. (2013), Lobo (2019), and Suandika et al. (2023), applied manual acupressure by directly pressing on acupuncture points. The results of the studies showed a significant reduction in fatigue levels compared to the control group, with Sabouhi and Lobo reporting significance values with $p < 0.05$. Meanwhile, Suandika et al. reported a significance with a value of b = -1.71 (95% CI: -1.90 to -1.51). This acupressure method was applied periodically for four to eight weeks. Chun & Park (2016) evaluated auricular acupressure, which uses stickers to provide stimulation to acupuncture points on the ear, with the method being applied for 10 weeks. Although it did not involve direct manual pressing, this method also showed a reduction in fatigue ($F = 18.33$, $p < 0.001$) as well as improvements in sleep quality and addressing pruritus.

Radiation stimulation was evaluated in a study conducted by Liao et al. (2024), which studied the effects of far-infrared radiation applied to the Neiguan (P6) acupuncture point. This method was applied for 12 weeks. The study showed that infrared radiation, applied at a certain distance from the skin, resulted in a significant reduction in fatigue ($\beta = 24$, $p < 0.001$) as well as an improvement in heart rate variability (HRV).

Overall, the results of this systematic review reveal that all the non-invasive acupoint stimulation methods studied had positive effects in reducing fatigue in hemodialysis patients. The research shows that both electrical stimulation, manual or physical stimulation, and radiation stimulation provide therapeutic benefits. These findings provide a basis for recommending the use of non-invasive acupoint stimulation methods in the management of fatigue in hemodialysis patients. Further research is needed to determine the most effective and optimal methods for patients.

Number of Stimulation Points

The studies reviewed showed variations in the number of stimulation points used in non-invasive acupoint stimulation methods. The study by Sabouhi et al. (2013) used six acupuncture points: K1, GB34, ST36, SP6, BL23, and HT7. Meanwhile, Chun and Park (2016) applied stimulation to seven auricular points in the ear. Suandika et al. (2023) added two other points, K1 and ST36, in addition to Neiguan (P6). Hadadian et al. (2016) used three points, namely ST36, SP6, and LI4, while Lobo (2019) applied stimulation to nine points: K1, GB34, ST36, K3, K6, K7, GB21, H7, and LI.

On the other hand, the studies by Biçer & Taşci (2022) and Liao et al. (2024) only targeted one point, namely Neiguan (P6). The results of these various studies suggest that although some studies used more stimulation points, the use of one or two specific points can also yield significant results in reducing fatigue. These findings confirm that both multiple-point use and single-point use can significantly contribute to reducing fatigue.

Gunawan Susanto*, Arif Setyo Upoyo

Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman
Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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Stimulation Duration Per Session

The duration of stimulation per session varied among the reviewed studies. Sabouhi et al. (2013) applied acupressure for 20 minutes per day, with 3 minutes of pressure on each point. Similarly, Suandika et al. (2023) also applied pressure for 3 minutes per point, with a total duration of 18 minutes for both legs. In contrast, in Lobo's (2019) study, each acupuncture point was intervened for 4 minutes, consisting of 1 minute of strong pressure followed by 3 minutes of massage. With 9 acupuncture points intervened, the total intervention duration per session reached 36 minutes. Biçer & Taşci (2022) provided therapy for one hour per session, while Liao et al. (2024) used infrared radiation with a duration of 40 minutes per session. Hadadian et al. (2016) used Transcutaneous Electrical Acupoint Stimulation (TEAS) with a duration of 50 seconds per point, resulting in a total duration of 5 minutes per session

The results from the reviewed studies showed variations in the duration of stimulation per session, but there is no direct evidence confirming that longer durations consistently provide a more significant impact on reducing fatigue. Longer durations may allow for more effective and deeper stimulation, as applied in the study by Biçer & Taşci (2022), which used one hour per session. However, clinical outcome comparisons between studies with different durations require further analysis to draw definitive conclusions.

Total Duration of Intervention

The total duration of the intervention varied among existing studies. Sabouhi et al. (2013) and Suandika et al. (2023) conducted the intervention for 4 weeks, while Hadadian et al. (2016) conducted the intervention for 5 weeks. Biçer & Taşci (2022) conducted the intervention for 1 month, while Lobo (2019) applied therapy for 8 weeks, and Liao et al. (2024) continued therapy for 12 weeks. The studies by Lobo (2019) and Liao et al. (2024) had longer intervention periods, allowing for exploration of the long-term effects of therapy on reducing fatigue, although there is no direct data comparing the rate of fatigue reduction across all studies.

From the overall studies analyzed, all results showed significant reductions in fatigue scores with p-values < 0.05, indicating that non-invasive acupoint stimulation methods consistently effectively reduce fatigue in hemodialysis patients. This supports the hypothesis that non-invasive acupoint stimulation methods, whether electrical stimulation, manual or physical stimulation, and radiation stimulation, can be a safe and effective non-pharmacological intervention for reducing fatigue in this patient population. These results also suggest that the duration and frequency of acupressure interventions play an important role in the effectiveness of the therapy, with various studies using different frequencies and durations still achieving significant results.

Measurement Of Fatigue Severity

The seven studies reviewed, various instruments were used to measure fatigue, including the Visual Analog Scale (VAS) for fatigue, the Piper Fatigue Scale (PFS), the Severity of Fatigue Scale, the Fatigue Scale, the Brief Fatigue Inventory (BFI), and one study used the Multidimensional Fatigue Scale developed by Tack. These measurement tools varied in their approach to the physical, psychological, and behavioral dimensions of fatigue.

Studies using the VAS, such as Biçer & Taşci (2022) and Sabouhi et al. (2013), showed significant reductions in fatigue after the intervention. Biçer & Taşci (2022) reported a decrease in the mean score from 7.27 to 4.74 ($p < 0.05$). VAS was considered effective due to its simplicity, allowing patients to quickly indicate the level of fatigue they felt. The Brief Fatigue Inventory (BFI) was used by Suandika et al. (2023) and Hadadian et al. (2016) to assess fatigue in the last 24 hours. Both studies reported significant reductions in fatigue intensity. Suandika et al. (2023) reported that after 4 weeks of intervention, the experimental group showed a significant reduction in fatigue scores, with a value of $b = -1.71$. Meanwhile, Hadadian et al. (2016) reported that fatigue scores in the TEAS group showed a significant reduction after the intervention (mean rank decreased from 30.68 to 21.68). Sabouhi et al. (2013) and Biçer & Taşci (2022) also used the Piper Fatigue Scale (PFS), which evaluates fatigue multidimensionally. After acupressure intervention, a reduction in PFS scores was reported in the behavioral, emotional, sensory, and cognitive dimensions Liao et al. (2024) applied a Fatigue Scale questionnaire specifically designed for hemodialysis patients, which assessed various psychological and behavioral factors related to fatigue. This study reported a negative β value indicating a significant reduction in fatigue in various

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aspects, namely: energy and motivation (β = -2.97), physical strength (β = -1.28), mental ability (β = -2.38

Chun & Park (2016) used the Multidimensional Fatigue Scale developed by Tack, a questionnaire with 11 items that measures fatigue levels and their impact on daily activities. The results showed a significant decrease in fatigue scores after the acupressure intervention. The study reported a reduction in fatigue scores from pretest (4.78) to post 5 weeks (3.91) and further to post 10 weeks (3.15).

Lobo (2019) used this measurement tool to assess the severity of fatigue experienced by patients. This study found a significant reduction in fatigue severity in the intervention group. It showed a decrease in the mean fatigue scores in the experimental group after the intervention, from 169.83 to 122.43.

Overall, the results from all studies that used various measurement instruments showed a significant reduction in fatigue levels in the groups receiving the Non-Invasive Acupoint Stimulation Method intervention, compared to the control groups. This highlights the effectiveness of the Non-Invasive Acupoint Stimulation Method in reducing fatigue in hemodialysis patients, although variations in measurement methods and intervention session frequencies were found among the reviewed studies.

DISCUSSION

This systematic review demonstrates that the Non-Invasive Acupoint Stimulation Method, through electrical, manual, or radiation stimulation, has a significant effect in reducing fatigue in hemodialysis patients. The variation in methods, number of stimulation points, session duration, and total intervention length yields consistent results, namely a reduction in fatigue. These findings support the use of Non-Invasive Acupoint Stimulation Method as a safe and effective complementary therapy in managing fatigue in chronic kidney disease patients undergoing hemodialysis (Biçer & Taşci, 2022; Hadadian et al., 2016; Lobo, 2019).

Non-Invasive Acupoint Stimulation Method

The results of this systematic review indicate that various non-invasive acupoint stimulation methods are effective in reducing fatigue in hemodialysis patients. These findings are consistent with previous research suggesting that acupoint stimulation can offer significant benefits in managing fatigue, a common condition often experienced by hemodialysis patients (Melo et al., 2020).

Two studies evaluating electrical stimulation, namely Biçer & Taşci (2022) and Hadadian et al. (2016), show consistent results regarding fatigue reduction ($P < 0.05$). The application of electrical stimulation over one to five weeks significantly reduces fatigue levels, supporting the hypothesis that electrical stimulation can effectively stimulate acupoints, improve blood circulation, and stimulate the nervous system (Yang et al., 2022). Furthermore, the use of Transcutaneous Electrical Acupoint Stimulation (TEAS), as investigated by Hadadian et al. (2016), shows greater fatigue reduction compared to the sham control group, reinforcing the finding that TEAS can function as an effective non-invasive intervention.

Manual stimulation methods, as used in the studies by Sabouhi et al. (2013), Suandika et al. (2023), and Lobo (2019), also show that manual acupoint stimulation is effective in reducing fatigue, with a significant value of $P < 0.05$. Suandika et al. (2023) reported that acupressure significantly reduces fatigue (b=-1.71, 95% CI: -1.90 to -1.51). Acupressure effectively reduces general fatigue as well as subdomains of fatigue, including behavioral, emotional, sensory, and cognitive fatigue (Chang et al., 2024). Research by Chun & Park (2016) demonstrates that auricular acupressure significantly reduces fatigue ($F=18.33$, $p<0.001$), pruritus ($F=13.93$, $p<0.001$), and improves sleep quality in hemodialysis patients. Other studies also show that auricular acupressure reduces cancer-related fatigue (CRF) in lung cancer patients undergoing chemotherapy, especially physical and affective fatigue ($F: 24.63$, $p<0.01$) (Lin et al., 2021). Improved sleep quality plays a key role in reducing fatigue, supporting physical and mental recovery, and improving the patients' quality of life.

Research by Liao et al. (2024) highlights the effectiveness of infrared radiation in reducing fatigue. Although different from manual and electrical methods, infrared radiation applied to the Neiguan (P6) point shows a significant positive effect ($\beta = 24$, $p < 0.001$). The increase in heart rate variability (HRV) observed as a result of this application suggests that infrared radiation may help improve autonomic nervous system balance, which in turn may contribute to reducing fatigue (Matsui et al., 2023).

Gunawan Susanto*, Arif Setyo Upoyo

Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman
Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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The conclusions of this systematic review show that non-invasive acupoint stimulation methods, such as electrostimulation, TEAS, manual acupressure, auricular acupressure, and infrared radiation, are effective in reducing fatigue in hemodialysis patients. These findings support previous evidence that both finger stimulation and device-assisted stimulation have comparable effects in mitigating fatigue, a common condition in hemodialysis patients (Chang et al., 2024).

Number of Stimulation Points

The results of this systematic review show that the number of stimulation points used in the Non-Invasive Acupoint Stimulation Method varies, with interesting implications for effectiveness in reducing fatigue in hemodialysis patients. These findings support the theory that not only the number of points but also the appropriate selection of points can affect therapeutic outcomes.

Several studies, such as the one conducted by Sabouhi et al. (2013), used six acupoints: K1, GB34, ST36, SP6, BL23, and HT7. Meanwhile, research by Lobo (2019) used nine acupoints, namely K1, GB34, ST36, K3, K6, K7, GB21, H7, and L1. Other studies show that targeting acupressure points such as HT7 (Shenmen), in addition to other points like SP6 (Sanyinjiao), KI1 (Yongquan), and ST36 (Zusanli), significantly enhances the fatigue-reduction effect. The decrease in brain activity after HT7 stimulation, associated with improved sleep, supports the hypothesis that increased total sleep time reduces fatigue symptoms, making HT7 effective in reducing fatigue in hemodialysis patients (Chang et al., 2024). This research aligns with other studies showing that the use of more acupoints may provide broader stimulation, potentially maximizing the effect compared to single-point or non-point use (Zheng et al., 2020).

Conversely, Chun & Park (2016) applied stimulation to seven auricular points in the ear, emphasizing the importance of auricular points in fatigue management. This study shows that although relying only on points in the ear, this intervention significantly reduces fatigue and improves sleep quality and overall well-being. Similar findings were observed in a study conducted on women post-cesarean section, where auricular acupressure on the shenmen point was proven effective in reducing postpartum fatigue and anxiety. Although the context is different, the mechanism of acupressure, such as auricular point stimulation related to nervous system regulation and endorphin release, may provide similar benefits in other conditions, including hemodialysis patients (Kuo et al., 2016). This indicates that acupressure, whether on auricular points or other body points, has the potential to be an effective intervention in managing fatigue in various populations. These findings support the potential application of acupressure as a non-invasive therapy to reduce fatigue, including in patients undergoing hemodialysis, although further research is still needed to confirm this.

On the other hand, studies by Biçer & Taşci (2022) and Liao et al. (2024) targeted only one point, namely Neiguan (P6). Although the number of points used is limited, these studies still show a significant reduction in fatigue levels. Suandika et al. (2023) added two other points, K1 and ST36, to the intervention that focused on Neiguan (P6). These findings suggest that combining one point with several additional points can enhance the effectiveness of the intervention

The study by Hadadian et al. (2016) used three points, namely ST36, SP6, and LI4, and reported positive results in reducing fatigue. Other research also supports that stimulation at these three points can provide significant benefits in reducing fatigue symptoms in patients with other chronic conditions, such as multiple sclerosis (Yeni et al., 2022). Additionally, acupoints ST36, SP6, and KI3 are also often used in the treatment of Cancer-Related Fatigue, showing consistent relevance across different conditions (Ling et al., 2014).

Although varied, these findings suggest the potential of acupoint stimulation methods as non-invasive therapies to reduce fatigue, including in hemodialysis patients. Further research is needed to confirm this effectiveness and explain the mechanisms behind the observed benefits.

Duration of Stimulation Per Session

The duration of stimulation per session significantly influences the effectiveness of interventions in reducing fatigue among hemodialysis patients. Of the seven studies reviewed, it is evident that the duration varies, but consistently yields positive outcomes in fatigue reduction.

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Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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Sabouhi et al. (2013) demonstrated that 20-minute acupressure interventions resulted in significant fatigue reduction. This study highlighted the importance of adequate duration to achieve therapeutic outcomes. Similarly, Suandika et al. (2023) provided 18-minute sessions, with results also showing a significant decrease in fatigue. On the other hand, Biçer and Taşci (2022) applied a one-hour session, which not only significantly reduced fatigue but also lowered blood pressure. These findings indicate that longer durations provide the body with enough time to adapt to the therapy.

In the study by Lobo (2019), each acupuncture point was stimulated for 4 minutes, consisting of 1 minute of strong pressure followed by 3 minutes of massage. With 9 acupuncture points stimulated, the total duration of each session reached 36 minutes. The results showed a significant reduction in fatigue scores in the intervention group. Conversely, Chun and Park (2016) reported the effectiveness of auriculotherapy using a different procedure and duration. Acupuncture stickers were applied to both ears and left in place for 3 days before being removed on the 4th day. Each therapy cycle consisted of 3 days of sticker application followed by 4 days of rest to prevent the accumulation of "bad qi."

Liao et al. (2024), with 40-minute sessions over 12 weeks, showed that a combination of adequate duration and innovative methods like far-infrared stimulation can enhance fatigue reduction. Hadadian et al. (2016), with 50-second stimulations per second, totaling 5 minutes per session, also showed significant differences between the TEAS and Sham groups after the intervention. Although the session duration was shorter, the results showed a significant reduction in fatigue scores in the intervention group.

Overall, although session duration varies, consistency in implementing the intervention and selecting the appropriate stimulation points is key to maximizing outcomes. It is recommended for clinical practitioners to consider an ideal duration, such as 20-minute or one-hour sessions, to achieve the best results in reducing fatigue in hemodialysis patients.

However, there is still a gap in the literature regarding the lack of studies that directly compare different durations. Further research is needed to explore the relationship between stimulation duration and intervention effectiveness, as well as the types of points used.

Total Duration of Intervention

An analysis of the seven journals reviewed in this systematic review shows significant variation in the total duration of interventions and the frequency of sessions applied. The duration of interventions in these studies ranged from four weeks to 12 weeks, with session frequency varying between two to three times per week, and in some cases, daily. This variation suggests flexibility in therapeutic approaches applied to hemodialysis patients to reduce fatigue.

Longer interventions, such as the one by Liao et al. (2024), which provided therapy for 12 weeks at a frequency of 3 times per week, and Chun & Park (2016), which offered interventions for 10 weeks at a frequency of 1 time per week, resulted in more consistent and sustained fatigue reduction. These findings emphasize the importance of considering longer therapy durations, especially for hemodialysis patients who tend to experience chronic fatigue. Longer durations appear to give the body sufficient time to adapt to the intervention, resulting in more stable and long-lasting effects.

However, it is important to note that studies with shorter intervention durations also show positive results. Sabouhi et al. (2013) and Suandika et al. (2023), who conducted interventions for four weeks with a frequency of 3 times per week, reported significant reductions in fatigue levels. Despite the shorter duration, increased session frequency seemed to be a key factor supporting the success of these therapies. This aligns with studies suggesting that acupuncture or acupressure for Cancer-Related Fatigue be conducted for four weeks, with weekly sessions of 20-30 minutes and daily self-acupressure for better effectiveness (Ling et al., 2014).

Lobo (2019), in his study that provided an 8-week intervention with a frequency of 2 times per week, also showed positive results in reducing fatigue in patients. Similarly, Biçer and Taşci (2022), who conducted interventions for one month with a frequency of 3 times per week, and Hadadian et al. (2016), who provided therapy for 5 weeks with a frequency of 2-3 times per week, also showed significant results in reducing fatigue. Despite the variation in intervention duration and frequency, significant results in reducing fatigue were achieved across all the studies analyzed. This indicates that both long and short durations can be effective, as long as the frequency and intervention method are suited to the clinical needs of the patients.

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Fatigue Measurement

Various instruments were used to measure fatigue, such as the Visual Analog Scale (VAS), Brief Fatigue Inventory (BFI), Piper Fatigue Scale (PFS), Fatigue Questionnaire, and the Multidimensional Fatigue Scale developed by Tack, providing a comprehensive overview of the effectiveness of acupressure in this context.

For instance, the study by Biçer and Taşci (2022) demonstrated a significant decrease in Visual Analog Scale (VAS) scores from 7.27 to 4.74, reflecting the effectiveness of non-invasive acupoint stimulation methods in helping patients express and experience a reduction in fatigue. These findings are supported by Sabouhi et al. (2013), who reported similar reductions in VAS scores, further strengthening the conclusion that non-invasive acupoint stimulation methods can be an efficient and well-received approach to managing fatigue. Thus, the use of the Visual Analog Scale (VAS) to assess patients' fatigue levels proved relevant in supporting the effectiveness of non-invasive acupoint stimulation methods (Ju et al., 2020).

The study by Suandika et al. (2023) using the Brief Fatigue Inventory (BFI) reported a significant reduction in fatigue intensity with a value of b = -1.71, indicating that the benefits of non-invasive acupoint stimulation methods can be felt within a relatively short period. These findings are supported by Hadadian et al. (2016), who also recorded a significant reduction in fatigue scores, showing consistency in results across different measurement methods. The BFI not only assesses fatigue severity but also evaluates the interference caused by fatigue in various aspects of life, such as general activity, mood, and enjoyment of life (Debnath et al., 2021).

Chun & Park (2016) used a multidimensional fatigue scale developed by Tack and modified for dialysis patients. The tool consists of 11 questions, including 3 questions about fatigue levels and 8 questions about the impact of fatigue. Each question is scored on a 10-point scale from 1 to 10, with higher scores indicating higher levels of fatigue. The study results showed that fatigue score reductions could continue over time, from 4.78 at pretest to 3.15 after 10 weeks of intervention (Chun & Park, 2016).

Liao et al. (2024) developed a more specific approach using the Fatigue Questionnaire as a tool to screen and evaluate fatigue levels in dialysis patients. This questionnaire consists of five parts, each used to determine: (1) decreased energy and motivation, (2) reduced physical strength, (3) diminished mental abilities, (4) reduced daily activities, and (5) depressed mood and loss of control. These five different sections provide a comprehensive overview of how fatigue affects the daily lives of hemodialysis patients. This study reported significant reductions in various aspects of fatigue.

Additionally, Lobo's (2019) study used the Severity of Fatigue Tool, a 28-item scale from 0 to 10, divided into four sections: physical, cognitive, social, and affective. This tool provides a comprehensive picture of individual fatigue levels. The study reported a reduction in fatigue severity, with the average score decreasing from 169.83 to 122.43.

Studies using the Piper Fatigue Scale include Sabouhi et al. (2013) and Biçer & Taşci (2022). Sabouhi et al. (2013) reported a significant decrease in total fatigue scores across all dimensions, with the largest reduction seen in the sensory dimension (average reduction of 2.7). Meanwhile, Biçer & Taşci (2022) reported reductions in fatigue scores ranging from 0.39 to 0.92. The Piper Fatigue Scale is a comprehensive and in-depth tool for evaluating fatigue, especially as it encompasses various dimensions of fatigue that can be experienced by an individual, including mental fatigue and the behavioral, emotional, sensory, and cognitive dimensions.

Despite these positive results, there are some limitations to note. Variations in measurement methods and study designs can affect the outcomes, as can differences in the frequency and duration of the interventions applied. Therefore, although non-invasive acupoint stimulation methods show effectiveness, it is important to consider the context and methods used in each study.

Based on these findings, it is recommended to conduct further research with more homogeneous and larger study designs to confirm these results and further explore the mechanisms of non-invasive acupoint stimulation methods in reducing fatigue in hemodialysis patients. With a better understanding of how acupressure can be optimized, we can improve care and the quality of life for patients with this chronic condition.

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Corresponding author: *E-mail: gunawan.susanto@mhs.unsoed.ac.id

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LIMITATIONS OF THE STUDY

Although the results of this review support the use of non-invasive acupoint stimulation methods as a complementary therapy for managing fatigue in hemodialysis patients, there are several limitations. First, the limited number of studies and the variations in methodology may limit the generalizability of the findings. Additionally, many factors contributing to fatigue, such as depression, anemia, and sleep disorders, were not fully controlled in all studies, which could affect the accuracy of the findings. Therefore, further studies with stricter control over these variables are needed to ensure the validity of the results.

CONCLUSION

This systematic review concludes that non-invasive acupoint stimulation holds great potential as an effective complementary approach for reducing fatigue in hemodialysis patients. Despite variations in stimulation methods, the number of acupoints, and the duration of interventions, all studies reported significant reductions in fatigue. Whether through electrical, manual or physical stimulation, or radiation, all methods provided therapeutic benefits, especially with longer session durations and intervention periods.

From a clinical perspective, non-invasive acupoint stimulation methods offer great advantages as a safe, easily applicable therapy with no significant side effects, making it an ideal option for hemodialysis patients who often experience fatigue. Thus, non-invasive acupoint stimulation methods can be integrated into hemodialysis care protocols to improve the quality of life for patients.

However, given the limited number of studies and variations in methodology, more research with larger randomized clinical trial designs and stricter variable controls is needed to confirm the effectiveness of this therapy. Further research is crucial to identify the most optimal non-invasive acupoint stimulation method, including the most effective number of acupoints, session durations, and overall intervention periods for hemodialysis patients.

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