Impact of Pedaling Exercise on Blood Pressure among Patients with chronic Kidney Disease Maintained on Hemodialysis

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Abstract

Background: Chronic kidney disease (CKD) is a chronic decrease in kidney function that causes permanent and advanced kidney tissue impairment. Blood pressure is a major factor that could cause death up to 20 times among patients with CKD undergoing hemodialysis. **Aim**: To evaluate the impact of pedaling exercise on blood pressure among patients with chronic kidney disease maintained on hemodialysis. **Research design**: Quasi-experimental one group pre-post design was used. **Study Setting**: This study was conducted in hemodialysis unit at kafrelsheikh University Hospital. **Study sample:** A convenience sample of 54 patients with CKD Maintained on Hemodialysis three times / week. **Tools**: One tool for data collection was used in this study divided into three parts as follow: part (I) structured interview questionnaire, part (II) included medical data, comorbidities and exercise regimen and part (III) included blood pressure measurement follow up sheet. **Results**: the results showed significant decrease in in blood pressure measurements among the studied group. one way ANOVA test showed a statistical difference between total blood pressure mean scores in relation to time of intervention (preintervention, one week post postintervention , six weeks and 12 weeks later) as Mean ±SD = (138.7±10.9, 132.7 ±10.8 , 123.2 ±10.9, &112.5 ±11.3) and (F= 53.344&p= <0.001) in systolic blood pressure respectively and Mean ±SD = (90.3 ±6.9, 84.5 ±6.5, 80.1 ±5.3 &75.7 ±4.5) and (F= 56.698&p=<0.001) in diastolic blood pressure consequently. **Conclusion**: pedaling exercise can lower blood pressure among patients with CKD undergoing hemodialysis therapy. **Recommendations:** Nurses educate patients to use save nonpharmacological measures as pedaling exercise to decrease blood pressure among patients with CKD on hemodialysis.

Keywords: Chronic kidney disease, Hemodialysis, Pedaling.

Introduction:

Globally, chronic kidney disease (CKD) has been recognized as a primary public health problem and could finally lead to end-stage renal disease **(Thurlow, et al 2022)**. End stage renal disease is the last stage of chronic kidney disease that may be caused by essential hypertension. This occurs when the kidneys can no longer able to sustain the body`s needs. it is also called end stage kidney disease **(Chen, Knicely, & Grams, 2021 & Renal Association,2017).** The prevalence of CKD had been appraised by 13.4% (11.7-15.1%), and patients with end-stage kidney disease (ESKD) requiring renal replacement therapy such as dialysis and / or renal transplantation, this ratio included between 4.902 and 7.083 million patients (**Lv & Zhang, 2019**). Evidences revealed that ESKD has a dramatic increasing rate of occurrence with burden on health and health care system, and both ESKD and CKD has high morbidity and mortality rate all over the globe **(Al-Aly, & Bowe, 2020 and Thurlow, et al 2022**).

ESKD is the point of irreversible deterioration of renal function. beyond it, life cannot be maintained without replacement therapy in the form of peritoneal dialysis, hemodialysis or kidney transplantation. **(World Kidney Day, 2020)**. ESRD occurs when the glomerular filtration rate (GFR) exceeds 15% of the normal GFR rate. Kidney histology include a decrease in renal capillaries and glomerulus scarring. Intestinal fibrosis and tubular atrophy are also present with gradual reduction in the kidney mass **(**Ji **et al., 2020).**

Worldwide, chronic kidney disease (CKD) signifies a great problem, about 10 % of the population suffered from CKD with one million death per year. Two million patient received renal replacement therapy in the form of dialysis or transplantation represent a large economic burden for the countries as well for the families, for example in the United States of America the treatment cost exceeds 48

billion dollars per year which represents about 6.8 % of the total budget of the Medicare **(Amouzegar et al., 2021).**

High blood pressure and diabetes are considered the most communal causes of CKD and consequent ESRD. These circumstances could negatively affect the kidneys. ESRD almost always comes after chronic kidney disease. The kidneys may slowly stop working during a period of 10 to 20 years before end-stage disease results (**Agustin, et al., 2022**). Causes of ESRD in Egypt includes diabetes, hypertension, adult polycystic kidney disease and glomerulonephritis. According to 9th Annual Report of The Egyptian Renal Registry provided by Egyptian Society of Nephrology and Transplantation (ESNT), prevalence of ESRD in Egypt raised to 483 patients per million **(Hassaballa, et al., 2022**).

The nephrons in the kidneys are supplied with a group of blood vessels, and high volumes of blood stream through these blood vessels cause uncontrolled hypertension which lead to narrowing, deterioration or coarseness of the arteries that supply the kidney causing decrease in blood supply to kidney, results in kidney failure and CKD **(American Heart Association, 2022)**

Hemodialysis (HD) is one type of renal replacement therapy used in the treatment ESRD to replaces kidney function. HD filters waste, removes extra fluid and balances electrolytes such as sodium, potassium, bicarbonate, chloride, calcium, magnesium and phosphate (**Benjamin & Lappin, 2023).** HD is used when kidney function goes below 10% to 15% and are no longer able to filter the blood and make urine. This causes toxins to build up in the body along with excess fluid. Hemodialysis performed by the patient could maintain survival while changing the patient's lifestyle **(Bucharles, Wallbach, Moraes & Pecoits-Filho, 2019).**

Hypertension and chronic renal failure are closely related. Hypertension could be a cause of renal failure and conversely, kidney disease can cause hypertension through sodium and fluid retention mechanisms (**Minnis, & Cronkleton, 2019**). Research proved that exercise during hemodialysis is important for blood pressure change, this exercise includes aerobic exercise, and pedaling, in this study we will evaluate the effect of pedaling exercise on blood pressure changes among such group of patients.

American heart association says that pedaling on an exercise bike could help bring down high blood pressure and unhealthy cholesterol levels **(Murdeshwar, & Anjum, 2022)**. Therefore, the healthcare professional team such as doctors and nurses should develops continuous care management and interventions such as exercise program (pedaling for 10-15 minutes during dialysis session) which may help in improving patients' overall health especially cardiovascular related health issues such as blood pressure. This approach is the focus of current research.

Significance of the Study

More than 500,000 people in the United States live with end-stage renal disease (ESRD). The development of chronic kidney disease (CKD) and its progression to this terminal disease remains a significant cause of reduced quality of life and premature mortality **(Hashmi, Benjamin, & Lappin, 2023)**.

Blood pressure is a major factor that could cause death up to 20 times in CKD patients undergoing hemodialysis therapy and its management remains a major challenge. According to 9th Annual Report of The Egyptian Renal Registry provided by Egyptian Society of Nephrology and Transplantation (ESNT), prevalence of ESRD in Egypt raised to 483 patients per million. Mean age is about 49.8 ± 19 years. Males represented 55.2 % while females were about 44.8 % **(Egyptian Renal Data System, 2020).** In addition, the revision of the medical record and statistical data of Kafrelsheikh University Hospital revealed that the number of patients with CKD who are planned to be treated with hemodialysis based on accessibility of the dialysis machines and after referral to other hospitals are 87 patients (2022).

Elevated blood pressure is common and poorly controlled among patients with CKD maintained on dialysis **(Bucharles et al., 2019).** When Blood pressure (BP) and volume control as a life-threatening components of dialysis care are not controlled and /or treated, patients' symptoms such as cardiovascular

system related symptoms and quality of life will be negatively affected. Hemodialysis is a serious procedure, patients receiving hemodialysis are at increased risk of developing blood infection because bacteria invade the body and spread through the blood, causing numerous organ failure **(Nguyen, Arduino, & Patel 2019)**.

Patients with CKD and on hemodialysis are at increased risk for rapid deterioration **(Spahn, et al, 2019 & Lin, et al., 2020).** As mentioned before, the global estimated prevalence of CKD is 13.4% (11.7-15.1%), and patients with end-stage kidney disease (ESKD) needing renal replacement therapy is estimated between 4.902 and 7.083 million in Egypt. Hypertension (blood pressure > 140/90 mm Hg) is very common among patients undergoing regular dialysis, with a prevalence of 70-80%, and only the minority has adequate blood pressure (BP) control. It needs to be treated and /or controlled with pharmacological and /or nonpharmacological approaches such as pedaling exercise **(Cockwell & Fisher, 2020).**

Therefore, the finding of this study may evaluate the effect of pedaling exercise on blood pressure among patients with chronic kidney disease maintained on hemodialysis. There were not enough nursing researches that studied the effect of pedaling exercise during dialysis. In addition, **(Jhingan, 2017)** reported that several studies could not confirm the positive effects of intradialytic exercise on blood pressure. The current study results may have a positive effect on patients' health status, through decreasing blood pressure, Furthermore, data derived from this study may provide a base for other qualitative and quantitative studies in such field.

Operational definition

Pedaling exercise

In the current study, pedaling exercise means that patients practice pedaling /cycling exercise for ≥ 10-15 minutes during hemodialysis session, three times/week.

Aim of the Study:

The aim of this study was to evaluate the impact of pedaling exercise on blood pressure among patients with chronic kidney disease maintained on hemodialysis, through comparing blood pressure measurements before pedaling exercise and (one week, six weeks and 12 weeks after practicing pedaling exercise consequently)

Study Hypothesis

H1: Among patients with chronic kidney disease, maintained on hemodialysis, patients who will practice pedaling exercise for ≥10-15 minutes will have lowered blood pressure in posttest and follow up compared with pretest.

H2: There will be a significant difference in blood pressure mean scores among patients with chronic kidney disease, maintained on hemodialysis after practicing pedaling exercise for ≥ 10-15 minutes.

Research Design: quasi-experimental research design (one group pre and posttest) was used to conduct this study.

Study Setting: The study was conducted in hemodialysis unit at kafrelsheikh university hospital. The unit consisted of fifteen bed and fifteen dialysis machines divided into thirteen for any patient undergoing hemodialysis and two machines specialized for patients with positive hepatis C virus (HCV).

Study Subjects

A convenience sample of 54 patients with chronic kidney disease and undergoing hemodialysis were included according to the following inclusion criteria; adult patients, age 20-60 years old, male or female, and able to communicate, are on a stable hemodialysis regimen (approximately 4 hours, 3 times/week). Patients with comorbidities such as asthma and decompensated heart disease as well as any physical or psychological disability that would impact study participation, uncontrolled hypertension (pre-dialysis blood pressure >180/100 mmHg), and lower-limb amputees were excluded from the study.

Sample size calculation:

Based on data from pilot study, considering level of significance of 5%, and power of study of 80%, the sample size can be calculated using the following formula:

$$n = \frac{(Z\alpha/2 + Z\beta)^2 \times 2(SD)^2}{d^2}$$

where, SD = standard deviation obtained from previous study; Zα/2, for 5% this is 1.96; Zβ, for 80% this is 0.84 and d, for the expected difference. Therefore, n = $\frac{(1.96+0.84)^2 \times 2(5.2)^2}{(2.81)^2}$ =53.7. Based on the above formula, the sample size required is 54.

Methodology:

Tool of the Study

Tool (I): Structured Interview Questionnaire

It was developed by the researcher after reviewing the recent relevant literatures, it consisted of two parts:

Part (1): **Patients` demographic data** such as age, sex, occupation, level of education, income, marital status, residence data and smoking habit…etc.

Part (2): **Patients` Medical Data** which included: pedaling exercise performance checklist; time, duration and frequency of practicing exercise.

Part (3): **Systolic and diastolic blood pressure measurements sheet** (before intervention and one week, six weeks and twelve weeks after intervention respectively).

Validity and Reliability

Relevancy, clarity, comprehensiveness, and applicability of the tool was checked by Panel of five professions and experts of the specialty of medical- surgical nursing and nephrology in the faculty of nursing and medicine at kafrelsheikh university. According to their opinions, no modifications were done. Reliability was done by Cronbach alpha test (0.88).

Ethical Considerations

Ethical approval was obtained from the Scientific Ethical Committee of faculty of medicine, kafrelsheikh University with approval code (50-9-13). The purpose of the study was explained to the patients and informed consent was obtained from them to participate in this study. All participants informed that they have the opportunity to withdraw from the study without given a reason at any time. Anonymity was assured, and confidentiality of information was protected through coding system. Ethics, values, culture, and beliefs were respected.

Pilot study

A pilot study was conducted on 6 patients with the same inclusion criteria to ensure the feasibility of the study and the study tool for data collection, also to estimate time needed to fill in the study tool as well as to examine issues related to the research design. Based on feedback taken from the pilot study there were no modifications needed for the study tool. Patients participated in the pilot study were included in the total study sample.

Procedure

The study was conducted on four phases as the following: assessment, planning, implementation, and evaluation phase**.**

Assessment phase: It involved collecting data through reviewing the literature regarding the disease process and its treatment (hemodialysis). After receiving the formal approval from Research Ethical Committee at Faculty of Medicine, Kafreelsheikh University to conduct this study, Each Patient was approached individually for half an hour by the researcher to explain the purpose, nature of the study, benefits of adherence to intervention (pedaling exercise) and all the previous mentioned ethical considerations. Each patient was asked to sign the consent form, then; the researcher was conducting structural interview with each patient to fill in the research tool. An official permission was taken from the dialysis unit at kafreelsheikh University Hospital and hospital administrators to conduct this study tool for, checking its feasibility to the aim of the study, also, to test the accessibility of the sample was assessed.

Planning phase; based on the outcome of the assessment phase, final decision about time needed and frequency of patients' interview was developed, also, the researcher develop schedule to collect data including day, time, and duration according to patients identified needed during the assessment phase.

Implementation phase: this phase was started from September 2022 to August 2023. Each patient with the predetermined inclusion

and exclusion criteria. The researcher visited the dialysis unit 3 days weekly from 9:00 am to 1:00 pm. During hemodialysis therapy, the researcher began by introducing herself to every patient, welcoming, making them to feel secure.

The researcher teaches patients to practice pedaling exercise for ≥10- 15 minutes every dialysis session (3 –times/week) for a period of 3 months. The researcher explained the exercise to patients to start with sitting on the pedaling machine in comfortable position, catching the hand of pedaling machine with the head of patient in the center not high and not low, and practice pedaling with both legs for ≥ 10 to 15 minutes at the beginning of the dialysis session. The researcher advised the patient to report if he/she felt dizzy or discomfort and confirmed if that happened patient can stop the exercise. Blood pressure was assessed at baseline, one week post intervention, six weeks postintervention and follow up after twelve weeks later using the same blood pressure measuring device.

The researcher instructed the patients to perform the exercises 3 times/week at the beginning of dialysis. The researcher also provided the patients with written instructions colored pictures about pedaling exercise and how to practice and follow up them in dialysis unit

Evaluation phase: blood pressure measuring was assessed at the baseline when staring dialysis, one week post intervention, six weeks postintervention, and twelve weeks postintervention) using the same blood pressure measurement device.

Data analysis

Upon completion of data collection data was scored, tabulated, computed, and analyzed using Statistical Package for the Social Sciences (SPSS) program, version 22. Descriptive statistics including frequency distribution, percentage, means and standard deviations also correlational test such as t test were used.

Results:

Table 1 presented the demographic characteristics of the studied subjects and showed that the majority of the study subjects were male (74.1%), resided in rural areas (77.8%), and their age ranged from (41-50 years old). Regarding educational level, two thirds of the subjects (66.7%) were not able to read and write, while the others were able. In relation to employment status, the minority of the subjects were housewife and (44.4% & 35.2 %) had governmental and nongovernmental work respectively. In relation to smoking, the majority of the subjects (79.6%) were non-smokers while the minority (20.4) were smokers. NB: no patients found with age (20-30).

Table 2 showed that near to half (46.3%) of the study subjects started dialysis for one year ago, while (20.4%) started dialysis less than one year ago and one third of the subjects started from more than one year. Regarding comorbidities, the majority of the study subjects (70.4%) have been diagnosed with hypertension, while, (13.0, 3.7, 1.9, 5.5 &5.5) have been diagnosed with diabetes, systemic lupus, genetic diseases, and hyperthyroidism w respectively. In relation to pedaling practice, the majority of the subjects 87.0 % practiced ≥10-15 minutes compared to only13.0 % practiced ten minutes.

Figure 1 showed that there was a statistical difference between total systolic blood pressure mean scores in relation to time of intervention among the studied group as mean scores decreased from 138.7 to 132.7 to 123.2 to 112.5 in pre-intervention, one week post intervention, 6 weeks post intervention and 12 weeks post intervention respectively, and (F= 53.344&p=<0.001). In addition, the figure displayed that there was a statistical difference between total diastolic blood pressure mean scores in relation to time of intervention among the same group as mean scores decreased from 90.3 to 84.5 to 80.1 to75.7 in pre-intervention, one week post intervention, 6 weeks post intervention and 12 weeks post intervention respectively, and (F=56.698&p= 0.001).one-way ANOVA Test was used to answer the research hypothesis through testing the change in blood pressure mean scores over the time of intervention between the same group.

Table 3 showed that showed that there was statistical significance between blood pressure and some variables such as educational level, practicing exercise, duration of exercise and smoking as (T=6.120, P<0.001, T=4.224,

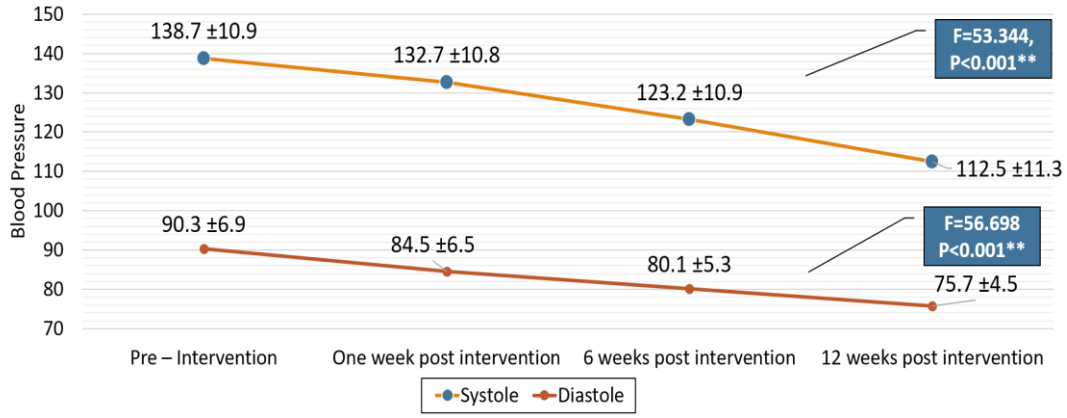
P<0.001, T=3.266, P=0.002 & T=2.475, P=0.016) and (T=6.901, P<0.001, T=3.995, P<0.001, T=3.133, P=0.003, &T=2.449, P=0.017) in systolic and diastolic blood pressure respectively. On the other hand, the table showed that there was no statistical significance between blood pressure and age, gender, residence and employment status.

Table (1): Number and distribution of the general characteristics of the study sample (N=54)

	N	%
Age (Years)		
31 – 40	11	20.3
41 – 50	36	66.7
51 – 60	7	13
Mean ±SD	43.6 ±5.7	
Gender		
Male	40	74.1
Female	14	25.9
Residence		
Rural	42	77.8
Urban	12	22.2
Educational Level		
Can not read and write	36	66.7
Can read and write	18	33.3
Employment Status		
Governmental work	24	44.4
Non-governmental work	19	35.2
Housewife	11	20.4
Smoking Status		
Yes	11	20.4
No	43	79.6

Table (2): Distribution of the medical history among the studied group (N=54).

	N	%
Time of starting dialysis		
One year ago	25	46.3
More than one year	18	33.3
Less than one year	11	20.4
Comorbidities with CKF		
Hypertension	38	70.4
Diabetes mellitus	7	13.0
Systemic lupus	2	3.7
Genetic diseases	1	1.9
Hepatitis C virus	3	5.5
Hyperthyroidism	3	5.5
Duration of practicing pedaling		
10 minutes	7	13.0
≥10-15 minutes	47	87.0



*significant <0.05

Figure (1): Comparison between blood pressure mean scores in relation to time of intervention (pre-intervention, one week post intervention, 6 weeks post intervention and 12 weeks post intervention).

Table (3): Association between the general characteristics of the study sample and blood pressure (N=54).

	Systolic BP Mean ±SD	Diastolic BP Mean ±SD
Age (Years)		
31 – 40	109.3 ±11.0	75.4 ±5.6
41 – 50	114.0 ±11.7	75.9 ±4.5
51 – 60	113.1 ±10.8	75.6 ±3.6
One-way ANOVA	F=0.809, P=0.451	F=0.044, P=0.957
Gender		
Male	112.8 ±11.2	76.1 ±4.4
Female	111.7 ±11.9	74.4 ±4.8
Student's T – Test	T=0.308, P=0.759	T=1.219, P=0.228
Residence		
Rural	112.2 ±11.6	76.1 ±4.4
Urban	112.8 ±11.2	75.3 ±4.6
Student's T – Test	T=0.167, P=0.868	T=0.595, P=0.555
Educational Level		
Can not read &write	102.6 ±10.9	80.4 ±4.5
Can read & write	102.5 ±11.6	71.3 ±4.6
Student's T – Test	T=6.120, P<0.001**	T=6.901, P<0.001**
Employment Status		
Governmental work	112.4 ±11.6	76.3 ±4.4
Non-governmental work	112.1 ±11.7	75.6 ±4.8
Housewife	113.5 ±10.8	74.6 ±4.4
One-way ANOVA	F=0.050, P=0.951	F=0.483, P=0.620
Practice Exercise		
Yes	105.4 ±7.2	72.6 ±4.7
No	117.9 ±11.9	79.2 ±3.4
Student's T – Test	T=4.224, P<0.001**	T=3.995, P<0.001**
Exercise Duration		
10 minutes	118.1 ±7.0	78.5 ±3.4
≥10-15 minutes	103.2 ±11.7	72.7 ±4.7
Student's T – Test	T=3.266, P=0.002*	T=3.133, P=0.003*
Smoking Status		
Yes	117.7 ±13.1	77.5 ±4.1
No	108.2 ±10.9	73.7 ±4.7

Student's T – Test	T=2.475, P=0.016*	T=2.449, P=0.017*

Discussion:

A sample of 54 patients with CKD maintained on hemodialysis was utilized in the current study. Regarding the demographic characteristics, this study results indicated that; the majority of the studied subjects were male, resided in rural areas, cannot read, and write, their age ranged between (41-50) years old. This result is in the same line with the results of study done by **(Agustin, et al, 2022)** whom studied" effect of intradialytic exercise on changes in blood pressure in chronic kidney failure patients during hemodialysis therapy" and reported that the largest number of respondents were male and not able to read and write.

Regarding comorbidities, our study mentioned the majority of the study subjects have been diagnosed with hypertension, while, (13.0, 3.7, 1.9, 5. &5.5) percent have been diagnosed with diabetes, systemic lupus, genetic diseases, and hyperthyroidism respectively, The study is supported by the study finding done by **(Mousa et al., 2021)** who studied "Prevalence and Associated Factors of Chronic Kidney Disease among Relatives of Hemodialysis Patients in Saudi Arabia" and reported that the majority of their study subjects had history of hypertension followed by diabetes and other diseases.

Additionally, regarding the relation between educational level and blood pressure measurement, our study showed that there was statistical significance between blood pressure and educational level. This result is supported by the study finding done by **(Sun et al., 2022)** whom studied "Association of education levels with the risk of hypertension and hypertension control: a nationwide cohort study in Chinese adults and reported in their conclusion that the risk of death among patients with hypertension on hemodialysis is greater than patients with lower level of education than highly educated patients.

On investigating the relation between pedaling exercise and blood pressure, the current study showed that there was a statistical difference between total blood pressure mean scores in relation to time of intervention (preintervention, one week post intervention, six weeks postintervention & twelve weeks later).The study is supported by the finding of study done by **(Jhingan, 2017)** Who studied "Effect of Cycling on Glycaemia, Blood Pressure, and Weight in Young Individuals with Type 2 Diabetes" and mentioned in the conclusion that regular aerobic exercise (cycling) had significant reduction in HbA1c, BP and weight in post intervention periods compared to baseline.

This finding is also congruent with the results of study done by (**Elshinnawy, Mohamed, Farrag, & Abd-Elgawad, &2021)** who studied "Effect of intradialytic exercise on bone profile in hemodialysis patients" and reported in their conclusion that pedaling exercise had appositive effect on decreasing blood pressure measurement among patients with CKD undergoing hemodialysis. However, several studies could not confirm the positive effects of intradialytic exercise on blood pressure **(Jhingan, 2017).**

This finding is also congruent with results of study done by (**Ashby et al., 2019**) who studied "Renal Association Clinical Practice Guideline on Hemodialysis" and reported that pedaling exercise decrease blood pressure among hemodialysis patients. In addition, our study results are matched with the study finding done by **(Andrade et al., 2019**) who studied " Effects of intradialytic exercise on cardiopulmonary capacity in chronic kidney disease: systematic review and meta-analysis of randomized clinical trials" and reported in their conclusion that pedaling exercise had positive effect on blood pressure among CKD patients undergoing hemodialysis.

Conclusion

This study concluded that; pedaling exercise for ≥10 -15 minutes at the beginning of every dialysis session can lower blood pressure among CKD patients undergoing hemodialysis therapy.

Recommendations

Based on the current study findings, the following recommendations are formulated:

- Nursing role as an educator should be continuing to teach patients with CKD undergoing hemodialysis about pedaling

exercise as non-pharmacological approach and its impact on reducing blood pressure.

- Replication of the study on a larger probability sample selected from different geographical areas is recommended to obtain more generalizable data.
- Further studies should be applied to evaluate the impact of pedaling exercise on blood pressure among patients with chronic kidney disease maintained on hemodialysis.

References:

Agustin, W. R., Safitri, W., Kurniasari, D., Setiyawan, S., Murharyati, A., & Fitriana, R. N. (2022). Intradialytic Exercise on Changes in Blood Pressure in Chronic Kidney Failure Patients during Hemodialysis Therapy. *Open Access Macedonian Journal of Medical Sciences*, *10*(G), 1–5. https:// doi. org/ 10. 3889/ oamjms.2022.7271

Al-Aly, Z., & Bowe, B. (2020). Air Pollution and Kidney Disease. *Clinical Journal of the American Society of Nephrology*, *15*(3), 301–303. https://doi.org/10.2215/cjn.16031219

American Heart Association. (2022). *How high blood pressure can lead to kidney damage or failure*. Www.heart.org. https:// www. heart. org/ en/ health- topics/ high- blood-pressure/ health- threats- from- high- blood-pressure/ how- high- blood- pressure- can- lead- to-kidney- damage- or- failure

Amouzegar, A., Abu-Alfa, A. K., Alrukhaimi, M. N., Bello, A. K., Ghnaimat, M. A., Johnson, D. W., Jha, V., Harris, D. C. H., Levin, A., Tonelli, M., Lunney, M., Saad, S., Khan, M., Zaidi, D., Osman, M. A., Ye, F., Okpechi, I. G., & Ossareh, S. (2021). International Society of Nephrology Global Kidney Health Atlas: structures, organization, and services for the management of kidney failure in the Middle East. *Kidney International Supplements*, *11*(2), e47–e56. https://doi. org/ 10. 1016/j.kisu.2021.01.002

Andrade, F. P., Rezende, P. de S., Ferreira, T. de S., Borba, G. C., Müller, A. M., & Rovedder, P. M. E. (2019). Effects of intradialytic exercise on cardiopulmonary capacity in chronic kidney disease: systematic review and meta-analysis of randomized clinical trials. *Scientific Reports*, *9*(1). https:// doi. org/ 10. 1038/ s41598- 019-54953-x

Ashby, D., Borman, N., Burton, J., Corbett, R., Davenport, A., Farrington, K., Flowers, K., Fotheringham, J., Andrea Fox, R. N., Franklin, G., Gardiner, C., Martin Gerrish, R. N., Greenwood, S., Hothi, D., Khares, A., Koufaki, P., Levy, J., Lindley, E., Macdonald, J., & Mafrici, B. (2019). Renal Association Clinical Practice Guideline on Haemodialysis. *BMC Nephrology*, *20*(1). https:// doi.org/10.1186/s12882-019-1527-3

Benjamin, O., & Lappin, S. L. (2023, February 19). *End-Stage Renal Disease*. National library of medicine PubMed; Nih.gov; StatPearls Publishing. https:// www. ncbi. nlm. nih. gov/ books/NBK499861/

Bucharles, S. G. E., Wallbach, K. K. S., de Moraes, T. P., & Pecoits-Filho, R. (2019). Hypertension in patients on dialysis: diagnosis, mechanisms, and management. *Journal Brasileiro de Nephrology*, *41*(3), 400–411. https://doi. org/ 10. 1590/ 2175-8239-JBN-2018-0155

Chen, T. K., Knicely, D. H., & Grams, M. E. (2021). Chronic Kidney Disease Diagnosis and Management. *JAMA*, *322*(13), 1294. https://doi.org/10.1001/jama.2019.14745

Chronic Kidney Disease. (n.d.). World Kidney Day. http://www. worldkidneyday. org/ faqs/ chronic- kidney-disease/

Cockwell, P., & Fisher, L.-A. (2020). The global burden of chronic kidney disease. *The Lancet*, *395*(10225), 662–664. https:// doi. org/ 10. 1016/s0140-6736(19)32977-0

Egyptian Renal Data System (ERDS) 3rd Annual Report (2020) 3 rd Annual Report of End Stage Renal Disease in Egypt (2020). (n.d.). https://esnt-online.com/wp-content/uploads/2022/06/ERDS-2020.pdf

Elshinnawy, H. A., Mohamed, A. M. B. B., Farrag, D. A. B., & AbdElgawad, M. A. E. (2021). Effect of intradialytic exercise on bone profile in hemodialysis patients. *Egyptian Rheumatology and Rehabilitation*, *48*(1). https://doi.org/10.1186/s43166-021-00071-4

Hassabalah et al .*(2022).Egyptian Renal Data System (ERDS) 3rd Annual Report (2020). 3 rd Annual Report of End Stage Renal Disease in Egypt*. Journal of the Egyptian Society nephrology**.** volume22; issue1; p.p1-64. available at Retrieved April 25, 2023, from https://esnt-online.com/wp-content/uploads/2022/06/ERDS-2020.pdf

Jhingan, A. (2017). Effect of Cycling on Glycaemia, Blood Pressure, and Weight in

Young Individuals with Type 2 Diabetes. *JOURNAL of CLINICAL and DIAGNOSTIC RESEARCH*. https://doi.org/ 10.7860/jcdr/2017/28111.10162

Ji, C., Yin, L., Mo, Y., Lu, Z., Lu, F., Lin, Q., Liu, X., Zou, C., & Wu, Y. (2021). Rhubarb Enema Decreases Circulating Trimethylamine N-Oxide Level and Improves Renal Fibrosis Accompanied With Gut Microbiota Change in Chronic Kidney Disease Rats. *Frontiers in Pharmacology*, *12*. https://doi.org/ 10.3389/ fphar.2021.780924

Lin, Y.-L., Liou, H.-H., Wang, C.-H., Lai, Y.-H., Kuo, C.-H., Chen, S.-Y., & Hsu, B.-G. (2020). Impact of sarcopenia and its diagnostic criteria on hospitalization and mortality in chronic hemodialysis patients: A 3-year longitudinal study. *Journal of the Formosan Medical Association*, *119*(7), 1219–1229. https:// doi.org/ 10.1016/j.jfma.2019.10.020

Lv, J.-C., & Zhang, L.-X. (2019). Prevalence and Disease Burden of Chronic Kidney Disease. *Advances in Experimental Medicine and Biology*, *1165*, 3–15. https:// doi. org/10.1007/978-981-13-8871-2_1

Lv, J.-C., & Zhang, L.-X. (2019). Prevalence and Disease Burden of Chronic Kidney Disease. *Advances in Experimental Medicine and Biology*, *1165*, 3–15. https:// doi. org/10.1007/978-981-13-8871-2_1

Minnis,G., & Cronkleton, E. (2020).*Stationary Bike Workout Benefits and Exercise Plans*. Healthline. Retrieved February 14, 2020, from https://www.healthline.com/health/fitness-exercise/stationary-bike-workout#benefits

Mousa, D., Alharbi, A., Helal, I., Al-homrany, M., Alhujaili, F., Alhweish, A., Marie, M. A., & Sayyari, A. A. (2021). Prevalence and Associated Factors of Chronic Kidney Disease among Relatives of Hemodialysis Patients in Saudi Arabia. *Kidney International Reports*, *6*(3), 817–820. https://doi. org/ 10. 1016/ j.ekir.2020.12.029

Murdeshwar, H. N., & Anjum, F. (2023). *Hemodialysis*. national library of medicine. PubMed; StatPearls Publishing. https://pubmed.ncbi.nlm.nih.gov/33085443.

Nguyen ,D, Arduino, DrPH, & Patel, P.(2019). Hemodialysis-Associated Infections. Chronic Kidney Disease, Dialysis, and Transplantation. Doi: 10.1016/B978-0-323-52978-5.00025-2:P.P 389–410. Available at :https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7152337/

OPTN: Organ Procurement and Transplantation Network - OPTN. (n.d.). Optn. transplant. hrsa. gov. Retrieved June 5, 2020, from http://optn.transplant.hrsa.gov/ *Home | USRDS*. (2020). USRDS. http://www. usrds. org/ 2015/view/v2_07.aspx

Renal Association, A. and the. (2017). Conference Abstracts from 3rd joint meeting of ABCD and the Renal Association. *British Journal of Diabetes*, *17*(2), 1. https:// doi. org/ 10. 15277/ bjd.2017.135

Spahn, D. R., Bouillon, B., Cerny, V., Duranteau, J., Filipescu, D., Hunt, B. J., Komadina, R., Maegele, M., Nardi, G., Riddez, L., Samama, C.-M., Vincent, J.-L., & Rossaint, R. (2019). The European guideline on management of major bleeding and coagulopathy following trauma: fifth edition. *Critical Care*, *23*(1). https://doi.org/10.1186/s13054-019-2347-3

Sun, K., Lin, D., Li, M., Mu, Y., Zhao, J., Liu, C., Bi, Y., Chen, L., Shi, L., Li, Q., Yang, T., Wan, Q., Wu, S., Wang, G., Luo, Z., Qin, Y., Tang, X., Chen, G., Huo, Y., & Gao, Z. (2022). Association of education levels with the risk of hypertension and hypertension control: a nationwide cohort study in Chinese adults. *J Epidemiol Community Health*, *76*(5). https://doi.org/10.1136/jech-2021-217006

Thurlow, J. S., Joshi, M., Yan, G., Norris, K. C., Agodoa, L. Y., Yuan, C. M., & Nee, R. (2022). Global Epidemiology of End-Stage Kidney Disease and Disparities in Kidney Replacement Therapy. *American Journal of Nephrology*, *52*(2), 98–107. https:// doi. org/ 10. 1159/ 000514550.

World Kidney Day.(2020). *Chronic Kidney Disease*. http:// www. worldkidneyday. org/ faqs/ chronic- kidney- disease/