Effects of home-based exercise program on physical functioning of hemodialysis patients: A randomized controlled trial

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Abstract

Chronic kidney disease is one of the leading causes of death, which is often neglected due to lack of knowledge and resources. The objective of this study was to determine the effects of home-based exercise on physical functioning, quality of life and fatigue assessment for patients on hemodialysis. A randomized control trial was conducted, with participants divided into two groups. Twenty-six (26) participants were enrolled, and were assigned equally to each group. The control group received hospital-based care, and the intervention group received a home exercise program. Both groups received three sessions per week, for six weeks. Outcome measures included six-minute walk test, standing balance, 4-metre gait speed, chair stand, fatigue assessment scale and quality of life. Significant improvement in six-minute walk test, fatigue assessment scale, 4 meter gait speed, chair stand test and standing balance was noted in the intervention group as compared with control group. This study concluded that aerobic and resistance exercises are more effective in improving the functional outcomes of patients on hemodialysis as compared to routine physical therapy.

Introduction

Chronic Kidney Disease (CKD) occurs when kidneys are not able to purify blood, due to damage in kidneys over a longer period of time. This causes fluid retention in the body, which contributes to poor sleep and muscular weakness.[1] This disruption in kidney function leads to the clinical symptoms and signs of renal failure.[2] At the age of 30 years, both GFR and Renal Plasma Flow (RPF) decreases with increasing age.[3] In stages 3 to 5 there is irreversible decrease in nephrons quantity.[3,4] CKD is associated with decline in age-related renal function while there is an increase in high blood pressure, diabetic mellitus, and other disorders.[5] CKD has various levels of urgency; if it left untreated, it may cause failure of kidney, heart related disease, or even death.[6]

The burden of CKD was high in general and high-risk populations from underprivileged and middle-class countries.[7] In the United States, the rise of CKD prevalence reached a record high in the mid-2000s. The European studies on CKD burden were scrutinized, which concluded that the results had shown a high prevalence of CKD, similar to the United States.[8] The prevalence of CKD-was found to be 70% in Pakistan.[9] The evaluated prevalence of CKD, in five ethnic groups, was found to have highest prevalence among Sindhis; meanwhile, the lowest prevalence was among Baloch and Pashtuns.[10]

The typical signs and symptoms of CKD are: decreased urine output, tiredness, or shortness of breath. In late phases, subsequent changes in renal function, pruritus, anorexia, weight loss, nausea, and vomiting may occur. Deep respiration (Kussmaul breathing) due to profound metabolic acidosis may also occur in some patients.[11] Declining concentration of urine hinders the capacity to excrete excess phosphate, acid, and potassium from the urine.[12] CKD results in increase of blood pressure and also immune system related disorder.[13] Conservative treatment approaches are progressively undertaken as an appropriate treatment, for patients with CKD, who are unlikely to benefit from dialysis, or who choose non-dialysis care.[14] Most appropriate management of CKD are by reduction of cardiovascular risks, and adjustments to drug dosing.[15] CKD patients clinically are treated by injecting intravenous iron administration, which promotes oxidative damage to peripheral blood lymphocyte DNA, lipid peroxidation, and protein oxidations.[16]

Hemodialysis (HD) is a treatment to filter out wastes and balance electrolytes and water from the blood. HD also helps in controlling blood pressure and balances important minerals in blood. HD is not a complete treatment for kidney failure.[17] The physiotherapeutic exercise program during HD improves the Quality of Life (QoL) of chronic renal patients, in physical, social, environmental and psychological aspects. On a regular basis, physiotherapy intervention is provided to lower the frequency of edema and muscle cramps, and to reduce the intensity of pain.[18] In 2019, a study reported that aerobic, as well as strength training proved to have favorable short and long-term effects, on the physical performance and the functional balance in patients, on maintenance renal HD.[19] A randomized controlled trial concluded that physiotherapeutic programs (resistance and

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Informed consent: Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

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home based) can improve aerobic capacity, health related QoL, and nutritional and metabolic parameters without any adverse effects in dialysis patients.[20]

As exercise has been shown to have benefits, when used in conjunction with HD, this study formed an exercise protocol to determine its effects on the QoL in patients with CKD. The aim of this study was to determine the effects of home-based exercise therapy on physical functioning, QoL and fatigue assessment for chronic kidney disease patients on HD.

Materials and Methods

It was a single-blinded randomized controlled trial. This study followed the Consolidated Standards of Reporting Trials 2010 guidelines for reporting parallel group randomized trials and reports the required information accordingly.

After obtaining written consent, participants were randomly assigned to home-based exercise therapy group, and control group. Measures included: six-Minute Walk Test (6MWT), short physical performance battery, standing balance assessed in different positions (feet together, semi-tandem, and tandem) for 10 seconds without support, 4-meter gait speed, chair stand test, fatigue assessment scale. QoL was also evaluated by KD-QOL – 36. Each tool was assessed at the start of the study, and upon completion of study duration.

Patients were recruited from the Pakistan Institute of Medical Sciences (PIMS), Islamabad. A total of 26 patients participated in the study, and 13 patients were assigned to each group. The inclusion criteria were as follows: either gender with the range between 30–65 years; Stage 5; Kidney Failure (GFR <15) and who were on HD thrice a week and also undertaking sessions for last 3 months. Individuals who were hemodynamically stable and stable clinical and functional state for at least 4 weeks were also included. The exclusion criteria were as follows: any hospitalization within past 4 weeks (with dialysis or non-dialysis reasons), patients with acute illness or infection, recent surgery, or vascular intervention, uncontrolled hypertension, patients with difficulty walking, without a walking aid owing to orthopedic problems, patients with neurological, musculoskeletal, cardiac and pulmonary disease and physical impairment.

This study was approved by the Riphah International University Institutional Review Board. All procedures on human subjects were performed in accordance with the Helsinki declaration. All participants provided written informed consent to participate. Figure 1 depicts the Consolidated Standards of Reporting Trials study flow diagram.

Non-probability purposive sampling technique and randomization was done through sealed envelope method. Participants were randomly allocated into two groups. A session recorded list was provided to the participants by one allocated outcome assessor.

Intervention

Home based exercise therapy group

Patients in this exercise group were asked to perform unsupervised walk, thrice a week for 6 weeks. Physiotherapy exercise were taught to the caregivers, and also performed once by the participant, to ensure the proper follow up at home.

Aerobic training

The target training zone was set at 40%–60% of the peak heart rate, as determined in the baseline 6MWT. The target walking speed was kept the same, as speed two levels below the maximum speed in the 6MWT, and the patients were trained to walk at the target speed, under the supervision of the Physical therapist, for 50m or more at the baseline examination. Patients started the program at 20 minutes per session, and progressed to 30 minutes per session, with an increased pace according to the compliance of patient.

Resistance training was prescribed at 70% of one Repetition Maximum (RM). One RM is the maximum amount of weight an individual can lift once, and the target training weight was almost the same, as the weight an individual can lift or press 10 times. Patients were instructed to train a variety of upper and lower body muscle groups (*e.g.,* latissimus, deltoid, biceps, quadriceps, and gastrocnemius muscles), using Thera-band for 1 set of 10 repetitions twice a week. One RM reassessed monthly, and the program was tailored accordingly.

Control group treatment was given as per criteria of the hospital (metaxalone for muscular pain and hand grip used for fistula as well as conservative treatment). Checklist was provided to monitor their adherence to both aerobic exercise (including the duration of each walking session) and resistance training. The number of sessions performed in 6 weeks was calculated as a percentage of the total possible sessions.

Six-minute walk test

This is the sub-maximal exercise test that is used to assess the aerobic capacity as well functional capacity. The length cov-

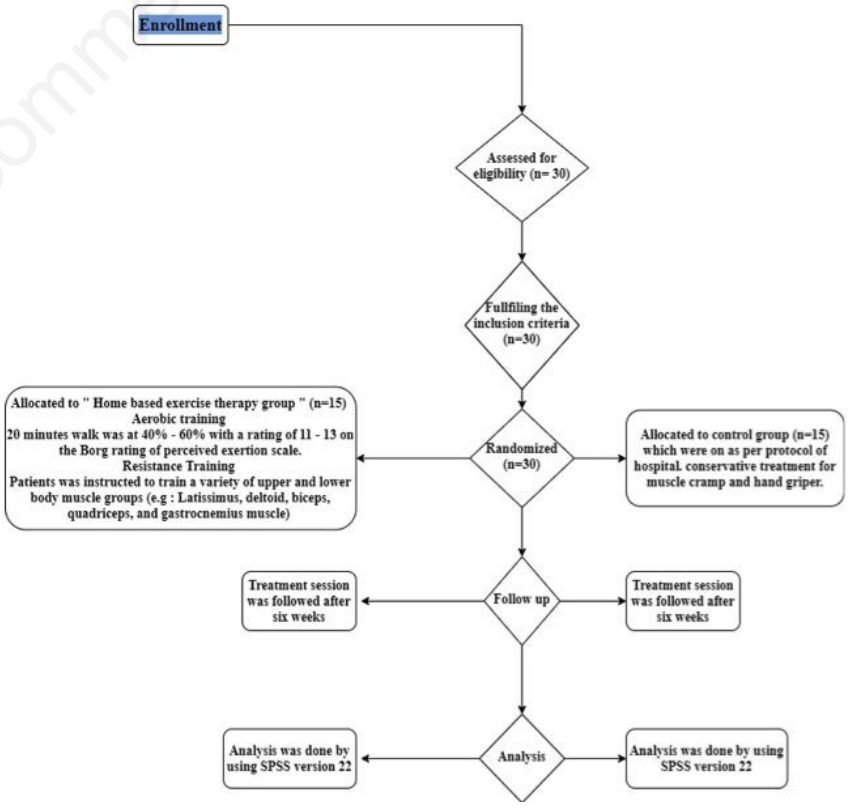

Figure 1. Consolidated standards of reporting trials study flow.

ered in 6 minutes, performed in a gallery having a distance of 20rn in length, in a straight line, is used as the outcome, by which to compare the changes in performance capacity, this is used to evaluate the physical performance of the participant which provides valuable findings in terms of all the systems during physical performance which includes pulmonary and cardiovascular systems, movement of blood, neuromuscular units, body metabolism, and peripheral circulation.[21] Zero (0) value shows absolute dependence to 100 value being independence;[22] 1 autonomous 100; 2 light dependence >60; 3 moderate dependence 55–40; 4 severe dependence 35–20; 5 depend total: <20.[23]

Short physical performance battery

This examines three subcomponents of the lower extremity's function, these are standing balance, 4-metre gait speed, and chair stand these are of essential tasks for independent living among CKD patients on HD.[24] This is an objective assessment tool which is used to measure lower extremity function. Tests will be performed by following the sequence: i) standing balance test, ii) 4-metre gait speed, and iii) chair stand test (5 repetitions).

Fatigue assessment scale

Fatigue assessing scale and its correlations can help in assessing fatigue, and in carry out of interventions to alleviate fatigue.[25] The FAS is based on 10-item, which is used to evaluate symptoms of chronic fatigue.[26] This is the self-reported questionnaire, measured by a notebook and pen, the time required to fulfill the self-assessment form is to take approximately 2 minutes.[27]

Kidney Disease Quality of Life — SF36 (KDQOL-SF 36)

The National forum of the quality conducted the QoL in adult patients with CKD for outcome.[28] This questionnaire asks about how the patient feels about his/her QoL, health, and other areas of life. The KDQOL-36 is a self-administered, and surrogates' responders will require paper- and-pencil measure, which took approximately 5 minutes.

Statistical Analyses

Data was analyzed by SPSS version 22. The normal value of variables was checked by applying Normality test. Within group analysis, Friedman test was used. From baseline to 3rd and 6th week of trial, Wilcoxon signed rank test was used. For QoL, both within and intergroup analysis was used, Wilcoxon and Mann-Whitney test.

Results

There were a total of 26 participants with CKD on HD included in the study and randomly allocated into control group and interventional group as shown in Table 1. The mean height, weight, body mass index,

Table 1. Demographic data of hemodialysis patients.

Variables	Study Group (%)	Control Group (%)
Gender		
Male	11 (73.3)	11 (73.3)
Female	4 (26.7)	4 (26.7)
Employed	13 (100)	11 (84.6)
Diabetic	5 (38.4)	4 (30.7)
Hypertensive	9 (69.2)	13 (100)
Age (Years)	46.13 ±10.57	43.60 ±11.15
Weight in Kilogram (Kg)	61.70±5.83	60.26±8.43
Height in inches (Inches)	64.60±3.62	64.00±2.75
Body Mass Index (kg/m^2)	22.05±1.18	22.27±1.85
Duration of Diagnosis (Years and months)	3.08±2.58	4.73±3.92
Duration of Hemodialysis (Years and months)	3.26±2.69	5.83±3.86
SPO_2 (mg/L)	96.26±1.94	95.66±1.49
Pulse Rate (Beats per minute)	79.53±12.76	78.33±9.33
Respiratory Rate Breaths per minute)	18.33±2.05	19.93±2.81
Systolic (mmHg)	142.20±16.87	154.40±19.08
Diastolic (mmHg)	75.86±12.76	84.66±9.34

Table 2. Results of Wilcoxon test and Friedman test of assessment tools.

Assessment	Group	Baseline Median (IQR)/Mean±S.D	Week 3 Median (IQR)/Mean±S.D	Wilcoxon/ Indepe P-value	Week 6 Median (IQR)	Wilcoxon P-value	Friedman P-value
Six minute walk test							
	1	410 (20)	400 (19)	0.460	398 (20)	0.064	0.247
	2	411 (13)	422 (8)	0.002	427 (15)	<0.001	<0.001
Fatigue assessment scale							
	1	30.20 ±60.47	27.93± 4.58	0.255	29.20± 5.63	0.564	0.386
	2	31.80 ±40.64	24.46 ±6.08	0.04	19.53 ±2.94	0.030	<0.001
Standing balance							
	1	4 (1)	4 (3)	0.655	4 (3)	0.2851	0.717
	2	4 (0)	4 (0)	1.00	4 (0)	0.180	0.273
4-metre gait speed							
	1	2 (1)	2 (1)	0.564	2 (1)	0.317	0.584
	2	2 (0)	3 (1)	0.005	3 (0)	0.001	< .001
Chair stand test							
	1	1 (0)	1(0)	0.157	1 (1)	0.564	0.472
	2	1(0)	1(1)	0.034	2 (0)	0.001	< .001

duration of diagnosis, duration of HD, oxygen saturation, pulse rate, respiratory rate, systolic, diastolic are shown in Table 1. There were 13 (100%) participants who had a history of smoking, and in study group there was only one smoker. Most of the participants were hypertensive in the control group. Wilcoxon, and Mann-Whitney U test results are highlighted in Tables 2 and 3, respectively. The values of KDQOL-SF 36 for both the groups were taken at pre- and post-treatment durations of 0 week and 6th week respectively.

The findings of inter group comparison between the subcomponent of KDQOL-SF 36 scores of two respective groups showed no significance difference in physical functioning pre, role limitation due to physical health pre, emotional wellbeing pre, social functioning pre, pain pre, general health pre, health change pre and health change post difference p=0.950, p=0.494, p=0.226, p=0.763, p=0.116, p=0.261, p=0.966 and p=0.780 respectively. These subcomponents shown significant difference in physical functioning post (p<0.001), role limitations due to physical health post and (p=0.007), role limitations due to emotional problems pre (p=0.048), role limitations due to emotional problems post (p=0.011), energy/fatigue pre (p=0.005), energy/fatigue post (p<0.001), emotional well-being post (p<0.001), social functioning post (p< 0.001), pain post (p<0.001) and general health change post (p<0.001), with the median (IQR) values physical functioning pre 25 (15), physical functioning post 25 (30), role limitation due to physical health post 75 (25), role limitation due to emotional problem post 66.7 (66.7), energy fatigue post 55 (5), emotional well-being post 80 (8), social functioning post 100 (25), pain post 80 (22.5), general health post 35 (10), of subcomponent of KDQOL SF-36 being higher for interventional group compared to control group. Furthermore, in terms of pre- and post-treatment comparison for both the groups, as all variables were not normally distributed; thus, Wilcoxon test was applied and a significant difference was observed in the interventional group (p<0.05).

Significant differences were noted in the variables measured. The home-based group demonstrated improvements in 6MWT (p<0.001), FAS (p=0.03), 4 meter gait speed (p=0.001), and chair stand test (p=0.001). Neither the control group, or the intervention group showed any improvement in standing balance (p=0.28 in the control group, and p=0.18 in the intervention group).

Discussion

This present study was performed to assess the benefits of home exercise program compared with hospital-based treatment, on the physical functioning, and the QoL in patients with CKD on HD. The results of this study showed that there were significant differences between groups in the QOL. A study was conducted to determine the effects of home-based exercise on physical functioning which compares with hospital based physical therapy (control group) in the management of patients with CKD on dialysis. In the current study, the patients were given six weeks treatment and the outcomes were evaluated at follow up intervals of three weeks and six weeks, while KDQOL –SF36 questionnaire was assessed on 6th week follow up only. The finding of current study represents 20-minute walk and using Thera-band for 1 set of 10 repetitions which is significantly effective (p<0.001) in terms of better outcome measure of 6MWT, standing balance, 4-metre gait speed and chair stand test and some sub component of KDQOL-SF 36 test questionnaire score. A randomized control trial which was conducted by Kiyotaka *et al*. in 2018 on the effects of aerobic exercise and resistance training in the management of physical functioning, outcome measures contained used in the study were incremental shuttle walk test, hand grip strength and quadriceps strength and health related QoL.[29] The finding of the study showed that aerobic and resistance training to be effective with regards to improved general strength of the body and QoL while the doses of analgesics and calcium channel blockers were reduced. Flisinski *et al*. aimed to analyze overall outcome measures, they also tried to represent deleted data values, with the average value being noted.[30]

A nurse led exercise training program at home-based for HD patients showed between group effects of normal gait speed is significantly improved in study group than control group (p=0.038). However, patients in the study group reported significant improvement on the parameter of 10 sit to stand test is reduced from 19.78 to 14.03 (p<0.001) seconds when recorded from baseline to week 12th.[31] In current study, findings are in parallel with previous studies on the same test, it was p <0.001 at the 6th week, whereas at 3rd week it was p=0.487. Another reason that highlights the importance of exercise adherence in the CKD population is the increased prevalence of sarcopenia. Maintaining an active lifestyle can help in reducing the detrimental effects that sarcopenia has on this population.[32]

The present study shows that people with CKD who are receiving HD, and are unable to attend in-person rehabilitation sessions, can benefit from a home-based exercise program. Benefits received include and increase in physical, and mental, functioning.

Table 3. Mann-Whittney test for SF-36 within the group.

Variable	P-value
Physical functioning pre	0.950
Physical functioning post	<0.001
Role limitations due to physical health pre	0.494
Role limitations due to physical health post	0.007
Role limitations due to emotional problems pre	0.048
Role limitations due to emotional problems post	0.011
Energy/fatigue pre	0.005
Energy/fatigue post	<0.001
Emotional well-being pre	0.226
Emotional well-being post	<0.001
Social functioning pre	0.763
Social functioning post	<0.001
Pain pre	0.116
Pain post	<0.001
General health pre	0.261
General health post	<0.001
Health change pre	0.966
Health change post	0.780

Limitations and future directions

All of the patients in control group were smokers and also majority of patients were hypertensive which may have confounded the results. The sample size of his study was small, thus affecting generalizability. It is recommended that further studies should be carried out for physical therapeutic intervention during dialysis or after dialysis with increased follow-up to assess long term effects of physical therapy interventions.

Conclusions

A home-based, exercise program is effective in improving cardiorespiratory fitness, decreasing fatigue, and improving QoL in patients on dialysis, as compared with hospital-based rehabilitation. This will provide benefits to patients who are unable to attend in-person physical therapy sessions, while maintaining, and eventually improving, their physical conditioning, thus providing them a cost-effective method of maintaining the long-term conditioning of their disorder.

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