

Originales

## Effects of a home-based exercise program on patients undergoing haemodialysis: an exploratory study

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### ABSTRACT

**Background and Objectives:** Patients undergoing haemodialysis are particularly vulnerable due to comorbidities and immunosuppressive drugs. In response, this study aimed to evaluate an alternative home-based exercise program implemented to maintain the physical fitness of HD patients.

**Methods:** A out-of-clinic resistance training program based on calisthenic exercise was proposed to those HD patients who were participating in an intradialytic exercise program interrupted for ten weeks. Patients were advised to perform a home exercise routine 2 days a week. The impact of the program on physical function was assessed through tests measuring upper and lower body muscle strength, cardiorespiratory fitness, and functional autonomy.

**Results:** Of the 53 patients eligible for the study, 38 agreed to participate and were assigned to either the exercise group (n=17) or the control group (n=21). Twelve participants completed at least 80% of the exercise sessions and were included in the final analysis. The intervention had no significant intra-group effect on the variables assessed. Comparison between groups indicated a significant improvement in lower body muscle strength, favoring the exercise group.

**Conclusions:** Findings from this exploratory study indicate that a home-based exercise program performed for ten weeks, helped HD patients to prevent muscle function decline.

**Keywords:** Intradialytic physical exercise; Physical activity; Renal failure; Hemodialysis; Exercise program.

## Efectos de un programa de ejercicios en casa para pacientes sometidos a hemodiálisis: un estudio exploratorio

### RESUMEN

**Antecedentes y objetivos:** Los pacientes sometidos a hemodiálisis (HD) son particularmente vulnerables debido a las comorbilidades y a los fármacos inmunosupresores. En respuesta, este estudio tuvo como objetivo evaluar un programa alternativo de ejercicio en casa implementado para mantener la forma física de los pacientes en HD.

**Métodos:** Se propuso un programa de entrenamiento de resistencia fuera de la clínica basado en ejercicios calisténicos a aquellos pacientes en HD que participaban en un programa de ejercicio intradialítico interrumpido durante diez semanas. Se aconsejó a los pacientes que realizaran una rutina de ejercicios en casa dos días a la semana. El impacto del programa sobre la función física se evaluó mediante pruebas que medían la fuerza muscular del tren superior e inferior, la aptitud cardiorrespiratoria y la autonomía funcional.

**Resultados:** De los 53 pacientes elegibles para el estudio, 38 aceptaron participar y fueron asignados al grupo de ejercicio (n=17) o al grupo de control (n=21). Doce participantes completaron al menos el 80% de las sesiones de ejercicio y fueron incluidos en el análisis final. La intervención no tuvo efectos significativos intragrupo en las variables evaluadas. La comparación entre grupos indicó una mejora significativa en la fuerza muscular de la parte inferior del cuerpo, a favor del grupo de ejercicio.

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**Conclusiones:** Los resultados de este estudio exploratorio indican que un programa de ejercicios en casa realizado durante diez semanas ayudó a los pacientes con HD a prevenir el deterioro de la función muscular.

**Palabras clave:** Ejercicio físico intradialítico; Actividad física; Insuficiencia renal; Hemodiálisis; Programa de ejercicios.

## Efeitos de um programa de exercício físico domiciliário em doentes submetidos a hemodiálise: um estudo exploratório

### RESUMO

**Antecedentes e objetivos:** Os doentes submetidos a hemodiálise são particularmente vulneráveis devido às comorbilidades e aos fármacos imunossuppressores. Em resposta, este estudo teve como objetivo avaliar um programa alternativo de exercício em casa implementado para manter a aptidão física dos doentes em HD.

**Métodos:** Foi proposto um programa de treino de resistência fora da clínica, baseado em exercícios calisténicos, aos doentes em HD que estavam a participar num programa de exercício intradialítico interrompido durante dez semanas. Os doentes foram aconselhados a realizar uma rotina de exercício em casa 2 dias por semana. O impacto do programa na função física foi avaliado através de testes que mediram a força muscular dos membros superiores e inferiores, a aptidão cardiorrespiratória e a autonomia funcional.

**Resultados:** Dos 53 doentes elegíveis para o estudo, 38 concordaram em participar e foram atribuídos ao grupo de exercício (n=17) ou ao grupo de controlo (n=21). Doze participantes completaram pelo menos 80% das sessões de exercício e foram incluídos na análise final. A intervenção não teve efeito significativo intra-grupo nas variáveis avaliadas. A comparação entre grupos indicou uma melhoria significativa da força muscular dos membros inferiores, favorecendo o grupo de exercício.

**Conclusões:** Os resultados deste estudo exploratório indicam que um programa de exercícios em casa, realizado durante dez semanas, ajudou os doentes em HD a prevenir o declínio da função muscular.

**Palavras-chave:** Exercício físico intradialítico; Actividade física; Insuficiência renal; Hemodiálise; Programa de exercício.

### Introduction

Social distancing is a necessary strategy imposed by the governments to contain the spread of the novel coronavirus disease (COVID-19). This measure is extremely important for people with chronic conditions like chronic kidney disease (CKD), a pathology that seems to be associated with an enhanced risk of severe COVID-19 infection<sup>1</sup>, and also with a higher risk for in-hospital death<sup>2</sup>. Hence, patients with CKD, and especially those undergoing haemodialysis (HD), who are even more vulnerable to COVID-19 infection due to multiple comorbidities and the use of immunosuppressive drugs, have been advised to take extra precaution to minimize risk exposure to the virus<sup>3</sup>.

In accordance with all these, in our Nephrology and Dialysis Unit we had to implement preventive strategies to minimize social contact and physical presence, taking into account the number of patients and practitioners sharing a room, as well as the existence of available equipment, as previously suggested<sup>4</sup>. One of the first measures taken on the bases of these recommendations, was suspend the intradialytic exercise program that is usually offered to our patients as an additional therapy. However, we were aware that this decision could put our patient at risk of a further deterioration on their physical health, as intradialytic exercise has shown to improve fitness, physical function as well as dialysis adequacy<sup>5,6</sup>. The fact that patients had to stay at home while off dialysis due to the forced confinement established by the Spanish Government, could also aggravate the negative consequences of this action on their functional status.

Since no previous experience has prepared the scientific community to face a situation like this, it has been suggested that local initiatives can be of help in defining management strategies<sup>4</sup>. Thus, in this investigation we present the results of an alternative based-home exercise program that we implemented for maintaining the physical function of our HD patients. The information provided

here could of help for developing effective exercise programs for this population.

### Methods

#### Participants

The participants of this study were HD patients with haemoglobin concentrations of 10.5 to 12.0 g/dL who were undergoing an intradialytic exercise program offered in two outpatient HD centres located in the North of Spain for more than three months. None of the patients had suffered a stroke or a cardiac event in the last 6 months, or showed uncontrolled hypertension, low blood sugar ( $\geq 60$  mg/dl) or heart failure (New York Heart Association stage  $\geq 4$ ).

Once the program was suspended, an alternative exercise program was offered to all of these patients who wished to keep going exercise, provided that they had a mobile phone/email address for being contacted, showed normal range of motion values of the lower extremity joints and absence of cognitive impairment. Those patients who did not fulfil these criteria served as a comparison group and were asked to keep their usual routine through the investigation.

Out of the 53 haemodialysis patients eligible for this study, 38 of them agreed to participate and were allocated to the exercise (n=17; mean age:  $59.70 \pm 16.30$ ; mean years in HD:  $7.7 \pm 7.46$ ; 41.1% women) or the control (n= 21; mean age:  $64.13 \pm 14.82$ ; mean years in HD:  $6.07 \pm 4.96$ ; 50% women) groups. Twelve participants completed at least 80% of the exercise sessions and were included in the final analysis (Figure 1). All participants signed an informed consent before testing. The research protocol followed the principles of the Declaration of Helsinki regarding biomedical research involving human subjects (64th WMA General Assembly, Fortaleza, Brazil, 2013). Approval was granted by the HD centres teams management boards and by the Local Ethical Research Committee.

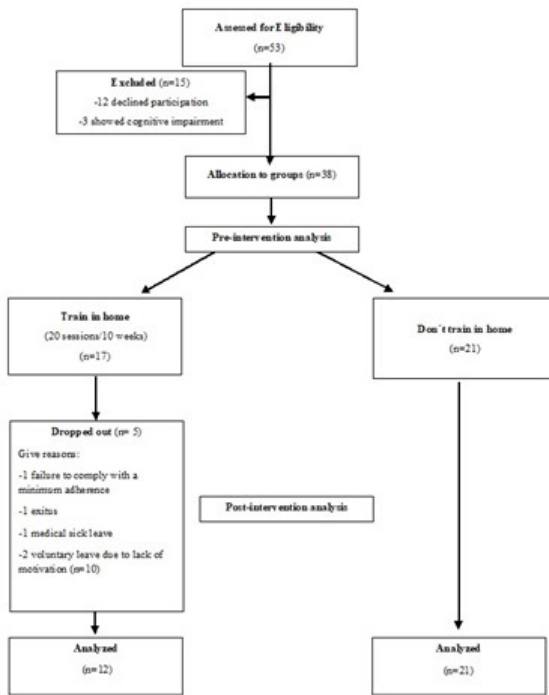


Figure 1. Flow chart

### Procedure

A 10-week-out-of clinic resistance-training program based on the performance of callisthenic exercises was developed (Table 1). Patients were advised to carry out the proposed exercise routine at home 2 days per week. Although the vast majority of the exercises were already known by the participants, since they were usually performed during the intradialytic sessions, they were contacted one day a week in order to identify whether they had difficulties with the exercise execution, to check if fatigue or pain were present, to motivate the participants to keep exercising and to propose new exercises. All the sessions were designed and supervised by a specialist in physical and exercise who were in charge of the intradialytic exercise program.

### Measurements

For identifying the impact of the program on the participants' physical function, their upper-body lower muscular strength, cardiorespiratory fitness and functional autonomy, were tested by means of the Hand-grip (HG) test, 10-time-repeated sit-to-stand (STS-10), Six-minute walking test (6MWT) and Timed-up-and-go (TUG) test respectively. All these field-based tests have been shown to be feasible and accurate for functional assessment in HD patients<sup>7</sup>. All the measurements were carried out at our Nephrology and Dialysis and were performed two weeks before and two weeks after the intervention took place, under the supervision of the person in charge of the intradialytic exercise program.

### Statistical analysis

Values are reported as mean  $\pm$  standard deviation (SD). Sample size was calculated (using GPower Version 3.1.9.4) introducing the following parameters: effect size (ES) 1; and  $\alpha$  error probability (0.05) and power (0.95), which resulted in a sample size of 33 subjects. Application of the Kolmogorov-Smirnov test, in conjunction with the Lilliefors test, showed that the sample distribution was normal, linear, and homoscedastic. Mixed-design factorial analysis

of variance (mixed ANOVA) was used to detect changes in the physical conditioning after a physical exercise program. Two factors were included in the mixed-design ANOVA model. Time (changes detected between assessment point one and two) was used as the within-subjects variable and group (EG and CG) was used as the independent factor. Bonferroni post hoc tests with adjustment for 95% confidence intervals were used to compare the main effects and identify significant individual differences. The effect sizes in mixed-design ANOVA were reported as partial eta square ( $\eta^2$ ) and interpreted as small (0.01), moderate (0.06), or large (0.14)<sup>8</sup>. An alpha level of  $p \leq 0.05$  was considered statistically significant. All data were analyzed using SPSS v24.0 for Windows (SPSS Inc., Chicago, IL, USA).

### Results

No significant differences at baseline were observed between both groups. The obtained results are shown in table 2. The exercise intervention did not have any significant effect on the variables assessed. A significant interaction MOMENT\*PROGRAMS was found for the STS10 ( $F = 4.882$ ;  $p = 0.038$ ;  $\eta^2 = 0.182$ ). This finding indicates that patients in the control group experienced a worsening of more than 8% in their lower body muscular strength, while a slight increase in this fitness dimension (3%) was observed among those who completed the exercise program.

### Discussion

In this study we sought to identify whether CKD patients who were used to exercise during dialysis, were able to continue exercising once intradialytic exercise sessions were interrupted. Our results indicated that performing exercise at home was feasible, since few drop-outs due to exercise were noted, and adherence was generally acceptable. Nevertheless, we observed that two patients stopped exercising due to lack of motivation, which has been previously as an exercise barrier for dialysis patients<sup>9</sup>. We could also not ruled out the possibility that the lack of social interaction discouraged these patients from exercise<sup>10</sup>. In any event, it should be noted that more than a half of the sample was not interested on taken part in the exercise program, despite performing exercise on a regular basis while on dialysis. This lack of motivation towards exercising outside the HD sessions could be due to a lack of potential expectations regarding the benefits of exercise, as well as to a scarce perceived additional motivational and attention provided by caregivers and trainers, as previously indicated<sup>11</sup>.

In our study, the proposed exercise program did not have a significant impact on the physical function of the participants, although, it could help prevent muscle function decline. These findings are contrary to the results obtained on a recent meta-analysis indicating that home-based exercise programs led to significant improvements on both HG and 6MWT scores on people with CKD<sup>12</sup>. Investigations specifically carried out with HD patients also obtained significant improvements on muscular strength and cardiorespiratory fitness<sup>13,14</sup>. The lack of effects observed in our program could be due to the fact that the sessions were mainly based on the performance of lower-body muscular resistance exercises of low intensity. Moreover, we could also fail to provide an accurate increase in the exercise load, indicating that phone assistance might not be a successful strategy in this regard. The short duration of the program could be also another reason for the absence of notable improvements. Nevertheless, other authors have reported a lack of significant effects on the fitness and functionality of patients with HD after performing longer home-based exercise programs, lasting 4 months<sup>15</sup> or 8 months<sup>16</sup>. These findings indicate that these kinds of interventions are not always successful.

A finding worth of mentioning in this research is the fact that patients in the control group experienced a greater decrement in lower-body muscular strength, in comparison with those who

**Table 1.** Main exercises proposed to be performed at home

Intervention exercises	
<b>Warm-up exercises</b>	
<ul style="list-style-type: none"> <li>• Ankle flexion and extensión</li> <li>• Hip abduction and adduction</li> <li>• Hip flexion and extensión</li> <li>• Neck flexion and extensión</li> <li>• Lateral neck bends</li> <li>• Deep breaths</li> </ul>	
Sets: 1 of 5 reps	
Duration: each exercise last for 20s	
Resistance exercises	
<ul style="list-style-type: none"> <li>• Hip flexion with knee extended</li> <li>• Hip extension against a cushion</li> <li>• Knee flexion against a cushion</li> <li>• Hip adduction against a cushion</li> <li>• Hip abduction with knee extended</li> <li>• Standing ankle flexion</li> <li>• Ankle flexion without resistance</li> </ul>	
Sets: 2-4 complete secuencias.	
Repetitions: 8-15.	
Duration: each exercise lasts between 20 and 60s	
Resting time: 60s between each set and 120s between each exercise	
Cooling-off activities	
<ul style="list-style-type: none"> <li>• Deep breaths</li> </ul>	
Sets: 1 of 10 reps	
Duration: 60s	

**Table 2.** Mean values obtained before and after the intervention

Test	Exp Group (n=12)		Control Group (n=20)		F	P	ES
	Before	After	Before	After			
HG (kg)	21.65 ± 11.49	22.90 ± 8.78	23.40 ± 19.34	18.82 ± 7.16	2.262	0.61	0.026
STS10 (rpts)	28.78 ± 7.19	27.86 ± 5.52	29.97 ± 6.19	32.76 ± 7.06	1.235	0.27	0.053
6MWT (m)	314.62 ± 91.69	306.33 ± 111.45	245.17 ± 113.23	243.60 ± 94.96	0.262	0.61	0.009
TUG (s)	10.65 ± 3.70	9.15 ± 2.25	14.21 ± 8.34	12.80 ± 5.93	4.171	0.051	0.13

HG: Hand-grip test; STS-10: 10-time-repeated sit-to-stand test; 6MWT: Six-minute walking test; TUG: Timed-up-and-go test

underwent the exercise program. In a similar vein, Bohm et al. <sup>17</sup> reported that a home-based exercise program was not effective in improving cardiorespiratory fitness in HD patients, but significant changes on lower-body muscular strength were observed. Given that muscle function is negatively affected by a variety of conditions inherent to CKD and to dialysis treatment, our results point out that encouraging HD patients to exercise at home can at least be a good strategy for avoiding muscular performance decline.

In this context, our study provides two interesting facts. First, a considerable number of patients who performed supervised exercise while at dialysis, were not keen to keep up exercising by themselves. Secondly, a home-based exercise program did not have a significant impact on the patients' physical function, however, it could have

helped to prevent muscle function decline. Although these findings are limited by the fact that the research was not randomized, the sample size was small and allocation to groups were based on motivation towards exercise, the information showed here can be of help for practitioners planning exercise interventions in HD patients.

In conclusion, the findings from this exploratory study indicate that a home-based exercise program performed during ten weeks, helped HD patients to prevent muscle function decline. Practitioners intending to plan unsupervised training programs for this population are advised to include resistance and aerobic exercises, in order to improve the patients' physical function. Further randomized studies with greater samples are needed to consolidate and expand the results of this research.

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