

## The Effects of Exercise Training on Physical Performance and Self-efficacy in Hemodialysis Patients: A Randomized Controlled Clinical Trial

### Abstract

**Background:** Hemodialysis patients are faced with challenges in carrying out their daily activities. Self-efficacy is a social cognitive concept that can affect behavioral control in these patients. Hence, the purpose of the present study was to investigate the effects of exercise training on physical performance and self-efficacy in hemodialysis patients. **Materials and Methods:** This randomized controlled clinical trial was conducted on 60 hemodialysis patients who visited hospitals affiliated to Mazandaran University of Medical Sciences in Sari, Iran. The participants were randomly divided into two groups. The patients in the intervention/exercise group received the 8-week exercise program. Patients in the control group received routine care. The Six-Minute Walk Test (6MWT) was used to assess the patients' functional ability and the Exercise Self-Efficacy Scale (ESES) and Chronic Disease Self-Efficacy Scale (CDSSES) were used to assess their self-efficacy before and 2 and 8 weeks after the intervention. For statistical analysis, independent t-test and paired t-test were used. **Results:** The comparison of self-efficacy between the exercise group and control group after 8 weeks of intervention showed a significant difference between the groups in terms of the CDSSES ( $F_{1,43} = 22.92, p < 0.001$ ) and ESES ( $F_{1,38} = 10.84, p < 0.001$ ) results. Moreover, the comparison of mean distance walked based on the 6MWT showed significant changes in this variable ( $F_1 = 2.05, p = 0.015$ ). **Conclusions:** The designed exercise program can improve self-efficacy and physical performance in hemodialysis patients. This intervention is recommended for hemodialysis patients due to its effectiveness, simplicity, and uncomplicated characteristics

**Keywords:** Exercise, Physical functional performance, Renal dialysis, Self-efficacy

### Introduction

Diminished activity in patients with End-Stage Renal Disease (ESRD) compared to healthy individuals of a similar age and gender shows that the ability to perform activities decreases with time, especially on dialysis days.<sup>[1,2]</sup> Studies on hemodialysis patients have shown that reduced physical performance and Activities of Daily Living (ADL) are associated with negative clinical outcomes.<sup>[3-5]</sup> In contrast, exercise training in hemodialysis patients leads to decreased fatigue, uremic nephropathy, myopathy, muscle cramps, improved peripheral cardiovascular function, blood pressure, muscle blood circulation, and physical work capacity.<sup>[6]</sup> Exercise also improves depression and Quality Of Life (QOL) in these patients.<sup>[7]</sup> Despite all the benefits of exercise in hemodialysis patients,

these patients often follow a sedentary lifestyle.<sup>[7,8]</sup> Self-care and self-efficacy are fundamental concepts in patients with Chronic Kidney Disease (CKD).<sup>[9,10]</sup> Moreover, individuals who are confident about their abilities, actively participate in health-promoting programs and are more successful in controlling their disease.<sup>[11]</sup>

Despite reports of the low level of physical activity in hemodialysis patients and evidence of the benefits of regular exercise for these patients, the encouragement of patients to exercise by doctors and nurses has not yet become a norm in hemodialysis departments.<sup>[1,7,12]</sup> Nurses have a key role in patients' rehabilitation and they are able to help enhance patients' ability to perform ADL and reduce their social, mental, and economic problems.<sup>[10]</sup> Today, planned exercise activities that take into account

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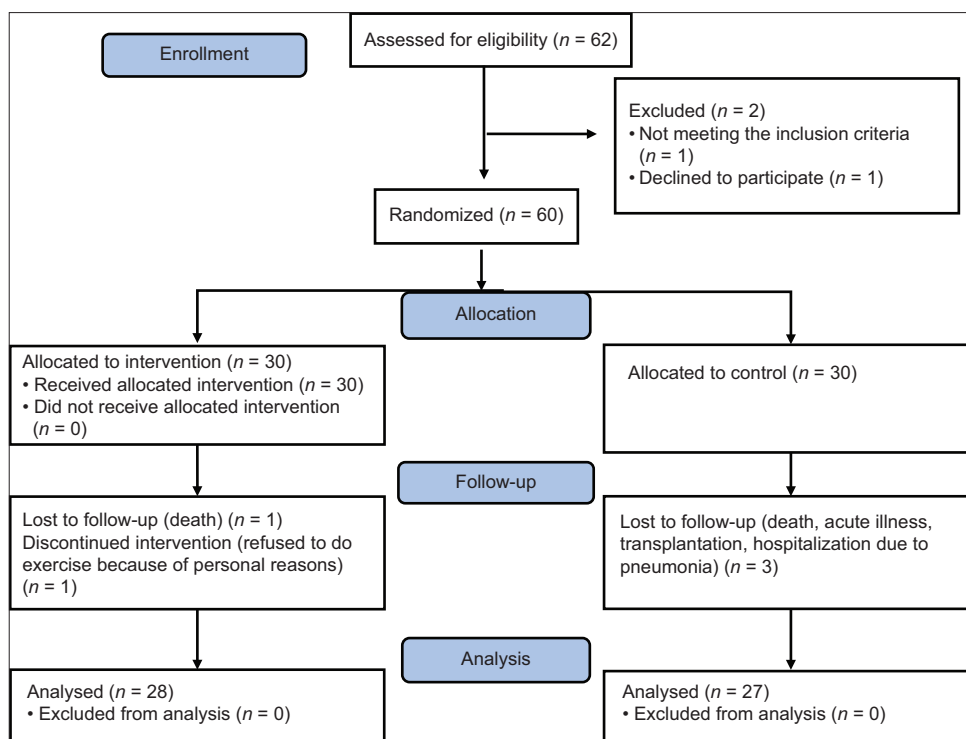


Figure 1: CONSORT 2010 flow diagram

the patient's conditions and abilities have attracted the attention of sports medicine and rehabilitation specialists.<sup>[13]</sup> Implementing supervised exercise programs in hospitals can increase patients' participation and commitment, as they are peer activities and the medical team directly motivates them to do these activities; however, supervised exercise in each dialysis session is not financially or practically feasible in many centers.<sup>[1,14,15]</sup> Some studies have recommended exercise at home, which allows the patients to exercise in a private setting and feel more comfortable in a familiar environment and not have to travel a distance to reach exercise facilities. Some of the obstacles to an active lifestyle are thus eliminated.<sup>[8]</sup> According to sports medicine specialists, if people with a sedentary lifestyle begin an exercise program without the necessary preparations, they might face certain complications.<sup>[16-18]</sup>

Regular exercise, both aerobic and resistance training can help dialysis patients improve their physical performance and objective measures of physical function for ESRD.<sup>[19,20]</sup> In order to increase daily physical activity and decrease dependence, walking is an appropriate exercise for this group of patients, because of cost-effectiveness, lack of side effects, applicability at any time and place, and lack of requirement of special equipment.<sup>[21,22]</sup> Therefore, the present study aimed to investigate the effects of exercise training on self-efficacy and physical performance of hemodialysis patients. In this combined exercise plan, first, the patients did some exercises during their dialysis in order to strengthen their lower extremities over 2 weeks, and then, started the 6-week walking program at home.

## Materials and Methods

This parallel, randomized, controlled trial (IRCT2016111824342N4) was conducted on 60 hemodialysis patients who underwent hemodialysis in two dialysis centers affiliated to Mazandaran University of Medical Sciences, Iran (30 patients in each group) from January 2017 to May 2017. The participants were selected using a convenience sampling method, and those patients who had the inclusion criteria were entered into the study. Then, patients were selected for control and an exercise group through allocation concealment using a computer-generated random number system (allocation ratio one by one). To calculate the sample size, a test power of 90%, sample attrition of 10%, and a Confidence Interval (CI) of 95% were considered. During the study, five patients withdrew from the intervention. Data analysis was performed on the remaining patients without replacement [Figure 1]. To prevent interaction between patients about the interventions, one center was considered for the intervention group and the other for the control group, randomly.

The inclusion criteria included 18 to 65 years of age, at least 3 months history of chronic hemodialysis, undergoing hemodialysis 3 times a week, and ability to ambulate without assistance. Patients who had been diagnosed with a mental illness, already performed regular exercise for the past 3 months, had an unstable physical condition and acute medical illness in the past month, or had symptomatic cardiovascular disease in the past 3 months and were

unable to exercise were excluded from the study. Data were collected via a demographic questionnaire, the Six-Minute Walk Test (6MWT) to assess physical performance, and the Exercise Self-Efficacy Scale (ESES) and the Chronic Disease Self-Efficacy Scale (CDESES) to assess self-efficacy.<sup>[23]</sup> The 6MWT was distributed among the participants in the hallway of the hemodialysis department after giving the patients instructions and allowing them to have a short warm-up. For the test, the patients had to walk 6 minutes at their normal pace for as long a distance as they could and they were allowed to rest during their walk, if necessary.<sup>[24]</sup> Before and after the test, vital signs were controlled for each patient.

After obtaining the approval of the Ethics Committee and written consent from patients, the patients' physical performance and self-efficacy were measured 2 and 8 weeks after the intervention. Initially, for a period of 2 weeks, the intervention/exercise group performed core stability exercises 3 times per week during their hemodialysis sessions in order to strengthen their lower extremities and prepare for the walk-at-home exercise. These exercises were adjusted to the level of endurance of the hemodialysis patients and were performed under the supervision of a specialist in exercise medicine. The patients performed the exercise within the first 2 hours of their hemodialysis sessions, as it is impossible to exercise in the third hour of hemodialysis due to decreased blood pressure.<sup>[25]</sup> Hand movements were performed before dialysis and feet movements were performed during dialysis. The patients' vital signs were monitored before the beginning of the exercise, and if anything seemed abnormal or the patients felt unwell, training was not performed in that session. The patients and their main caregivers received verbal instructions on how to perform the exercises and were given pamphlets with illustrated instructions about the exercises. The patients performed each exercise 10 times under the supervision of the researchers during their dialysis sessions.<sup>[18]</sup>

After the 2 weeks were over, the exercise group was asked to walk at home 3 times per week on days in which they did not visit for hemodialysis and depending on their individual capacities. The researcher reminded the patients about the home walking sessions and followed up with them through phone calls. The walk-at-home exercise consisted of a short warm-up, a 20-minute walk, and a 5-minute cool-down. A) Short warm-up: The patients had to walk slowly for 5 minutes to gradually prepare their cardiovascular system and slowly increase their heart rate. B) Walking: The patients were advised to walk for two 10-minute intervals and take a 5-minute rest between them if they were unwilling/unable to walk for longer periods at the time. At this stage, the patients were told to walk fast enough to feel their heart rate increase, depending on their tolerance. The participants had to exercise within a range of 11 to 13 on the Borg Rating of Perceived Exertion (RPE)

scale, which is a 15-point scale ranging from 6 to 20.<sup>[18]</sup> This scale, which was computed by researchers, is a way to control the intensity of activities based on the subject's perception of the pressure and fatigue during the activity.<sup>[26]</sup> C) Cool-down: The patients had to reduce their walking speed within 5 minutes to gradually contract their muscles and make their heart rate slowly return to normal. In this study, patients in the control group received routine care.

The ESES consists of 10 items that are scored based on a 4-point Likert scale with the choices of "Not at all true" (0 points), "Hardly true" (2 points), "Moderately true" (3 points), and "Exactly true" (4 points). The total score of the scale ranges from 10 to 40 and higher scores indicate a higher self-efficacy. The validity and reliability of the ESES have been previously approved.<sup>[27]</sup> In this study, the percentage of agreement of the ESES was estimated as 94%. The CDESES has 33 items in three scales and each scale consists of one or several subscales. The items are scored on a scale ranging between 1 and 10 (from "Not at all confident" to "Totally confident"). The first scale of the CDESES measures self-efficacy in performing self-management behaviors and consists of the subscales of "exercise regularly" (items 1-3), "get information about disease" (item 4), "obtain help from community, family, and friends" (items 5-8), and "communicate with physician" (items 9-11). The second scale measures general self-efficacy and contains the single subscale of 'manage disease in general' (items 12-16). The third scale assesses self-efficacy in achieving outcomes and consists of the subscales of "do chores" (items 17-19), "social/recreational activities" (items 20-21), "manage symptoms" (items 22-26), "manage shortness of breath" (items 27), and "control/manage depression" (items 28-33). The patient rates each item from 1 to 10, and if two close numbers are chosen for an item, the lower number is taken as the score, and if the chosen numbers are wide apart, no scores are assigned to that item. Higher scores on this scale indicate a higher self-efficacy. The reliability of the CDESES was reported within the range of 0.70–0.95.<sup>[28,29]</sup> In this study, the percentage of agreement of the CDESES was reported as 93%. After completing all questionnaires, the collected data were analyzed using SPSS software (version 16, SPSS Inc., Chicago, IL, USA). To compare the mean score between the two groups and determine the effects of the exercise program before the intervention, and 2 and 8 weeks after the intervention, t-test, a repeated measure was used, respectively. The normality of data distribution was assessed using the Kolmogorov–Smirnov test. A *p* value of less than 0.05 was considered statistically significant.

### Ethical considerations

This article was derived from the MSc thesis with ethical number IR.MAZUMS.REC.95.2428. The patients were informed of the general objectives of the study before they submitted their informed consent forms for participation

in the research. The subjects were all ensured of the confidentiality of their information.

### Results

Of the 60 hemodialysis patients, 55 (31 men and 24 women) completed the study. In the intervention group, the mean (SD) of age, body mass index (BMI), and duration

of dialysis were 52.07 (11.30) years, 26.60 (4.53) kg/m<sup>2</sup>, and 3.61 (2.69) years, respectively. In the control group, the mean (SD) of age, BMI, and duration of dialysis were 53.96 (10.01) years, 26.23 (4.03) kg/m<sup>2</sup>, and 4.52 (4.71) years, respectively. The *p* value of age, BMI, and duration of dialysis was 0.10, 0.56, and 0.15, respectively. In this study, no significant differences were observed

**Table 1: Demographic characteristics of the subjects (n=55)**

| Variables           | Groups                    |               | $\chi^2$   | <i>p</i> * |      |
|---------------------|---------------------------|---------------|------------|------------|------|
|                     | Exercise group            | Control group |            |            |      |
|                     |                           | N (%)         | N (%)      |            |      |
| Gender (%)          | Female                    | 12 (42.85)    | 12 (44.45) | 0.01       | 0.90 |
|                     | Male                      | 16 (57.15)    | 15 (55.55) |            |      |
| Education level (%) | No formal education       | 5 (17.85)     | 9 (33.34)  | 7.31       | 0.12 |
|                     | Primary education         | 8 (28.58)     | 7 (25.93)  |            |      |
|                     | Secondary education       | 13 (46.43)    | 10 (37.03) |            |      |
|                     | Tertiary education        | 2 (7.14)      | 1 (3.70)   |            |      |
| Marital status (%)  | Single                    | 2 (7.14)      | 1 (3.70)   | 0.66       | 0.71 |
|                     | Married                   | 24 (85.72)    | 25 (92.60) |            |      |
|                     | Widowed                   | 2 (7.14)      | 1 (3.70)   |            |      |
| Smoking (%)         | Yes                       | 4 (14.29)     | 6 (22.20)  | 1.18       | 0.55 |
|                     | No                        | 24 (85.71)    | 21 (77.80) |            |      |
| Comorbidity (%)     | Diabetes                  | 6 (21.43)     | 4 (14.81)  | 6.68       | 0.15 |
|                     | Hypertension              | 14 (50.00)    | 9 (33.34)  |            |      |
|                     | Chronic heart disease     | 2 (7.14)      | 0 (0.00)   |            |      |
|                     | Renal disease             | 4 (14.29)     | 9 (33.34)  |            |      |
|                     | Hypertension and diabetes | 2 (7.14)      | 5 (18.51)  |            |      |

\*Chi-squared test

**Table 2: Comparison of the Six-Minute Walk Test, Exercise Self-Efficacy Scale, and the Chronic Disease Self-Efficacy Scale in the two groups**

| Outcome Measures | Time          | Exercise group | Control group  | t    | <i>p</i> * |
|------------------|---------------|----------------|----------------|------|------------|
|                  |               | Means (SD)     | Means (SD)     |      |            |
| CDSES***         | Baseline      | 5.18 (1.21)    | 4.58 (1.570)   | 1.57 | 0.120      |
|                  | After 2 weeks | 5.55 (1.08)    | 4.51 (1.43)    | 3.03 | 0.004      |
|                  | After 8 weeks | 6.33 (0.08)    | 4.60 (1.32)    | 4.97 | <0.001     |
|                  | F             | 22.92          | 0.07           |      |            |
|                  | df            | 1.43           | 1.03           |      |            |
|                  | <i>p</i> **   | <0.001         | 0.79           |      |            |
| ESES****         | Baseline      | 2.64 (0.75)    | 2.44 (0.81)    | 0.97 | 0.330      |
|                  | After 2 weeks | 2.95 (0.50)    | 2.41 (0.80)    | 2.96 | 0.005      |
|                  | After 8 weeks | 3.04 (0.47)    | 2.30 (0.74)    | 4.40 | <0.001     |
|                  | F             | 10.84          | 1.19           |      |            |
|                  | df            | 1.38           | 1.05           |      |            |
|                  | <i>p</i> **   | <0.001         | 0.28           |      |            |
| 6MWT*****        | Baseline      | 298.01 (86.87) | 293.22 (57.03) | 0.24 | 0.81       |
|                  | After 2 weeks | 323.64 (85.28) | 295.84 (64.48) | 1.36 | 0.18       |
|                  | After 8 weeks | 343.51 (79.36) | 295.41 (60.57) | 2.52 | 0.01       |
|                  | F             | 14.35          | 0.08           |      |            |
|                  | df            | 1.63           | 1.27           |      |            |
|                  | <i>p</i> **   | <0.001         | 0.83           |      |            |

\* Independent t-test; \*\* Repeated Measure; \*\*\* Chronic Disease Self-Efficacy Scale; \*\*\*\* Exercise Self-Efficacy Scale; \*\*\*\*\* Six-Minute Walk Test

between the two groups in terms of patients' age, BMI, gender, educational level, marital status, smoking, and comorbidity [Table 1].

The results showed that the mean score of CDEES did not differ significantly between the two groups before the intervention ( $t = 1.57$ ,  $p = 0.120$ ), but differed significantly 2 weeks ( $t = 3.03$ ,  $p = 0.004$ ) and 8 weeks ( $t = 4.96$ ,  $p < 0.001$ ) after the intervention. Moreover, the groups did not differ significantly in terms of the mean score of ESES before the intervention ( $t = 2.42$ ,  $p = 0.811$ ), but differed significantly 2 weeks ( $t = 1.36$ ,  $p = 0.180$ ) and 8 weeks ( $t = 2.52$ ,  $p = 0.015$ ) after the intervention. No significant difference was observed in the mean of distance walked in the 6MWT between the two groups before the intervention ( $t = 0.24$ ,  $p = 0.811$ ). Furthermore, the mean 6MWT score had not significantly differed after 2 weeks ( $t = 1.36$ ,  $p = 0.180$ ), but it was significantly increased in the intervention group compared with the control group after 8 weeks of intervention ( $t = 2.52$ ,  $p = 0.015$ ) [Table 2].

## Discussion

The results showed that a combination of exercises during dialysis (to strengthen the lower extremities) and walking at home could be effective in improving self-efficacy and physical performance in hemodialysis patients. In the present study, the 8-week exercise program (2 weeks of supervised exercise during dialysis and 6 weeks at home) improved the physical performance of the hemodialysis patients. Simo *et al.* revealed that the distance walked in the intervention group of patients undergoing hemodialysis increased significantly, as suggested by the increase in mean 6MWT score from 234.4 (117.7) to 274.7 (144.9).<sup>[30]</sup> In a study by Bulckaen *et al.*, an improvement was observed in the 6MWT score in hemodialysis patients who walked at home.<sup>[31]</sup> In some studies, however, exercise did not affect the physical performance of hemodialysis patients and an increase was not observed in the distance walked (based on 6MWT results) in the intervention group compared to the control group.<sup>[1,32]</sup> It seems that planned exercises in which all the conditions and abilities of a person are considered are likely to have a positive effect on the person's physical performance.

In the present study, the patients were asked to regulate their exercise intensity between 11 and 13 according to the Borg RPE table. Hence, the low-intensity exercise program was carried out effectively and safely in ESRD patients. Planned exercise and physical activity help strengthen and improve the body organs, such as the heart and the respiratory system, and induce a sense of recovery in the patients.<sup>[18]</sup> Some studies have shown that low-intensity exercise is effective in hemodialysis patients.<sup>[30,31]</sup> Some others however have not determined an intensity or dose of effectiveness for the exercise programs given to these patients.<sup>[31,33]</sup> This disparity in findings may be due to the

low intensity and frequency of the exercise program and the small number of participants. The nature of the study also affects the study outcomes.<sup>[32]</sup>

The present study used a combination of two exercise programs, exercise during dialysis and at home, and this intervention effectively improved physical condition and self-efficacy in hemodialysis patients. In a study, hemodialysis patients were asked to walk on a treadmill, which improved their physical performance.<sup>[34]</sup> In another study, the effectiveness of exercise during dialysis and exercise at home was compared and no significant changes were observed in the status of any of the groups.<sup>[32]</sup> It should be noted that the exercise during dialysis was performed under the supervision of the researchers in the present study, and some studies have shown that supervised exercise is much more effective than unsupervised exercise.<sup>[31,35]</sup>

In the present study, the physical status of hemodialysis patients gradually improved over time. The patients in the exercise group stated that the exercise given to them during dialysis, especially since it was supervised, inspired them and showed them that they can perform regular exercise despite the adverse effects of hemodialysis on their health. It appears that exercise among a group of people with similar conditions and problems makes the patient perform the exercises more eagerly. In this study, the exercise group observed the effectiveness of the exercise program over time and improvement in their physical condition.<sup>[18]</sup>

The patients in the exercise group showed a significant improvement in their self-efficacy compared to the control group, which reflects the effectiveness of the designed exercise program on self-efficacy in hemodialysis patients. Similarly, Fletcher found that exercise training improves self-efficacy in hemodialysis patients in addition to positively affecting their health behaviors.<sup>[36]</sup> Kack also stated that physical activity is significantly influenced by the level of self-efficacy in hemodialysis patients and that self-efficacy should be carefully considered in promoting the participation of ESRD patients in physical activities.<sup>[37]</sup> Tamura also reported a positive relationship between exercise behavior and the level of self-efficacy and a reduction in symptoms of depression.<sup>[14]</sup> In a pilot study, however, Felice reported no significant changes in the mean scores of CDEES and ESES after 8 weeks of exercise training in hemodialysis patients.<sup>[38]</sup> Moreover, Felice suggested that these results may be due to factors such as lack of motivation, social support, and facilities, and environmental barriers that affect the results of self-efficacy tests.<sup>[38]</sup> In the present study, the mean scores of the ESES and all the scales of the CDEES, especially the "self-efficacy to perform self-management behaviors" scale, increased in the exercise group. This is indicative of the effectiveness of the designed exercise program on self-efficacy in hemodialysis patients since almost

the only fundamental change in the patients' lifestyle was the performance of the exercise program during the 8 weeks. Our study suggests that exercise was effective in promoting self-efficacy in patients in the exercise group, while no increase was observed in the self-efficacy of the control group. Muscular activity affects the nervous system and oxygen consumption and causes happiness and self-belief.<sup>[13]</sup> Engaging in exercise activities helps release negative emotions, increases self-confidence, self-esteem, and self-efficacy, and changes the sedentary lifestyle of hemodialysis patients. The limitation of the study was the assessment of patients' self-efficacy through a self-report method, which could have caused some mistakes.

## Conclusion

In this study, an exercise training program that combines home-based exercises and exercises during dialysis effectively improved the physical performance and self-efficacy of hemodialysis patients. Walking can be an appropriate activity to increase daily physical activity, reduce dependence, and increase independence in hemodialysis patients due to its simplicity, safety, low cost, feasibility at any time and place, and lack of requirement of special equipment. Therefore, nurses use this method on hemodialysis patients to increase their level of self-efficacy and physical performance. Educational planners, managers, nephrologists, and medical staff can use sport as a non-pharmacological treatment to rehabilitate hemodialysis patients.

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## Conflicts of interest

Nothing to declare.

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