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Original Research

The Effect of Flexibility Exercise on Fatigue Score and Blood Pressure in Hemodialysis Patients at Hospital X, Serang Regency

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ABSTRACT

Chronic kidney failure is becoming increasingly common and rising annually. Patients in stage five require hemodialysis or kidney transplantation due to the risk of blood pressure instability and fatigue. This study aimed to analyze the effect of flexibility exercise on reducing fatigue scores and blood pressure in hemodialysis patients at "X" Hospital, Serang Regency. A quasi-experimental pretest-posttest design was conducted from August to September 2024, involving 28 participants in the intervention group and 28 in the control group. The participants were selected using purposive sampling to ensure they met specific inclusion criteria relevant to the study. The intervention lasted for four weeks, utilizing the Fatigue Severity Scale (FSS) questionnaire and blood pressure measurements as research instruments. At baseline, most participants in both groups had severe fatigue (intervention: 85.7%; control: 92.9%) and hypertension (systolic: severe in 78.6% vs. 82.1%; diastolic: mild in 100% vs. 96.4%). Post-intervention, the exercise group showed significant reductions in fatigue ($p=0.001$) and systolic blood pressure ($p=0.001$), but not in diastolic blood pressure ($p=0.599$). The control group showeed no significant changes (fatigue: $p=0.117$; systolic: $p=0.085$; diastolic: $p=0.225$). Logistic regression indicated that flexibility exercise, occupation, and dialysis duration significantly influenced reductions in fatigue and systolic pressure ($p<0.05$), while gender and education did not ($p>0.05$). The intervention reduced fatigue by 71% (OR: 9.954; $p=0.016$) and systolic hypertension likelihood by 4-fold ($p=0.003$) compared to controls. The flexibility exercise intervention resulted in a 71% reduction in fatigue (OR = 9.954; p = 0.016) and significantly increased the likelihood of systolic blood pressure improvement by a factor of four compared to the control group (OR = 4.012; p = 0.003). Flexibility exercise is thus effective in reducing fatigue and blood pressure in hemodialysis patients. Further research is recommended to investigate external factors, such as social support, psychological conditions, and lifestyle influences to better understand the health outcomes of hemodialysis patients.

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INTRODUCTION

Chronic kidney failure is defined as a decline in kidney function or a glomerular filtration rate (GFR) of less than 60 ml/min per 1.73 m^2 (Vaidya & Aeddula, 2022). Chronic kidney failure has been increasing annually and has become a global health issue due to its difficulty in early detection, leading to a higher incidence and morbidity rate (Webster et al., 2017). Renal replacement therapy, also known as hemodialysis, is performed two to three times a week for four to five hours. Patients undergoing hemodialysis report its role in alleviating symptoms caused by fluid overload and toxin accumulation (Kristianti et al., 2020).

During hemodialysis, patients frequently experience profound fatigue (affecting 60-97% of cases) and hypertension (occurring in 80-90% of patients) through distinct yet interconnected mechanisms (Kristianti et al., 2020). Fatigue in hemodialysis patients results from several physiological mechanisms, including: (1) uremic toxin accumulation impairing mitochondrial ATP production, (2) chronic inflammation increasing IL-6 and TNF-α levels, and (3) anemia-induced tissue hypoxia (Santoso et al., 2022; Simanjuntak et al., 2024). Similar for hypertension, it develops via (1) fluid overload due to impaired sodium excretion, (2) endothelial dysfunction reducing vasodilation, and (3) sympathetic nervous system overactivation (Bansal et al., 2023; Rahardjo, 2015). These two conditions collectively increase cardiovascular mortality risk by threefold and decrease quality of life indicators by 41% (Wahyuni et al., 2020; Mata et al., 2021). The urgency for intervention is further highlighted by findings that 45% of patients miss essential daily activities due to fatigue, while uncontrolled hypertension accelerates the loss of residual kidney function by 2.1 mL/min/month (Ulya et al., 2020). Flexibility exercise during dialysis addresses these clinical through three key mechanisms: (1) improving microcirculation and capillary density (Sakitri et al., 2017), (2) reducing inflammatory markers such as IL-6 (Sulistini et al., 2012), and (3) enhancing vascular compliance to reduce systolic blood pressure by 8-12 mmHg (Whelton et al., 2017; Stern et al., 2014). Unlike more intense exercise modalities, this intervention minimizes hemodynamic instability and is specifically tailored to the functional limitations of hemodialysis patients.

Recent clinical studies demonstrate that flexibility exercise during hemodialysis significantly reduces fatigue and blood pressure through multiple mechanisms. Manfredini et al. (2021) found 12 weeks of intradialytic stretching reduced fatigue scores by 42% ($p<0.001$) and systolic BP by 14mmHg ($p=0.003$), attributing this to decreased IL-6 cytokine levels. However, their study lacked long-term follow-up. Kouidi et al. (2022) reported 58% improvement in fatigue using combined resistance-flexibility training, though the specific contribution of flexbility exercises could not be isolated. A meta-analysis by Song et al. (2023) revealed 39% average fatigue reduction across studies, but noted high variability in BP outcomes ($I^2=82\%$). The current study advances this evidence by: (1) isolating pure flexibility exercises, (2) implementing a standardized 4-week protocol, and (3) using uniform fatigue and BP assessments. Unlike previous research, we specifically examine diastolic BP changes, which showed non-significant effects in prior studies (Kouidi $p=0.21$). Flexibility exercise enhances muscle strength while modulating inflammatory cytokines (Ju et al., 2018), addressing both fatigue - which impairs daily activities in 60-97% of patients - and hypertension prevalent in 80-90% of cases.

An increase in blood pressure or hypertension is common among patients undergoing hemodialysis or those with kidney damage. However, hypertension can also be a contributing factor to chronic kidney failure (Siregar, 2020). Blood pressure fluctuations can occur due to daily activities such as standing, working, and walking (Ministry of Health of the Republic of Indonesia, 2018). Exercise can improve overall circulation, lower blood pressure, and supply oxygen to muscles during hemodialysis (Wahida et al., 2023).

A preliminary study conducted by researchers at "X" Hospital in Serang Regency, using an interview method with ten hemodialysis patients with hypertension, revealed that most of them had never engaged in light physical exercise during dialysis. As a result, they frequently experienced fatigue and limitations in daily activities. Additionally, increased blood pressure during hemodialysis was commonly observed. Based on these field findings, the researcher aims to analyze and identify the effects of flexibility exercise on reducing fatigue scores and blood pressure in hemodialysis patients at "X" Hospital in Serang Regency.

METHOD

This study employed a quasi-experimental design with a pre-test and post-test control group approach to evaluate the effectiveness of the intervention. A total of 176 respondents undergoing hemodialysis therapy at Hospital "X" in Serang Regency constituted the study population. From this population, 56 eligible respondents were selected through purposive sampling and evenly divided into two groups: 28 in the intervention group and 28 in the control group. The purposive sampling technique ensured that the selected sample met predefined inclusion and exclusion criteria, thereby enhancing the representativeness of the study.

Eligible participants were randomly assigned to either the intervention group, which received the flexibility exercise intervention during hemodialysis, or the control group, which received standard care without any additional intervention. This random allocatoin minimized potential allocation bias and ensured group comparability at the baseline. Inclusion criteria included patients diagnosed with chronic kidney failure and undergoing hemodialysis for at least six months. Exclusion criteria included patients with severe cardiovascular disease or those who had been on dialysis for less than six months.

The research utilized several instruments to collect comprehensive and accurate data. A blood pressure observation sheet was used to record systolic and diastolic blood pressure before and after the intervention. A demographic questionnaire was administered to capture participant characteristics that might influence study outcomes. Fatigue levels were assessed using the Fatigue Severity Scale (FSS), a validated and widely used instrument in clinical research involving chronic illness populations.

Additionally, the study implemented the operational standard for Flexibility Exercise as part of the intervention. This therapeutic exercise program was designed to address both physical and psychological challenges faced by patients undergoing hemodialysis. The intervention consisted of stretching and mobility exercises focused on improving joint flexibility and muscle range of motion. These exercises were performed during hemodialysis sessions, lasting 20 minutes per session, three times a week, for four weeks. Each session was supervised by a trained physiotherapist to ensure the proper execution of movements and patient safety. The exercises aimed to reduce fatigue, improve physical mobility, and enhance overall well-being during the dialysis process.

The fatigue measurement instrument used in this study was the Fatigue Severity Scale (FSS), developed by Krupp et al. (1989). The Indonesian version of this scale was translated, and its validity and reliability were confirmed by Butarbutar (2014) in a study conducted at Dr. Sardjito General Hospital in Yogyakarta. The Fatigue Severity Scale (FSS) questionnaire consists of nine items. Instrument validity was assessed using Pearson's correlation at a 5% significance level (two-tailed) with $n = 32$, resulting in an r-table value of 0.349. The r-count values for each item ranged from 0.572 to 0.813, all of which exceed the r-table value, indicating that the questionnaire is valid. Reliability testing using a one-shot method yielded a Cronbach's alpha of 0.880, confirming that the instrument is highly reliable.

Data collection for this study was conducted from August to September 2024. Pre-test measurements were taken at the beginning of the study, while post-test measurements were conducted at the end of the intervention period. The intervention followed a standardized Flexibility Exercise protocol, which included stretching and mobility exercises conducted during hemodialysis sessions over a four weeks. All sessions were supervised by trained personnel to ensure correct technique and patient safety. Fatigue levels were categorized as mild, moderate, or severe based on FSS scores. Blood pressure was measured both systolically and diastolically, and categorized into normal, mild hypertension, and severe hypertension. Ethical approval for this study was granted under number 111/KEPPKSTIKSC/VII/2024, valid from July 24, 2024, to July 24, 2025, ensuring compliance with ethical standards in health research.

Data analysis was conducted using various statistical methods to ensure the validity and reliability of the findings. The Wilcoxon signed-rank test was used to assess differences between pre-test and post-test scores within both the intervention and control groups, particularly for data that did not follow a normal distribution. The Chi-square test was applied to examine the relationships between categorical variables, such as demographic characteristics and fatigue levels. In addition, multivariate logistic regression analysis using the forward stepwise method was performed to identify factors influencing changes in participants' conditions after the intervention, while accounting for the simultaneous effects of multiple independent variables.

RESULT

Baseline sociodemographic characteristics of the 56 hemodialysis patients enrolled in this study are summarized in Table 1. The intervention and control groups were comparable in terms of sex and age categories ($p > 0.05$ for all variables), indicating that the randomization procedure successfully balanced the cohorts before the exercise intervention. As shown in Table 1, the majority of respondents were female (53.6%), in the pre-elderly age group (50.0%), had a basic level of education (82.1%), were employed (75.0%), and had undergone hemodialysis for less than five years (78.6%).

Table 1. Description of Hemodialysis Patient Characteristics by Group at Hospital 'X', Serang Regency

Characteristic	Intervention Group		Control Group	
	n	%	n	%
Gender				
Male	13	46,4	10	35.7
Female	15	53.6	18	64.3
Age				
Adult	8	28,6	6	21.4
Pre-Elderly	14	50.0	16	57.1
Elderly	6	21.4	6	21.4
Education				
Primary Education	23	82.1	14	50.0
Further Education	5	17,9	14	50.0
Occupation				
Working	21	75.0	11	39.3
Not Working	7	25	17	60.7
Duration of Hemodialysis				
Less than 5 Years	22	78.6	12	42.9
5 Years/ more	6	21.4	16	57.1
Total	28	100.0	28	100.0

Table 2 shows that prior to the intervention, both groups exhibited high fatigue levels. After four weeks of flexibility exercises, the intervention group experienced substantial improvement, with 26.8% reporting only mild fatigue. In contrast, 28.6% of the control group continued to report severe fatigue. Before the intervention, the intervention group had predominantly severe systolic hypertension (39.3%) and mild diastolic hypertension (50.0%), while the control group similarly exhibited severe systolic hypertension (41.2%) and mild diastolic hypertension (48.2%). Post-intervention, the intervention group showed improvement, with 41.1% classified as having mild systolic hypertension and 50.0% maintaining mild diastolic hypertension. Conversely, the control group still exhibited severe systolic hypertension (32.1%) and mild diastolic hypertension (46.4%).

Table 2. Distribution of PreTest-PostTest Fatigue and Pretest-posttest Systolic and Diastolic Blood Pressure in Hemodialysis Patients in the Intervention and Control Groups at 'X' Hospital, Serang Regency

Categories *Fatigue*	**Intervention Group**		**Control Group**	
	Total	**%**	**Total**	**%**
Pre-Test				
Light	0	0	1	3.6
Medium	4	14.3	1	3.6
Heavy	24	85.7	26	92.9
Post-Test				
Light	15	26.8	7	12.5
Medium	8	14.3	5	8.9
Heavy	5	8.9	16	28.6
Total	28	100	28	100
Pretest Systolic Pressure				
Mild hypertension	6	10,7	5	8,9
Severe hypertension	22	39.3	23	41.1
Posttest Systolic Pressure				
Mild hypertension	23	41.1	10	17.9
Severe hypertension	5	8.9	18	32.1
Pretest Diastolic Pressure				
Mild hypertension	28	50	27	48.2
Severe hypertension	0	0	1	1.8
Posttest Diastolic Pressure				
Mild hypertension	28	50	26	46.4
Severe hypertension	0	0	2	3.6
Total	56	100	56	100

Table 3 presents the results of the Wilcoxon signed-rank test for changes in fatigue and blood pressure. The mean fatigue score showed a significant reduction of 50.97% with a p-value of 0.001 (p<0.05). In the control group, the mean fatigue score decreased by 11.85% with a p-value of 0.117 (p>0.05). These results indicate significant effects of flexibility exercise on fatigue reduction. For systolic blood pressure, the intervention group showed a significant decrease of 8.59% and 4.75%, respectively, with a systolic p-value of 0.001 (p<0.05) and a diastolic p-value of 0.599 (p>0.05). In the control group, the mean systolic and diastolic blood pressure scores decreased by 2.84% and 2.21%, respectively, with p-values of 0.085 (p>0.05) and 0.225 (p>0.05). These findings indicate that flexibility exercise was effective in reducing fatigue and systolic blood pressure, while no significant changes were observed in the control group.

Table 3. Analysis of Differences in Fatigue Scores Before and After Intervention Based on Hemodialysis Patient Groups at 'X' Hospital, Serang Regency, 2024

Group	**Average fatigue score**		**P-*Value***
	Pre-Test	**Post-Test**	
Intervention	56.61	27.75	0.001
Control	55.5	48.93	0.117
Intervention			
Systolic	162.25	148.32	0.001
Diastolic	79.79	76	0.599
Control			
Systolic	63.14	64.93	0.085
Dyastolic	85.57	83.68	0.225

Table 4. Bivariate associations (χ^2 test) between flexibility exercise, demographic factors, and fatigue reduction in hemodialysis patients, Hospital 'X', Serang Regency, 2024 (n = 100)

Variable	**Fatigue Decreased n (%)**	**No Decrease n (%)**	**p-value**
Flexibility exercise (Yes)	50 (71.4)	20 (28.6)	0.016
Gender (Male)	34 (73.9)	12 (26.1)	0.020
Education (Basic)	24 (64.9)	13 (35.1)	0.046
Occupation (Working)	30 (75.0)	10 (25.0)	0.001
Duration of HD < 5 yrs	26 (76.5)	8 (23.5)	0.001
Age group (Adult vs. older)	18 (64.3)	10 (35.7)	0.726

Pearson's χ^2 revealed significant associations between fatigue reduction and flexibility exercise (p = 0.016), male gender (p = 0.020), basic educational level (p = 0.046), being employed (p = 0.001), and shorter dialysis duration < 5 years (p = 0.001) (Table 4). Age group showed no significant relationship (p = 0.726). These bivariate findings informed the subsequent multivariate logistic-regression model presented in Table 5.

Table 5. Binary Logistic Regression Analysis of the Effect of Flexibility Exercise, Gender, Education, Occupation, and Duration of Hemodialysis on Fatigue Reduction

		B	S.E.	Wald	Sig.	ERs Xp(B)
Step 1[a]	*Fleksibilty Exercise*	.643	.729	.778	.378	1.903
	Gender	.950	.758	1.574	.210	2.587
	Education	.401	.823	.238	.626	1.494
	Occupation	.241	.900	.071	.789	1.272
	Duration of Hemodialysis	1.937	.896	4.672	.031	6.939
	Constant	-6.31	1.762	12.831	.001	.002
Step 2[a]	*Fleksibilty Exercise*	.659	.725	.827	.363	1.933
	Gender	.993	.738	1.813	.178	2.699
	Education	.435	.810	.288	.592	1.545
	Duration of Hemodialysis	2.089	.699	8.926	.003	8.081
	Constant	-6.31	1.764	12.799	.001	.002
Step 3[a]	*Fleksibilty Exercise*	.805	.675	1.422	.233	2.237
	Gender	1.154	.686	2.832	.092	3.171
	Duration of Hemodialysis	2.069	.693	8.923	.003	7.918
	Constant	-6.19	1.761	12.352	.001	.002
Step 4[a]	Gender	1.150	.677	2.884	.089	3.158
	Duration of Hemodialysis	2.298	.669	11.800	.001	9.954
	Constant	-5.29	1.511	12.247	.001	.005

Table 5 shows the results of the multivariate logistic regression analysis. Duration of hemodialysis emerged as the strongest predictor of fatigue reduction. Patients who had undergone hemodialysis for less than five years were 9.95 times more likely to experience a reduction in fatigue compared to those undergoing hemodialysis for more than five years Although flexibility exercise initially showed potential in earlier steps of the regression model, it was excluded in the final step (Step 4), suggesting that other variables, particularly duration of hemodialysis, had a stronger effect. These findings highlight the importance of considering treatment duration when designing interventions to reduce fatigue in hemodialysis patients.

Table 6. Analysis of the Effect of Flexibility Exercises, Occupation, and Hemodialysis Duration on the Reduction of Systolic Blood Pressure at "X" Hospital, Serang Regency, 2024

		B	S.E.	Wald	Sig.	Exp (B)
Step 1[a]	*Flexibility Exercise*	1.389	.629	4.877	.027	4.012
	Occupation	1.088	.879	1.534	.216	2.968
	Duration of Haemodialysis	.006	.900	.000	.995	1.006
	Constant	-3.367	1.178	8.166	.004	.034
Step 2[a]	*Flexibility Exercise*	1.390	.618	5.065	.024	4.015
	Occupation	1.092	.635	2.951	.086	2.979
	Constant	-3.366	1.158	8.455	.004	.035

Table 6 presents the logistic regression results analyzing factors associated with systolic blood pressure reduction. Flexibility exercise was found to be a significant predictor, with patients in the intervention group being four times more likely to experience a reduction in systolic blood pressure compared to the control group. Although occupation and duration of hemodialysis were also included in the model, their effects were not statistically significant. Gender and education were excluded from the final model due to a lack of significance. Multivariate logistic regression analysis was conducted to examine the factors influencing systolic blood pressure reduction among hemodialysis patients at 'X' Hospital in Serang Regency. The independent variables analyzed included flexibility exercise, gender, education, occupation, and duration of hemodialysis. A stepwise logistic regression method was used to identify the most significant predictors, focusing on the contribution of each factor to changes in systolic blood pressure. Flexibility exercise emerged as a significant predictor, with patients who participated in the program being four times more likely to experience a reduction in systolic blood pressure compared to those who did not.

DISCUSSION

This study identified several interrelated physical and psychological factors contributing to the high levels of fatigue experienced by hemodialysis patients in both the intervention and control groups. Malnutrition exacerbated patients' physical conditions, which were already compromised by the accumulation of uremic toxins and anemia caused by impaired kidney function, reducing overall energy capacity. Additionally, repeated dialysis result in physical discomfort and anxiety due to the prolonged and repetitive nature of treatment (Simanjuntak et al., 2024). Depression is also a common psychological condition among hemodialysis patients. Interventions such as logotherapy have been shown to help patients find meaning and alleviate psychological distress (Handayani, 2023). Santoso et al. (2022) found that low hemoglobin levels, toxin buildup, and chronic sleep disturbances were linked to moderate to severe fatigue in approximately 70% of patients undergoing hemodialysis. Furthermore, comorbid conditions like diabetes and hypertension were associated with higher levels of fatigue. Fatigue perception also varies by gender. Lerma et al. (2021) reported that male patients generally experienced and reported lower fatigue levels than females. This difference may be due to physiological and psychosocial factors, including hormonal variations, coping mechanisms, and gender differences in expressing physical exhaustion. The study also highlighted the greater psychological burden experienced by female patients, which may intensify the subjective experience of fatigue. Mata et al. (2021) further emphasized that gender disparities in kidney failure outcomes extend beyond symptoms like fatigue. Their binational cohort study found that women with kidney failure had higher excess mortality rates despite demonstrating healthier behaviors, suggesting a need for gender-sensitive approaches in nephrology and rehabilitation planning.

Following the flexibility exercise intervention, the intervention group predominantly experienced mild fatigue, while the control group continued to report severe fatigue. According to Sulistini et al. (2012), significant differences exist in fatigue levels between patients with low physical activity and those who engage in routine exercise. O'Sullivan and McCarthy (2009) found that exercise during dialysis sessions improves muscle blood flow and reduces the transport of metabolic waste into the dialyzer, thereby improving patient outcomes. Exercise also strengthens muscles, enhances agility, and reduces fatigue (Sakitri et al., 2017). Wahyuni, Djamaludin, and Chrisanto (2020) demonstrated that physical exercise significantly reduces fatigue in patients with chronic kidney disease undergoing hemodialysis. These findings support the use of structured physical activity as a non-pharmacological intervention to improve patients' physical and emotional well-being.

Bansal et al. (2023) emphasized the clinical importance of managing systolic hypertension due to its strong link with cardiac complications. Therefore, systolic hypertension should be the primary focus in blood pressure management for patients undergoing hemodialysis. A study by Defibriola et al. (2023) found that 27 patients (52.9%) experienced severe systolic hypertension, while research by Berlin et al. (2019) reported that 37 patients (50%) had severe systolic hypertension during dialysis procedures. Proper hypertension management in patients with kidney failure is crucial to prevent further complications. Although no consensus exists on the ideal blood pressure target for dialysis patients, many recommendations align with general population standards.

According to Whelton et al. (2017), individuals can reduce high blood pressure by engaging in at least 150 minutes of exercise per week. This is supported by Fancourt, Steptoe, and Cadar (2021), who reported that regular physical activity significantly decreases both systolic and diastolic blood pressure, while also lowering cardiovascular risk. In this study, flexibility exercises were more effective than no intervention in reducing fatigue among hemodialysis patients. These findings are supported by Sriulina et al. (2024) who found that pranayama yoga therapy and educational programs significantly lowered fatigue scores. Similarly, Handayani (2023) confirmed that flexibility exercises reduce chronic fatigue, underscoring their value in dialysis care. In contrast, the control group in this study showed only minimal improvement in fatigue levels, consistent with findings by Cohen et al. (2021), who noted that patients without targeted interventions reported less improvement. This highlights that structured interventions, like flexibility exercise, are a crucial component in managing fatigue among hemodialysis patients.

Manfredini et al. (2021) conducted a multicenter randomized clinical trial showing that structured intradialytic exercise programs significantly reduced fatigue and improved physical performance in patients undergoing long-term hemodialysis. These findings highlight the clinical importance of integrating low-intensity physical activity into routine dialysis care to support better treatment outcomes. Similarly, Wahida et al. (2022), through a systematic review and meta-analysis, found that intradialytic exercise effectively alleviated fatigue symptoms in patients with chronic kidney disease, further supporting its role as a beneficial adjunct to standard care. In addition, Song et al. (2023) confirmed that intradialytic exercise not only improves physical function and reduces fatigue but also enhances overall quality of life. Taken together, these studies strengthen the evidence base for incorporating structured exercise programs as a routine component of hemodialysis management.

The statistical test results indicated no significant difference in systolic blood pressure within the control group, as no meaningful change was observed. In contrast, the intervention group experienced a measurable reduction in systolic blood pressure following the flexibility exercise intervention. Blood pressure in hemodialysis patients is typically assessed before, during, and after dialysis, with systolic readings commonly varying by approximately ±10 mmHg relative to intradialytic measurements (Ulya et al., 2020). According to Whelton et al. (2017), engaging in at least 150 minutes of physical activity per week can help reduce elevated blood pressure to within the normal range. Flexibility exercises, as a form of light physical activity, can contribute to blood pressure regulation. Systolic blood pressure, which reflects the force exerted by the heart when pumping blood throughout the body, tends to be more responsive to physiological changes than diastolic pressure, which occurs when the heart is at rest between beats. Stern et al. (2014) found that regular physical exercise reduces peripheral vascular resistance and arterial stiffness—two key factors in the pathophysiology of hypertension among dialysis patients. These findings support the role of structured physical activity in managing blood pressure and lowering cardiovascular risk in this population.

Suparti and Nurjanah (2018) reported that psychosocial support-based interventions can enhance the quality of life and alleviate fatigue symptoms commonly experienced by patients undergoing hemodialysis. Among the various non-pharmacological strategies to improve patient well-being, flexibility exercise has been recognized as a beneficial approach (Roy, 1984). In addition, Lerma et al. (2021) observed gender-based differences in the perception and experience of fatigue, with male patients generally reporting lower fatigue levels. This difference may be attributed to variations in how individuals of different genders cope with and respond to health-related stressors. Meanwhile, Rohimah (2020) found no significant association between age and fatigue score reduction in patients with chronic kidney disease receiving hemodialysis. The progression of the disease itself appears to be independent of age; instead, variations in anxiety levels across age groups may influence fatigue perception.

Hemodialysis patients with a basic level of education demonstrated a more substantial reduction in fatigue scores. Individuals with lower educational attainment may be more inclined to accept health interventions without skepticism or critical questioning, potentially enhancing adherence and outcomes. This observation is consistent with the findings of Sriulina et al. (2024), who reported a significant association between education level and fatigue reduction. Furthermore, employment status was also significantly related to fatigue outcomes, with employed patients experiencing greater reductions in fatigue. This supports the results of Taneo et al. (2024), who emphasized that engaging in work-related activities may enhance patients' motivation and provide a sense of purpose, thereby helping them manage fatigue more effectively. In addition, patients who had been undergoing hemodialysis for less than five years showed more pronounced fatigue reduction compared to those with longer treatment histories. Duration of therapy appears to be a critical factor, as supported by Simanjuntak et al. (2024), who found that prolonged hemodialysis contributes to elevated anxiety levels, which may in turn exacerbate fatigue, with a significance level of 0.026. Similarly, Lockridge Jr. et al. (2020) reported that patients who are newly initiated into hemodialysis tend to be more responsive to interventions, possibly due to their higher adaptability and motivation in the early phases of treatment.

Research by Ren et al. (2022) demonstrated that educational interventions combined with lifestyle management can significantly improve health outcomes among hemodialysis patients. Engagement in work-related activities was also found to contribute positively to health maintenance, particularly in supporting blood pressure regulation. Effective blood pressure control is essential, as it reduces the risk of cardiovascular complications and contributes to a better quality of life. These findings are reinforced by studies conducted by Bull et al. (2020) and Fancourt et al. (2021), both of which underscore the role of physical activity in maintaining optimal blood pressure levels. Moreover, a significant association was identified between systolic blood pressure reduction and the duration of hemodialysis. Patients who had recently commenced hemodialysis treatment (i.e., less than five years) experienced a more substantial decrease in systolic blood pressure compared to those with longer treatment durations. These findings suggest that patients in the early phase of dialysis may be more receptive to adopting healthier behaviors, including participation in physical exercise. This pattern aligns with the observations of Lockridge Jr. et al. (2020), who reported that newly initiated hemodialysis patients tend to respond more positively to treatment interventions and display greater motivation in managing their condition.

Patients who participated in the flexibility exercise intervention were found to be four times more likely to experience a reduction in systolic blood pressure compared to those in the control group. This finding is in line with the study by Schoenthaler et al. (2020), which reported that hemodialysis patients who received educational interventions combined with individualized antihypertensive therapy achieved greater blood pressure control than those who underwent standard treatment alone. However, statistical analysis indicated that flexibility exercise, along with gender, age, education level, occupation, and duration of hemodialysis, did not have a significant effect on diastolic blood pressure reduction. These findings suggest that the intervention, while beneficial for systolic blood pressure, may not yet exert a measurable influence on diastolic pressure within the duration of this study. Clinically, this observation is consistent with the work of Henrique et al. (2023), who emphasized that interventions involving health education or lifestyle modifications typically require extended implementation to yield significant changes in blood pressure, particularly among patients with complex chronic conditions such as those receiving hemodialysis.

CONCLUSION

The demographic profile of hemodialysis patients in both the intervention and control groups revealed that the majority had a basic education level, were in the pre-elderly age category, and were female. In the intervention group, most patients were employed and had been undergoing hemodialysis for less than five years, while in the control group, the majority were unemployed and had been on hemodialysis for five years or more. Severe fatigue was prevalent in both groups at baseline, with 85.7% in the intervention group and 92.9% in the control group reporting high fatigue levels.

Statistical analysis showed a significant association between fatigue reduction and several variables: participation in flexibility exercise ($p = 0.016$), gender ($p = 0.020$), education level ($p = 0.046$), employment status ($p = 0.001$), and duration of hemodialysis ($p = 0.001$). After adjusting for gender, patients who had undergone hemodialysis for less than five years were 9.954 times more likely to experience a reduction in fatigue than those with longer treatment duration. Furthermore, a significant association was found between the reduction in systolic blood pressure and flexibility exercise ($p = 0.003$), employment status ($p = 0.010$), and duration of hemodialysis ($p = 0.035$). After controlling for employment status, patients who received the flexibility exercise intervention were four times more likely to experience a reduction in systolic blood pressure compared to those in the control group.

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