Effect of Intradialytic Exercise on Fatigue, Psychological Distress, and Biochemical Findings among Hemodialysis Children

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Abstract

Background: End-stage renal disease is becoming important to public health in developing world. Hemodialysis is a kidney function replacement therapy that removes certain toxins or metabolic waste from the bloodstream. Patients on hemodialysis for chronic renal failure encounter a variety of issues, including psychological distress, fatigue, and biochemical disturbances. **The aim of the study** was to assess the effect of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children. **Research design**: A quasi-experimental design was used to conduct the study (study and control group pre/ posttest) was used to achieve the purpose of the study. **Data were collected** using the following tools (1) Pediatric quality of life inventory–multidimensional fatigue scale (PedsQL-MFS) (2) Depression Anxiety and stress scale (DASS-21) (3) Biochemical values developed by the researchers including blood samples for creatinine, blood urea nitrogen (BUN), sodium, calcium, potassium and phosphorus. **The study was conducted at** pediatric hemodialysis unit in Menofia University Hospital at Shebin El-Koom City, Egypt. **The results** revealed that there were highly statistically significant differences in children's fatigue before intervention, after four and eight weeks of intervention compared with the control group. Also, there was a highly significant difference in the total mean score of anxiety, depression, and stress after four and eight weeks of intervention between the study and control groups. Moreover, there was improvement in the mean score of blood urea nitrogen (BUN), calcium and phosphor in the study group after 4 and 8 weeks of intervention compared to before intervention. **Conclusion**: the study concluded that intradialytic exercise had a positive effect on fatigue, psychological distress, and biochemical findings among hemodialysis children. **Recommendation**: Intradialytic exercise should become a fundamental part of the total management of all patients undergoing hemodialysis.

Keywords: biochemical findings, fatigue, hemodialysis children, intradialytic exercise, psychological distress.

Introduction

End-stage renal disease (ESRD) is a major health problem in the developing countries (**Elshahat et al., 2020**). Renal replacement treatment is necessary to treat chronic kidney disease because it results in the progressive, irreversible damage of the nephrons in both kidneys, which accumulates toxins and fluids and causes fluid and electrolyte imbalances. Hemodialysis is the most popular and commonly utilized renal replacement therapy **(Paluchamy and Vaidyanathan, 2018).**

Additionally, the majority of evidence points to the increased risk of low exercise tolerance and decreased muscle strength for pediatric dialysis patients, which can have a substantial impact on their quality of life in terms of their health **(Ghafourifard et al., 2021).** Numerous researchs have shown that children with chronic renal failure have low results on exercise tolerance tests, like functional capacity tests or the peak oxygen uptake test **(Patti et al., 2021).**

Also, numerous studies illustrated that most of the patients on dialysis suffer from fatigue. A study conducted by **Parker Gregg et al., (2021)** displayed that approximately 70% of patients with CKD report fatigue, with up to 25% reporting severe symptoms. It's important to assess and manage fatigue to enhance outcome of patients receiving dialysis. Fatigue usually not identified and thus not treated **(Pu et al., 2019).**Fundamentally, fatigue was characterized as a state of weakness, loss of energy, and exhaustion. Additionally, fatigue has an impact on quality of life, emotional well-being, and everyday self-care tasks. The degree of fatigue and the level of activity are positively correlated. The person's strength decreased due to decreased activity, which increased fatigue and depression **(Albadr et al., 2020).**

Studies have also shown a connection between exercise training and improvements in aerobic capacity, haemoglobin concentration, and hematocrit levels. Additionally, the decrease in pulse pressure caused by exercise training reduces the requirement for anti-hypertensive drugs and relieves fatigue. Moreover, it aids in urea clearance improvement, which enhances toxin elimination through dialysis **(Paluchamy and Vaidyanathan, 2018).** Additionally, hemodialysis has a negative effect on the patient's psychological outcomes, which may be a factor in the patient's inactivity. Patients receiving hemodialysis experience severe and persistent depressions more frequently than the general population **(Al-Jabi et al., 2018).**

Hemodialysis patients frequently experience anxiety, emotional issues, and emotive coping mechanisms **(Zamanian et al., 2018).** Patients who suffer from depression and anxiety disorders are roughly engage in physical activity, which can be modified by the impact of physical activity interventions performed while receiving dialysis **(Ferrari et al., 2020).** There is some evidence that intradialytic exercise therapy is useful in improving patients' poor physical function. Although this research has certain limitations, some meta-analyses have shown that intradialytic exercise interventions can improve exercise tolerance, muscle strength, and quality of life. **(Matsuzawa et al., 2017;Salhab et al., 2019).**

Additionally, it has been revealed that intradialytic exercise rises the flexibility of muscle tissue by enhancing physiological processes such as skeletal muscle regeneration, myogenesis, and myostatin activity regulation. **(Spakova et al., 2020).** So, Patients taking hemodialysis were recommended to be involved in exercise program according to a renal rehabilitation guideline established in 2019 **(Yamagata et al., 2019).**

Intradialytic exercise is recommended to patients to stimulate their physical activity **(Fang et al., 2020).** Previous research has showed that intradialytic exercise is effective in decreasing the level of fatigue, elevating exercise tolerance , enhancing the sleep quality, improving quality of life, biochemical results, and psychological wellbeing **(Arazi et al., 2022).** Intradialytic exercise can improve the effectiveness of dialysis, lowering inflammation, enhancing nutrition and bone mineral density **(Pu et al., 2019).** So, the aim of this study was to investigate the effect of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children.

Significance of the study

International researchs explore the great benefits of exercise for children undergoing hemodialysis. Exercise causes the autonomic nervous system and blood vessels to dilate. By exposing more tissue and expanding the working muscle's vascular beds, intradialytic exercise improves urea clearance by allowing tissue fluid to move to the intravascular partition. During exercise, ions like phosphate and potassium are moved from the intracellular partition to the muscle interstitial fluid **(Palar & Lobo, 2022).** In Egypt, although all children undergoing hemodialysis complaining from fatigue, depression and biochemical changes, limited researches were done to relieve their complaining. Therefore, this study is done to determine the effect of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children.

Aim of the study

To evaluate the effectiveness of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children.

Subject and methods

Research Hypothesis

- Children who practice exercise during hemodialysis session will have lower mean scores in depression, anxiety and stress after the intervention than children who receive only routine hemodialysis session.
- Children who practice exercise during hemodialysis session will have lower fatigue level after the intervention than children who receive routine hemodialysis session only.
- Children who practice exercise during hemodialysis session will have better level of chemistry after the intervention than children who receive routine hemodialysis session only.

Research design: A quasi-experimental design (Study & control)

A quasi-experimental design was used to conduct the study two groups (study and control group pre/ posttest) were used to achieve the study purpose.

Study group: They practiced exercises for two months, three times a week, during the first two hours of hemodialysis sessions.

Control group: They only received scheduled hemodialysis sessions.

Research setting

This study was conducted in pediatric hemodialysis unit at Menoufia University Hospital at Shebin El-Koom City. The hemodialysis unit was located at the fourth floor of University Hospital beside the pediatric intensive care unit. There were 13 hemodialysis machines, 3 machines for positive hepatitis C patients and the others for negative cases. The positive cases machines were located at the right side of entrance door and the negative cases machines were located at the left side (5 machines). There were other 5 machines located in the front of the door. Children received dialysis sessions from 8.30am to 12.30pm or from 1pm to 5pm. There was one nurse in charge for one or maximum two patients. Only one nurse was responsible by rotation for hepatitis positive cases.

Research Subject

A Purposive sample of fifty children with chronic renal disease on hemodialysis was enrolled from the previously mentioned setting for a period of 6 months from the beginning of November 2020 to the end of April, 2021. The children were divided into study and control groups using a simple random sample.

Sample size:

Sample size was calculated at power 80%, confidence level 95%, and margin of error 5% accordingly by using the following equation:

$$n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$$

z for a 95% confidence level is 1.96. **p̂** for the population proportion is 0.05. **ε** for the margin of error is 0.05.

$$n = \frac{1.96^2 x 0.05(1-0.05)}{0.06^2} = 50.69\ children$$

Thus, a sample size of 50 hemodialysis children would be necessary for conducting the study.

The Inclusion criteria were: Age ranged from 6 to 18 years, being medically stable, being under hemodialysis for more than 2 months and receiving hemodialysis 3 times per week for 3 hours

The exclusion criteria were patients who have a cardiovascular problem, uncontrolled hypertension & diabetes mellitus, musculoskeletal problem, problems in arterio-venous fistula, and any psychological problem

Tools of the Study

Three tools were utilized for data collection

Tool (1): Pediatric quality of life inventory–multidimensional fatigue scale (PedsQL-MFS). It consisted of two parts as the followings

Part 1: **Socio-demographic data.** It was designed by the researchers to obtain socio-demographic data of age, gender and education level

Part 2: Pediatric quality of life inventory–multidimensional fatigue scale (PedsQL-MFS): The PedsQL-MFS is a Likert scale consisting of 18 items describing symptoms of fatigue. It was developed by Varni, et al., (2004). It contained three subscales assessing a child's sleep/rest fatigue (six items), cognitive fatigue (six items) and general fatigue (six items). Each item is rated on a 5-point scale from 0 "almost never" to 4 "almost always". The internal consistency reliability for the total scale score $\alpha = 0.88$. In addition, the internal consistency reliability for the subscale scores are sleep/rest fatigue $\alpha = 0.73$ (acceptable), cognitive fatigue $\alpha = 0.87$ (good) and general $\alpha = 0.81$ (good) (Smout, 2022).

Tool (2): Depression Anxiety and Stress Scale (DASS-21). It was developed by Lovibond & Lovibond., (1995). It is a likert scale contained of three subscales designed to measure the negative emotional states of depression, anxiety and stress. Each subscale contained of seven items. **The total score of DASS-21 is the summation of** each seven items with a minimum of 0 and maximum of 21. The Internal consistency reliability for each of the subscales is high (depression α=.97, anxiety α=.92, stress α=.95) were acceptable for group comparisons (Patrick et al., 2010).

Tool (3): Biochemical values, it was developed by the researchers based on literature review. Blood samples for creatinine, BUN, sodium, calcium, potassium and phosphorus were taken and the results were compared at the end of each month after dialysis.

Validity of the tools

The validity of the study tools had to be confirmed by a jury of five experts in pediatric and mental health nursing.

Ethical Considerations

Written informed consent was taken from the children and their parents. Patient rights are protected by assuring research participants that their participation in the study is harmless and voluntary, and that they have the right to withdraw at any time and without any rationale. To protect each subject's privacy and anonymity, all data was encoded.

Pilot Study

After the instruments were designed and before the data collection began, a pilot study was conducted on 10% of the total sample (5 children) to assess the tools' applicability, practicability, consistency, clarity, and feasibility as well as to estimate how long it would take to fill the tools.

Procedure

- The official permission to conduct the study was obtained from the directors of the chosen setting. The goal of the study, the methods used to acquire the data, and the anticipated results were all communicated to the director.
- After explaining the study's goals and methodology to the parents and their children a written consent was obtained from them.
- Data was obtained from the selected groups about the socio- demographic data, fatigue level, psychological distress and biochemical findings before the intervention then after one and two months of the intervention.
- Collection of study subject and application of the intradialytic exercise began from a beginning of November 2020 to the end of April 2021.The data in the current study was collected through three phases: assessment

phase, implementation phase and evaluation phase

1. **Assessment phase:** the socio-demographic data, fatigue level, psychological distress and biochemical findings for all children were assessed before the intervention.

2**. Implementation phase for the study group:**

- Once the patient was connected to the machine and all alarms were off, the exercise session was begun within the first two hours of beginning dialysis. Exercises for flexibility, range of motion, resistance, and relaxation were performed three times a week for 20 minutes during the first month, and then three times a week for 30 minutes during the second month.

- At the start of each exercise session, deep breathing exercises were done five times. The instructions to the patients were to inhale deeply through their noses, hold it for a while, and then softly exhale.

- After that, the flexibility exercises started, where the child gently stretched their muscles until light tension was felt on the muscles for 10 seconds. This exercise was repeated five times.

- Following the flexibility exercises, the patient performed the range of motion exercise alone. This exercise involves moving the arm that hasn't had a shunt's shoulder up and down and side to side, followed by flexion and extension of the elbow and the wrist from up to down and from side to side with rotating motion in clockwise and counter-clockwise. After that, flexion and extension of knee joints and movement of ankle joints from up to down direction from side to side with rotating motion clockwise and counterclockwise.

- After that, the resistance exercise was performed with the assistance of the researchers, in which they instructed the patient to pull and push the researcher's hand with the wrist and ankle.

- The relaxation exercises were done at the end of each session. The patients were told to sit quietly, close their eyes, and take five deep breaths.

- In order to prevent the needle from becoming disconnected, the body parts that were connected to the dialysis machine were not administered exercise; instead, the other body parts carried out the exercise. Additionally, the patients were told to discontinue exercise and notify the researchers if they experienced fatigue, a headache, palpitations, nausea, dizziness, or any other negative side effects. At least once while exercising; the vital signs were checked, and as necessary for individuals who exhibited hemodynamic instability. If the patient was unstable, the exercise was stopped

- **For the control group:** They only received scheduled hemodialysis sessions.

Reassessment phase: After one and two months of the intervention, the level of fatigue, psychological distress level, and biochemical data were reassessed and compared between the two groups.

Statistical Analysis

- Data was entered and analyzed by using SPSS (Statistical Package for Social Science) statistical package version 23. Graphics were done using Excel program.
- Quantitative data were expressed as mean & standard deviation (X ±SD) and analyzed by using paired sample t-test for comparison between two means pre and post intervention. while ANOVA test was used for comparison between more than two means

- Qualitative data were presented in the form of frequency distribution tables, number and percentage (No. & %). It was analyzed by chi-square (χ^2) test. Level of significance was set as P value <0.05 for all significant tests.

Results

Table (1) shows that, mean age of studied children in the study and control groups were (11.28 ±2.84& 12.04 ±3.29) respectively. Regarding gender of studied children, 72.0% and 56.0% of studied children were male in the study and control groups. In relation to educational level, 64.0% and 52.0% of studied children had Primary educational level in the study and control groups respectively.

Table 2: Illustrates that there were no significant differences between the study and control groups regarding the total mean score of depression, anxiety, and stress before intervention (p= .856), while there was a significant difference in the total mean score of depression, anxiety, and stress after 4 and 8 weeks of intervention (p= .000) between the study and control groups .

Table 3 & figure (1): Illustrates that there were no significant differences between the study and control groups regarding the total fatigue score before intervention (P = 0.849), while there was a significant difference in total fatigue score after 4 and 8 weeks of intervention (P = 0.001) between the study and control groups.

Table 4: Illustrates that there was improvement in the mean score of BUN, calcium and phosphor in the study group after 4 weeks and 8 weeks of intervention than on pre intervention, there was a significant difference in the total chemical values after 4 and 8 weeks of intervention (p= .001) between the study and control groups.

Table 5. Shows that there was a positive correlation between total score of fatigue and total score of anxiety, depression and stress for the study group, there was a highly statistical significance difference (P <.001) compared with control group (P>0.05).

Table (1): Socio-demographic Characteristics of the studied children.

Socio-demographic Characteristics	Study group (n=25)		Control group (n=25)	
	No	%	No	%
Age ***Mean*** ± SD	11.28 ±2.84		12.04 ±3.29	
Age				
6-12	13	52.0%	11	44.0%
12-18	12	48.0%	14	56.0%
Gender				
Male	18	72.0%	14	56.0%
Female	7	28.0%	11	44.0%
Educational level				
Primary	16	64.0%	13	52.0%
Preparatory	6	24.0%	7	28.0%
Secondary	3	12.0%	5	20.0%

Table (2): Comparison of the Depression, Anxiety and stress scores between the study and the control groups on pre intervention, after 4 and after 8 weeks of intervention.

Variables	Pre intervention X ± SD	After 4 weeks X ± SD	After 8 weeks X ± SD	*Anova test*	P -value
Anxiety score					
Study group	8.94 ±2.98	6.88 ±2.30	6.54 ±2.47	12.414	.000
Control group	9.12 ±3.03	7.92 ±2.59	7.92 ±2.27	1.686	.192
Independent t test	-.423	-3.206	-4.924		
p-value	.674	.002	.000		
Depression score					
Study group	9.66 ±3.04	8.32 ±3.13	7.48 ±2.98	6.483	.002
Control group	9.48 ±3.07	9.44 ±3.33	10.68 ±2.81	1.311	.276
Independent t test	.415	-2.683	-4.789		
p-value	.680	.010	.000		
Stress score					
Study group	13.74 ±3.30	12.12 ±3.17	9.72 ± 2.87	21.012	.000
Control group	13.56 ±3.58	13.36 ±3.12	12.00 ±3.45	1.548	.220
Independent t test	.382	-2.977	-4.789		
p-value	.704	.005	.000		
Total DAS score					
Study group	32.52± 7.94	24.00±5.61	19.88±4.34	28.58	.000
Control group	32.16 ± 6.20	30.64 ±5.97	27.60 ±4.50	4.276	.018
Independent t test	.183	-4.046	-6.166		
p-value	.856	.000	.000		

NB: *ns = not significant (p>.05),*= significant (p≤.05),** = highly significant (p≤.01), very highly significant ***P<0.001.*

Table (3): Comparison of the fatigue dimensions' scores between the study and the control groups on pre intervention, after 4 weeks of intervention and after 8 weeks of intervention.

Fatigue dimensions	Pre intervention X ± SD	After 4 weeks X ± SD	After 8 weeks X ± SD	*Anova test*	P -value
General fatigue					
Study group	12.58 ±3.26	10.30 ±2.90	9.70 ±3.27	4.015	.015
Control group	12.60 ±3.16	13.23 ±2.85	13.64 ±2.87	1.024	.364
Independent t test	-.043	-3.643	-5.167		
p-value	.966	.001	.000		
Cognitive fatigue					
Study group	10.68 ±2.35	8.880 ±3.19	8.60 ±3.01	7.688	.001
Control group	10.72 ±2.45	10.92 ±2.10	10.64 ±2.03	.107	.899
Independent t test	-.119	-5.857	-6.479		
p-value	.906	.000	.000		
Sleep and rest fatigue					
Study group	10.24 ±2.55	9.06 ±2.69	9.66 ±2.75	3.578	.030
Control group	10.35 ±2.88	10.32 ± 2.60	11.76± 1.61	1.525	.250
Independent t test	-.329	-3.706	-8.325		
p-value	.743	.001	.000		
Total score of fatigue					
Study group	33.32 ±6.77	25.60 ±6.52	23.88 ±5.73	15.646	.000
Control group	33.68 ±6.50	34.88 ±6.22	36.04 ±3.78	1.095	.340
Independent t test	-.192	-5.147	-8.854		
p-value	.849	.000	.000		

NB:*ns = not significant (p>.05) ,*= significant (p≤.05), ** = highly significant (p≤.01), very highly significant ***P<0.001*

Figure (1): Comparison of mean fatigue at different times between the study and control groups.

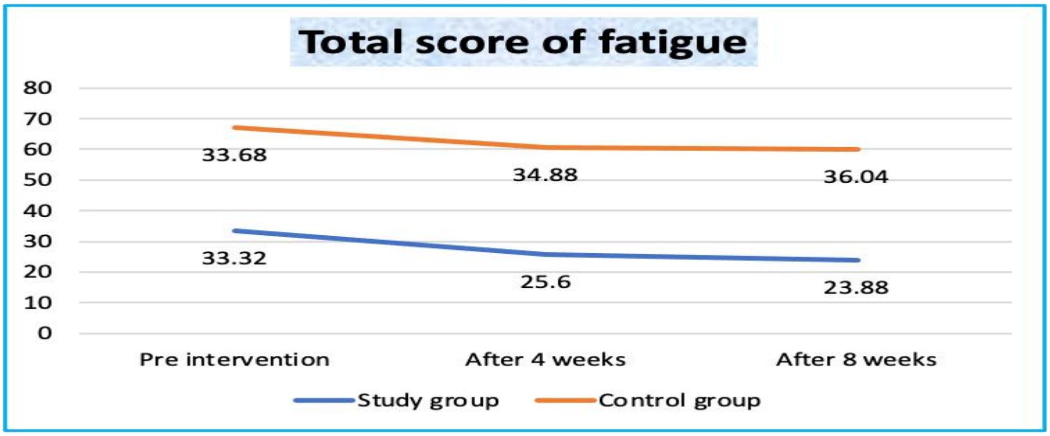

Table (4): Comparison of the chemical values between the study and the control groups on pre intervention, after 4 weeks and after 8 weeks.

Variables	Pre intervention X ± SD	After 4 weeks X ± SD	After 8 weeks X ± SD	*Anova test*	P -value
Creatinine					
Study group	7.40 ±2.87	7.39 ±2.75	7.02 ±2.57	.316	.729
Control group	7.09 ±3.04	7.18 ±2.95	7.41 ±2.78	.081	.922
Independent t test	.756	.542	-1.085		
p-value	.453	.590	.283		
BUN					
Study group	66.24 ±11.68	63.24 ±12.37	58.66 ±12.40	3.830	.033
Control group	66.84 ±11.48	65.84 ±11.85	66.00 ±11.33	.054	.947
Independent t test	-.360	-1.504	-2.618		
p-value	.721	.139	.012		
Sodium					
Study group	142.38 ±3.38	142.28 ±3.27	142.54 ±2.92	.084	.919
Control group	143.04 ±3.11	143.00 ±3.07	143.16 ±3.01	.018	.982
Independent t test	-1.391	-1.580	-1.520		
p-value	.171	.121	.135		
Potassium					
Study group	4.82 ±0.36	4.85 ±0.34	4.91 ±0.39	.728	.485
Control group	4.79 ±0.29	4.88 ±0.30	4.95 ±0.35	1.619	.205
Independent t test	.623	-.597	-.759		
p-value	.536	.553	.452		
Calcium					
Study group	7.48 ±0.79	6.91 ±0.75	6.02 ±0.78	6.649	.002
Control group	7.56 ± 0.72	7.17 ±0.63	7.52 ±0.62	2.692	.075
Independent t test	-.741	-2.552	-3.159		
p-value	.462	.014	.003		
Phosphor					
Study group	6.61 ±1.03	6.35 ±1.11	6.03 ±1.13	3.578	.030
Control group	6.67 ±1.05	6.87 ±1.07	6.59 ±1.15	.446	.642
Independent t test	-.339	-3.723	-3.559		
p-value	.736	.001	.001		

NB:*ns = not significant (p >.05) ,*= significant (p≤.05), ** = highly significant (p≤.01), very highly significant ***P<0.001*

Table (5): Pearson correlation between Total score of fatigue and Total score of anxiety depression and stress for the study and control groups.

Variables	Total score of fatigue			
	Study group		Control group	
	R	p. value	r	p. value
Total score of anxiety depression and stress	.417	.000	-.022	.855

Discussion

Children with renal failure frequently view hemodialysis periods as time taken from their lives filled with hopelessness and emptiness, which results in a negative emotional and cognitive view of the world **(Burrai et al 2019).** Additionally, depression and anxiety are prevalent mental health problems in such children and are linked to needle utilization, persistent pain, difficulty sleeping, ongoing inflammation, increased tiredness, and the need for three time hospital stays for therapy. Therefore, an alternative, cost-effective intervention should be used to counteract the children's negative views of hemodialysis and improve their standard of living **(Saraiva et al 2018).** Therefore, the current study aimed to evaluate effect of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children.

According to the current study, the mean ages of the children who participated in the study and control groups, respectively, were (11.28 ±2.84 & 12.04 ±3.29). It is confirmed that children's adoption of an unhealthy lifestyle and delaying treatment for any prior comorbidity that affected the integrity of the renal system during their age, such as frequent post-streptococcal glomerulonephritis, may be responsible for the development of chronic kidney diseases at this age. This result was in line with a research by **Gheissari (2012),** which found that children receiving hemodialysis were an average age was 11.01± 0.39 years. According to the current study's findings on the gender of the children who were studied, 72.0 percent of the study group and 56.0 percent of the control group's children were male, this is approved with fact that females less susceptible to suffer from chronic renal failure and exposure to dialysis than males **(Guzel, 2019).** This finding was supported by **Mahmoud Farrag et al., (2022)** investigate the effect of Non-pharmacological Strategies to Mitigate pain and anxiety among Children on Dialysis. They found that sixty percent and sixty-two percent of children were boys in the control and intervention group respectively.

Regarding hypothesis 1: Children who practice exercise during hemodialysis session will have lower mean scores in depression, anxiety and stress after the intervention than children who receive only routine hemodialysis session.

According to the current study, there was a highly significant difference between the study and control groups' total mean scores for anxiety, depression, and stress after 4 and 8 weeks of intervention. The total mean score for anxiety in the study group was 8.94 ±2.98 pre-intervention and continued to decrease after 4 weeks (6.88 ±2.30) and 8 weeks (6.54 ±2.47) post-intervention. Additionally, there was a significant difference in the anxiety mean score between the study and control groups after the fourth and eighth weeks of the intervention (P=.002 and P=.000, respectively).

This result was reinforced by **Mahmoud Farrag et al., (2022)** who examined the effect of "Non-pharmacological Strategies to Mitigate Pain and Anxiety among Children on Dialysis". They found that after receiving non-pharmacological strategies, the children in the intervention group had lower total mean scores of anxiety levels than the children in the control group. Also, **Dawood et al., (2021)** their result revealed that, guided visualization application resulted in a reduction in mean score of pain anxiety during arteriovenous fistula cannulation among the studied children where these techniques application are divert the child's attention away from the stressful stimuli. Moreover, **Bukola and Paula 2017** mentioned that distraction techniques are the most effective nonpharmacological interventions for mitigating the pain and anxiety experienced by children undergoing needle-related procedures.

The current study's findings regarding the effects of the intradialytic exercise on depression showed that the study group's total mean score of depression was 9.66 3.04 pre-intervention and continuously decreased after the 4th and 8th weeks (8.32 ±3.13 and 7.48 ±2.98, respectively) post-intervention. Additionally, there was a significant difference in the mean depression score between the study and control groups after the fourth and eighth weeks of the intervention (P=.010 and P=.000, respectively). This could be due to the fact that teaching the participants to perform various exercises such as flexibility, range of motion, resistance, and relaxation exercises helps them break the cycle of unpleasant thinking that motivates depression and anxiety by releasing feel-good endorphins, natural cannabis-like brain chemicals (endogenous cannabinoids), and other natural brain chemicals that improve their sense of well-being. This result was consistent with **Shimoda, et al., (2017)** who found that exercise training significantly reduced depressive symptoms in hemodialysis patients. They also found that aerobic exercise and interventions lasting ≥ 6 months significantly reduced depressive symptoms in hemodialysis patients. Also, **Rezaei, et al., (2015) studied** "Effect of Regular Exercise Program on Depression in Hemodialysis Patients". They found that while there were no initial differences between the case and control groups in terms of depression rates, there was a significant difference (P = 0.016) following the intervention, the mean and SD of depression in case group were 23.8 ± 9.29 at the start of the study and reduced to 11.07 ± 12.64 at the end. Contradicted to this result **Amirkhani et al. (2021)** studied "The Effect of Resilience Training on Stress, Anxiety, Depression, and Quality of Life of Hemodialysis Patients". They found that the intervention did not have a significant effect on the patients' depression. This might be as a result of variations in the population studied's age, the study's sample size, and its length.

Concerning to the effect of the intradialytic exercise on stress, the current study revealed that total mean score of stress in the study group was (13.74 ±3.30) pre-intervention and continuously decreased after the 4th week (12.12 ±3.17) and 8th week (9.72 ± 2.87) post-intervention. Also, stress score significantly decreased in the study group compared with the control group and continuously decrease after the 4th week and the 8th week (P < 0.001). The child coming to the dialysis is not able to predict the body's response to the treatment on a given day or what will happen to him. As a reaction to unknown stresses, this creates anxiety and apprehension.

In terms of the intradialytic exercise's effect on stress, the current study found that the study group's total mean stress score was (13.74 ±3.30) prior to the intervention and continuously decreased after the fourth week (12.12 ±3.17) and eighth week (9.72 ±2.87) after the intervention. A significant difference between the study group and the control group's stress levels was also decreased, and this difference persisted after the fourth and eighth weeks (P 0.001). When a teenager first starts dialysis, he or she has no idea how his or her body will react to the treatment that day or what will happen to him. This causes apprehension and anxiety as a response to unidentified stresses.

In order to engage and motivate the children, as well as communicate with them and encourage them to share their feelings, the researchers also educate the children how to exercise correctly during dialectical therapy, which reduces their stress levels. The improvement in post-intervention results observed in this study was consistent with **Amirkhani et al. (2021)** found that the patients' mean score of stress before and after the intervention was 22.68 ± 3.43 and 15.58 ± 4.67, respectively in the intervention group; indicated that resilience training significantly reduces stress (P < 0.001) in hemodialysis patients. Also, this finding was in harmony with the result of **Lestari, (2020)** found that, the intradialytic exercise had a significant effect on stress level in hemodialysis patients. The researchers indicated that, after being given the intervention of intradialytic exercise, the study participants showed a decrease in the score of stress as compared with control group.

Furthermore, **Kang and Chae, (2021)** revealed that, hemodialysis patient who engaged in visual, auditory, olfactory, tactile stimulation and motor exercise experience low physiological stress levels compared with those in the control group.

Concerning hypothesis 2: Children who practice exercise during hemodialysis session will have lower fatigue level after the intervention than children who receive routine hemodialysis session only.

The existing study revealed that the mean total score of fatigue in the study group was (33.32 ±6.77) at the beginning, and it continued to decrease after the 4th (25.60 ±6.52) and 8th weeks (23.88 ±5.73) following the intervention. As a result, there were highly statistically significant differences in Children's fatigue before intervention, after four weeks, and after eight weeks compared with the control group (P = 0.001). This might be as a result of the parasympathetic nervous system being activated during hemodialysis sessions, which releases noradrenaline and slows the heart rate, increases lung expansion, and relaxes the muscles. By increasing oxygen intake and removing extra carbon dioxide, deep breathing also enhances the body's capacity to produce energy and lessens fatigue. The children's desire and motivation to fight fatigue as well as instructions given during follow-up calls to practice light exercise for short periods at first and gradually increase depending on the children's tolerance are likely to be responsible for the continuous improvements. It is important to note that children should stop exercising if they experience exhaustion, headache, palpitations, nausea, dizziness, or any other negative effect. This result was consistent with a study by Mohamed et al., published in 2021, which examined the effects of reflexology massage on fatigue in school-aged children receiving hemodialysis. They discovered a statistically significant decrease in the level of fatigue among study participants following intervention as compared to pre-intervention. When examining the impact of deep breathing exercise training on fatigue level among maintenance hemodialysis patients, **Hamed and Abdel Aziz (2020)** discovered a statistically significant difference in fatigue score before and after deep breathing exercise in the intervention group (P <.01) compared to (p= 0.083) in the control group. Additionally, after four weeks of performing the exercise, the mean score was significantly decreased to (26.25±5.47) in the intervention group compared to (61.40±11.06) in the control group. Furthermore, Soliman (2015); investigated the effect of intradialytic exercise on fatigue, electrolytes level and blood pressure in hemodialysis patients. The result revealed that there was a significant variation in fatigue score pre and post eight week of the exercise program within the experimental group, as well as between experimental and control group where p <.05 that was as a result of range of motion exercises for 8 week.

In relation to hypothesis 3: Children who practice exercise during hemodialysis session will have better level of chemistry after the intervention than children who receive routine hemodialysis session only.

The current study discovered that the study group's mean BUN, calcium, and phosphor scores were improved after four and eight weeks of intervention compared to pre-intervention. This may be related to the effect of intradialytic exercise, which exposes more tissue and opens vascular beds in the working muscle, may be responsible for this. This enables fluid from the tissue to flow to the intravascular compartment and phosphate ions to move from the intracellular compartment to the muscle interstitial fluid. Additionally, it activates the parasympathetic nervous system, which stimulates the release of endorphins, slows down heartbeat, and expands the lungs. The clearance of toxins and metabolic wastes is accelerated as a result of the enhanced metabolism, and more energy is generated. This result was supported by **Adorati, (2000)** who proved that exercise helps dialysis patients feel better overall by decreasing urea rebound, increasing creatinine clearance, and, most crucially, increasing phosphate removal. Also, according to **Paluchamy and Vaidyanathan (2018),** in comparison to the control group, the intervention group's calcium, serum creatinine, blood urea, serum potassium, phosphorous, and quality of life were all improved by the prescribed intradialytic exercise intervention. Moreover, the current result was consistent with **Mohseni et al, (2013)** who reflected that thirty-eight percent improvement in Kt/V following eight weeks of intradialytic exercise program.

The current study found that, for the study group in comparison to the control group, there was a highly statistically significant positive correlation between the overall score of fatigue and the total scores of anxiety, depression, and stress (p=.000). This showed that the total scores of anxiety, depression, and stress would increase as the total score of fatigue increased. This could be attributed to fatigue brought on by the burden of the illness, which includes frequent clinic and hospital appointments, dietary restrictions, and monitoring of blood sugar, blood pressure, and weight. This comes on top of the challenges associated with dialysis, like needing to visit the clinic three times per week for hemodialysis. This limits children' daily activities, like playing with other children, which makes them feel lonely, anxious, and depressed. This result was congruent with **Al Naamani, et al., (2021)**, in their study of "Fatigue, Anxiety, Depression, and Sleep Quality in Individuals Undergoing Hemodialysis" they found that patients who reported feeling fatigued were 7.9 times more likely to experience anxiety. Also **Chen, et al., (2010); Bossola, et al. (2013)**; **Artom, et al., (2014), Wang, et al.,(2015), Bossola , et al., (2015), and Farragheret al.,(2017)** showed that there were significant correlations between fatigue and anxiety and depression. In contrast, **Letchmi, et al.,(2011)** found that there was no a significant relationship between fatigue and depression, as well as fatigue and anxiety. This discrepancy can result from the study's use of a different population and measurement method.

Conclusion

The study concluded that intradialytic exercise improved children receiving hemodialysis in terms of fatigue, psychological distress, and biochemical results. Additionally, compared to the control group, there were highly statistically significant differences in the level of fatigue in children before, after four weeks, and after eight weeks of intervention. Moreover, there was a highly significant difference between the study and control groups' overall mean scores for stress, anxiety, and depression following four and eight weeks of intervention. Furthermore, the study group's mean scores for blood urea nitrogen, calcium, and phosphorus improved over time, particularly after 4 and 8 weeks of intervention.

Recommendations

1- A similar study should be replicated using larger sample size from different geographical areas to further investigate the effects of intradialytic exercise on fatigue, psychological distress, and biochemical findings among hemodialysis children.

2- Intradialytic exercise should become an essential component of all patients' overall care while receiving hemodialysis.

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