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original article

Physical training improves physical fitness and the quality of life of patients on hemodialysis

Treinamento físico melhora a aptidão física e a qualidade de vida de pacientes em hemodiálise

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Abstract – The aim of this study was to analyze the effects of physical training (PT) on physical fitness and quality of life (QoL) of patients undergoing hemodialysis (HD). For this purpose, 22 patients were randomly divided into a nonintervention group (control, n=11) and an intervention group (n=11). Patients in the intervention group were submitted to PT (consisting of aerobic exercise, strength training, and stretching) during HD, three times/week, for 4 months. Physical fitness was evaluated by the six-minute walk test (T6), respiratory muscle strength (RMS) testing, chair-stand test (CST), and abdominal strength test. The SF-36 was used to evaluate QoL. In addition, a semistructured interview was applied to evaluate the patient's perception of the benefits of PT. After PT, patients in the intervention group showed an increase in the distance walked in the T6 ($p<0.004$), RMS (inspiratory pressure: $p<0.002$; expiratory pressure: $p<0.001$), CST ($p<0.001$), and abdominal strength test ($p<0.001$). In addition, improvement of QoL was observed in the following domains: physical functioning ($p<0.001$), physical role functioning ($p<0.003$), pain ($p<0.04$), general health ($p<0.02$), and emotional well-being ($p<0.01$). The interviews permitted to divide the patient's perception of the benefits of PT into three categories: physical, psychological, and social benefits. In conclusion, PT improved the physical fitness and QoL of patients on HD as demonstrated by the assessment of the researchers and by the perception of the patients themselves.

Key words: Chronic renal failure; Muscle strength; Physical exercise; Rehabilitation.

Resumo – *O objetivo do estudo foi analisar os efeitos do treinamento físico (TF) sobre a aptidão física e a qualidade de vida (QV) de pacientes em hemodiálise (HD). Para isso, 22 pacientes foram divididos aleatoriamente em grupo controle – GC (n=11) e grupo experimental – GE (n=11). O GE realizou TF (constituído por exercício aeróbio, contra resistência e alongamentos) durante a HD, três vezes/semana, por quatro meses. A aptidão física foi avaliada por meio do teste de seis minutos de caminhada (T6); da força muscular respiratória (TFMR); do teste de sentar e levantar (TSL); e da resistência muscular localizada (RML) de abdome. Para avaliar a QV, foi utilizado o SF-36. Além disso, uma entrevista semiestruturada foi aplicada para avaliar a percepção dos pacientes sobre os benefícios do TF. Após o TF o GE apresentou aumento na distância percorrida no T6 ($p<0,004$), no TFMR (pressão inspiratória: $p<0,002$; pressão expiratória: $p<0,001$); no TSL ($p<0,001$) e na RML de abdome ($p<0,001$). A melhora da QV de vida também foi observada, para os domínios funcionamento físico ($p<0,001$), função física ($p<0,003$), dor ($p<0,04$), saúde geral ($p<0,02$) e bem-estar emocional ($p<0,01$). A partir das entrevistas, três categorias foram criadas sobre os benefícios do TF na percepção dos pacientes: benefícios físicos, psicológicos e sociais. Sendo assim, foi possível concluir que o TF promoveu melhora na aptidão física e na QV de paciente em HD, tanto na avaliação dos pesquisadores, quanto na dos pesquisados.*

Palavras-chave: *Exercício físico; Força muscular; Insuficiência renal crônica; Reabilitação.*

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INTRODUCTION

According to the 2010 Brazilian dialysis census[1], the annual prevalence of patients enrolled in dialysis programs in Brazil was 483 million people, 22.4% of them living in the southern region. Hemodialysis (HD) was the most frequent type used by 89.7% of the patients[1].

Hemodialysis patients experience a monotonous and restricted daily life[2]. Activities are limited after the beginning of treatment, a fact contributing to physical inactivity and incapacity[3]. Physical inactivity and incapacity associated with the disease lead to a reduction in physical conditioning and low exercise tolerance, factors mainly related to muscle atrophy, myopathy and malnutrition[4]. A reduction in maximal oxygen uptake (about 50%) and muscle strength (30 to 40%) is observed in HD patients when compared to healthy subjects[5]. In addition to this loss in physical function, studies have emphasized that these patients have a poor perception of quality of life (QoL), a fact interfering with their rehabilitation[6,7].

Regular physical exercise seems to improve the physical fitness and QoL perception of individuals experiencing functional loss[8]. Studies have shown that structured exercise training contributes to the rehabilitation of HD patients, improving the perception of QoL and physical fitness[9,10]. However, these data were obtained in quantitative studies and did not take into consideration the patient's perception. The latter permits the patient to reflect about and report the changes mediated by regular physical exercise. In addition, the knowledge, understanding and perception of these benefits seem to be important for the adoption of a more active lifestyle[11]. Therefore, patients are an important part to judge the benefits of physical exercise programs, filling the gap in the literature.

The objective of the present study was to evaluate the effects of physical training on physical fitness and QoL domains based on physical tests, questionnaires and the perception of patients undergoing HD.

METHODOLOGICAL PROCEDURES

Study design

A qualiquantitative intervention study was conducted using simple random sampling to select the sample of each group. The study was approved by the Ethics Committee of the School of Physical Education, Federal University of Pelotas (Escola Superior de Educação Física, Universidade Federal de Pelotas) (Protocol No. 098/2009).

Population and sample

Among the 72 patients undergoing HD at the Renal Clinic of Santa Lúcia Hospital, Cruz Alta, RS, Brazil, 33 were selected according to the following criteria: duration of HD > 6 months, patients without mental disease or cognitive deficits, patients without decompensated heart disease, and patients with adequate physical condition to participate in the study. Five patients refused to participate and six were regarded as losses. Thus, 22 patients were randomly divided into two groups matched for gender: a nonintervention (control) group and an intervention group that completed the exercise training program.

Data collection

This study was part of a project conducted at the Renal Clinic which comprised different research areas: physical activity, nutrition, and QoL of patients with chronic renal failure. For this study, six interviewers, students of the Physical Education, Nutrition and Nursing courses of the University of Cruz Alta (UNICRUZ), were previously trained in collecting the data.

A pilot study (including five patients, duration of 4 weeks) was conducted to determine the possibility of implementing a physical exercise program during HD sessions. The results were positive as demonstrated by the fact that the patients adhered to the program and did not report discomfort after exercise.

The following variables and instruments for data collection were used: marital status was evaluated by applying a closed-ended dichotomous question: a) living with a partner and b) living without a partner. Education level and socioeconomic status were evaluated based on the Brazilian Standard Criterion of Economic Classification (2008) proposed by the Brazilian Association of Research Companies (Associação Brasileira de Empresas de Pesquisa)[12]. This instrument evaluates the education level based on the years of schooling of the household head; however, in this study the years of schooling refer to the patient on HD.

Quality of life was evaluated by the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36), validated and translated to Portuguese[13]. The instrument consists of 36 items subdivided into eight domains. Each domain provides a score of 0 (worst) to 100 (best).

Physical fitness was evaluated using the following tests:

- The six-minute walk test (T6)[14] was used to evaluate functional capacity. The patient was asked to walk as fast as possible over a period of 6 minutes and the distance covered over this period was recorded.
- Respiratory muscle strength testing was used to evaluate the strength of respiratory muscles. In this test, maximum inspiratory (PI_{max}) and expiratory pressures (PE_{max}) were measured with a manovacuometer (Famabras, Indústria Brasileira) as described by Black and Hyatt[15]. The patient was asked to perform three maximum inspiratory and three expiratory maneuvers while wearing a nasal clip. The mean of the three maneuvers was used for analysis.
- The 30-s chair-stand test (CST)[16] was used to evaluate lower limb strength. The patient sat on a chair (45 cm high) with straight back and with his/her feet shoulder width apart and placed on the floor. The patient was asked to rise and sit for 30 seconds and the maximum number of sit-to-stand repetitions was recorded.

- Abdominal muscle strength was evaluated according to the protocol of the Eurofit Manual for Adults[17]. This test consists of three different levels, with five repetitions of trunk flexion (abdominal) per level. The total number of repetitions (0 to 15) is then counted for the classification of abdominal muscle strength.

The perception of the patients regarding the physical exercise program was evaluated by semi-structured interview consisting of the following questions: 1) Did you perceive any benefit in your physical fitness after the period of physical training? Which benefit(s)? 2) Did you perceive any benefit in your quality of life after participating in the physical exercise program? The interviews were only applied to patients in the intervention group after the period of physical training and the answers were recorded and transcribed for subsequent analysis.

Intervention

Physical training was performed during the HD session three times per week and consisted of moderate intensity exercise whose duration was increased gradually (20 to 45 minutes). The training program lasted for 17 weeks.

Before the HD session, the patient underwent active stretching of the lower and upper limbs and trunk. The patient was asked to remain in the static position for a pre-determined period of 30 seconds. Next, warm up was performed on a stationary bicycle for 3 minutes and the patient was then submitted to aerobic training with an initial duration of 20 minutes. Exercise was prescribed and controlled based on the patient's heart rate using a target zone of 60 to 70% of the maximum heart rate[18]. Since many HD patients use beta-blockers, the modified Borg Scale (beginning: 3 = moderate) was also used as a parameter of exercise intensity. The load and volume of the localized muscle strength exercises were increased gradually. The physical training was completed by passive stretching of the lower limbs and of the arm opposite to the fistula. The complete description of the program has been published previously[19]. However, some specificities were adopted for this study.

Data analysis

The quantitative data were analyzed by descriptive statistics using the SPSS 17.0 program. Numerical variables are reported as the mean and standard deviation and categorical variables are expressed as percentage. The Student *t*-test for independent samples was used to compare means between the nonintervention and intervention groups before the test and the paired Student *t*-test was used to compare values before and after physical training in each group. A level of significance of 5% was adopted.

The interviews were interpreted by content analysis, which permits data classification[20]. The patients were identified as P1, P2, and so forth to maintain anonymity.

RESULTS

The characteristics of the patients participating in this study are shown in Table 1. In both groups, slightly more than 72% of the patients were men. The age group of higher prevalence was the 21- to 40-year group. Patient age ranged from 18 to 60 years (nonintervention: 42.1 ± 11.1 years; intervention: 45.1 ± 10.3 years), with no significant difference between groups. With respect to skin color, most patients in the two groups were white. The duration of HD ranged from 10 to 58 months and the mean duration was longer in the nonintervention group compared to the intervention group, but the difference was not significant. More than 54% of the patients lived with a partner. Most patients in the two groups had incomplete elementary school (nonintervention: 90.9%; intervention: 63.6%). With respect to socioeconomic status, category C was the most prevalent.

Table 1. Demographic and socioeconomic characteristics and duration of hemodialysis of the 22 patients seen at the Renal Clinic of Santa Lúcia Hospital, Cruz Alta, RS.

Variable	Nonintervention group % (n)	Intervention group % (n)
Gender		
Male	72.7 (8)	72.7 (8)
Female	27.3 (3)	27.3 (3)
Age (years)		
< 21	9.1 (1)	27.3 (3)
21 – 40	18.2 (2)	72. 7 (8)
41 – 60	72.7 (8)	-
Skin color		
White	54.5 (6)	72.7 (8)
Non-white	45.5 (5)	27.3 (3)
Duration of hemodialysis (months)		
6 – 12	-	9.1 (1)
> 12	100 (11)	90.9 (10)
Marital status		
Living with a partner	54.5 (6)	54.5 (6)
Living without a partner	45.5 (5)	45.5 (5)
Education level		
Incomplete elementary school	90.9 (10)	63.6 (7)
Complete elementary school	-	23.7 (3)
Incomplete high school	9.1 (1)	9.1 (1)
Socioeconomic status		
A	-	9.1 (1)
B	27.3 (3)	27.3 (3)
C	45.5 (5)	45.5 (5)
D	18.2 (2)	18.2 (2)

Table 2 shows the comparison of QoL domain scores pre- and post-test for the two groups. No significant differences in pre-test scores were observed between groups, indicating the homogeneity of the groups at the beginning of treatment. The QoL domains of the SF-36 most frequently affected in the nonintervention group were physical function, energy/fatigue, and emotional well-being. In contrast, in the intervention group, the most frequently affected domains were emotional well-being, general health status, physical function, and energy/fatigue.

Comparison between pre- and post-test scores in the intervention group showed a significant increase in the domains of physical functioning, physical role functioning, bodily pain, general health, and emotional well-being after physical training.

Table 3 shows the results of physical fitness evaluation of the HD patients. Intergroup comparison revealed no significant difference between groups. Patients in the intervention group presented improvement in the distance covered in the T6, maximum respiratory pressures, number of repetitions in the CST, and abdominal muscle strength, findings that might be explained by the introduction of physical training in their daily lives.

Table 2. Comparison of quality of life domains between the 22 patients in the nonintervention and intervention groups after physical training.

Quality of life	Nonintervention group (n=11)			Intervention group (n=11)		
	Pre-test	Post-test	p	Pre-test	Post-test	p
Physical function	68.6±18.2	59.4±19.9	0.3	67.7±19.4	75.9±18.3	0.001†
Physical role functioning	52.7±22.5	52.3±16.2	0.9	58.6±20.1	67.3±15.7	0.003†
Bodily pain	77.5±27.4	74.5±15.9	0.11	71.5±24.6	78.4±18.3	0.04†
General health	52.0±13.5	58.9±7.4	0.09	49.2±12.5	51.2±12.0	0.02†
Emotional well-being	49.9±23.3	48.1±21.5	0.3	45.1±19.6	54.0±16.1	0.01†
Emotional role functioning	70.7±12.9	66.8±12.1	0.2	72.3±17.7	74.5±15.7	0.05†
Social role functioning	72.7±16.8	72.7±15.2	1.0	72.7±13.8	74.1±10.9	0.3
Energy/fatigue	56.9±19.9	56.8±18.3	0.9	59.6±23.9	62.4± 20.4	0.09

Results are reported as the mean ± standard deviation. †p<0.05: differences between pre-test and post-test means in each group (paired Student t-test). No significant difference in pre-test scores was observed between the nonintervention and intervention groups (Student t-test for independent samples).

Table 3. Comparison of physical fitness variables between the nonintervention and intervention groups after the period of training.

Physical fitness	Nonintervention group (n=11)			Intervention group (n=11)		
	Pre-test	Post-test	p	Pre-test	Post-test	p
T6 (m)	464.2±62.7	457.6±64.2	0.14	469.4±66.1	486.4±62.7	0.004†
PI_{max}	58.2±18.3	58.9±17.5	1.00	52.7±20.0	62.8±14.9	0.002†
PE_{max}	70.6±12.0	69.8±12.7	0.34	72.4±11.2	80.7±10.2	<0.001†
CST (No. of repetitions)	12.2±2.4	11.2±1.7	0.067	12.1±3.2	17.4±3.2	<0.001†
Abdominal muscle strength	5.9±1.4	5.5±1.4	0.22	5.2±2.0	7.54±2.7	<0.001†

Results are reported as the mean ± standard deviation. †p<0.05: differences between pre-test and post-test means in each group (paired Student t-test). No significant difference in pre-test values was observed between the nonintervention and intervention groups (Student t-test for independent samples). T6: six-minute walk test; PImax: maximal inspiratory pressure; PEmax: maximal expiratory pressure; CST: chair-stand test.

Figure 1 shows the three categories of patient's perception regarding the benefits of physical training identified in the interviews. The categories "physical benefits" comprised the largest number of subcategories: "increased strength", "increased cardiopulmonary capacity", reduced cramping", and "improved sleep". The subcategories of the category "psychological benefits" included "the sensation that HD passes more rapidly", "improved mood", and "increased sense of well-being". The "social benefit" category included "improvement of living" with HD colleagues" and "improvement of relations between the medical team and patients".

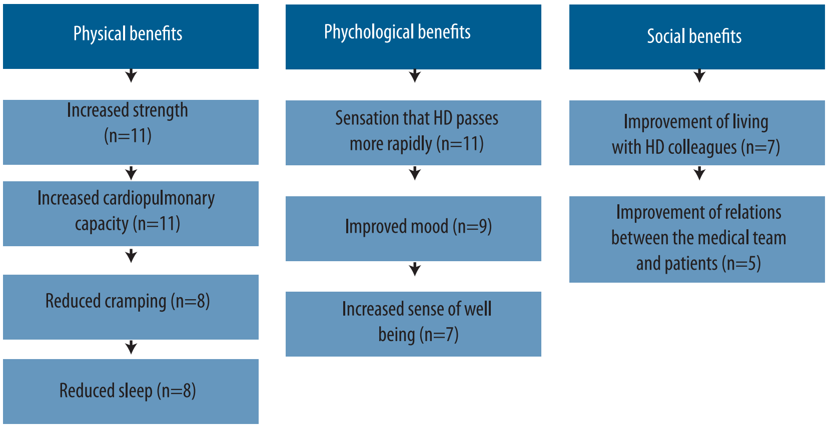

Figure 1. Benefits of the physical exercise program according to the perception of the 11 hemodialysis patients who participated in the intervention.

DISCUSSION

The main finding of the present study was the effectiveness of physical training during HD in improving physical fitness and QoL of patients with chronic kidney disease. In addition, according to patient perceptions, physical training provided physical, psychological and social benefits.

There was a predominance of men (72%) in the present sample, in agreement with the data of Sesso et al.[1] who showed that 57% of the 92,091 patients undergoing dialysis in Brazil were men. This finding can be explained by the fact that men are generally more exposed to risk factors of noncommunicable diseases and disorders[21].

With respect to age, all patients had reached the adult phase. Similarly, a data survey by the Brazilian Society of Nephrology[1] investigating 546 nephrology centers in Brazil found that 53,768 of 73,605 patients were in the 20- to 64-year age group.

The findings regarding education level agree with the Brazilian scenario in which a large part of the population has a low education level. A study investigating the impact of socioeconomic status on the QoL of HD patients showed that approximately 65% of the patients had only elementary school[22], in agreement with the present study in which elementary school level predominated.

Analysis of the data of Table 2 showed an increase in the mean scores of some QoL domains in the intervention group after training. Similar results have been observed for HD patients from San Francisco who presented an increase in functional capacity and improvement of some QoL domains after stretching, strength and aerobic exercises[23]. This improvement in the perception of QoL has also been reported by Oh-Park et al.[24] who prescribed training for 3 months, and by Koukouvou et al.[25] who used a longer training duration (6 months).

Physical exercise significantly improved physical fitness in the intervention group (Table 3), with the observation of a significant increase in the distance covered in the T6. Similarly, in a study investigating 18 patients given exercise two to three times per week for 3 months (aerobic exercise on a cycle ergometer and muscle strength exercise), the distance covered in the T6 increased in nine of 14 patients able to perform the test (mean of 55 m). Headley et al.[26] applied 12 weeks of strength training to 10 HD patients in order to determine whether an increase in muscle strength was accompanied by improvement of functional capacity. After training, the authors observed a significant increase in T6 distance and concluded that the impairment of functional capacity in patients with chronic kidney disease can be attenuated by an increase in muscle strength.

This result was also perceived by the patients themselves and is demonstrated by some answers to the interview questions:

> P1: "... after I started doing gymnastics here at the clinic I feel less breathless. I feel my heart getting less tired…".

> P5: "Ah, now I am much better to do anything. I can walk here and there, I feel good, without my heart jumping through the mouth. That must be it, right? The exercises left me more prepared ...".

With respect to respiratory muscle strength expressed as respiratory pressures, the present study showed that regular physical exercises significantly increased PI_{max} and PE_{max} in the intervention group. Similarly, a study using a combination of aerobic and localized muscle strength exercises also demonstrated a significant difference in PI_{max} ($p<0.05$) and PE_{max} ($p<0.02$) after training[17].

Analysis of lower limb and abdominal muscle strength showed a significant increase in the two parameters in the intervention group after training. Storer et al.[27] found that dialysis patients can have satisfactory gain in this variable after undergoing a physical exercise program. The authors studied 12 patients submitted to cycle ergometer exercise for 10 weeks and observed a significant increase in muscle function, as demonstrated by an increase from 20 to 28 repetitions in the sit-to-stand test and an increase of 16% in lower limb strength ($p=0.003$) and of 53% in fatigability ($p=0.029$)[27]. After 12 weeks of training, Headley et al.[26] observed a significant increase in quadriceps muscle strength (12.7%) measured by dynamometry. Kouidi et al.[28] evaluated seven HD patients by dynamometry and muscle biopsy before and after a period of exercise training and found an increase of 42% in muscle strength and a reduction in atrophy. However, in that study the physical exercise program was performed during the interdialysis period and consisted of aerobic exercise and muscle strength training.

The increase in muscle strength was perceived by all patients in the intervention group, as demonstrated below:

> P8: "...I think we are stronger, since this time of gymnastics it seems the bones and nerves are stronger. You know, I feel up to walking! Before, when I would take a walk to the bakery, I already felt that pain in the legs, you know, it seemed a weakness, you know how it is, right. Not now, I'm even stronger...".

Other perceptions of the patients included a reduction in cramping (n=8), which is characteristic of the signs and symptoms of patients undergoing HD. Regular practice and adequate prescription of physical exercise are able to relieve this condition[29]. Eight of the 11 patients participating in the training program reported sleep improvement. According to Buman and King[30], chronic pain and disabling conditions, as well as other factors, can lead to sleep impairment. On the other hand, physical exercise has been shown to exert positive effects on sleep quality[29].

Despite the observation of the benefits of exercise for the rehabilitation of HF patients, this study has some limitations. Since the study was conducted at a single center, the data cannot be generalized to the entire population with chronic kidney disease. However, in view of the selection process of the participants, the internal validity of the study is considered to be high. Another limitation is the fact that upper limb strength was not evaluated and the physical fitness variables were measured indirectly.

CONCLUSION

The results of the present study show that a planned physical exercise program that respects the limitations of HD patients has many benefits for the rehabilitation of patients with end-stage kidney disease, especially in terms of QoL and physical fitness variables. Therefore, the participation of Physical Education professionals in the nephrology team may favor physical and psychological rehabilitation, permitting the patient to perform certain activities that he/she was no longer able to do after the beginning of HD. Public health strategies, such as the implementation of physical training for HD patients, should be encouraged by administrators and professionals in an attempt to improve the health of these patients. Furthermore, this type of study should be conducted including HD patients with physical debilitation and cognitive deficits since these patients are largely excluded from the sample.

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