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Multidimensional Assessment of Physical Function for People in Dialysis: The Rehabilitation in Hemodialysis Area Centro Toscana (REACT) Study

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Keywords
Exercise · Physical activity · Chronic kidney disease · Assessment

Abstract

Background: Physical performance is poorly addressed in dialysis patients, due to several clinical and organizational barriers. In this study we investigated the physical functional status of a cohort of dialysis patients, using a multidimensional assessment. ***Methods:*** Four hundred and forty-six individuals from 8 hemodialysis centers (176 females), mean age 67.5 ± 14.1 years, and dialysis vintage 62 ± 72.1 months, were assessed by a multidimensional battery including Short Form Health Survey (SF12), Elderly Falls Screening Test (EFST), Short Physical Performance Battery (SPPB), and Handgrip Strength Test (HST). Individuals were stratified into 3 groups (poor, moderate, and good performers) according to the SPPB score. Functional assessments were performed by staff nurses, with the support of physiotherapists and nephrologists. ***Results:*** According to SPPB, 53.4% of dialysis patients showed a severe physical impairment. A significant difference emerged among the 3 SPPB groups for age, HST, EFST, and SF12. The main predictors of the SPPB score group were age ($p = 0.0001$), EFST ($p = 0.028$ moderate performers and $p = 0.0001$ poor performers), dominant HST ($p = 0.04$ moderate performers), and SF12 physical ($p = 0.003$ moderate performers and $p = 0.0001$ poor performers). Each age group showed physical performance comparable to a healthy general population of 10 years older. ***Conclusions:*** Our results confirmed the severe impairment of physical function in the end stage kidney disease population. The multidimensional assessment showed that SPPB test is an effective tool to stratify the dialysis population. Moreover, EFST, HST, and SF12 may contribute to the definition of a tailored physical activity program based on patient characteristics.

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Introduction

The chronic kidney disease (CKD) population usually shows low levels of physical functioning and reduced physical activity. A significant correlation between low physical activity and poor health outcomes in these patients has been reported [1].

Since physical functioning in CKD and dialysis patients is a multifactorial issue [2], its assessment should be performed regularly with validated instruments, in order to prescribe a tailored physical activity program and to evaluate its effects [3]. Multidisciplinary care models for patients with CKD have been shown to reduce all-cause mortality and decrease the hospitalization rate [4]. The efficacy of such approaches greatly relies on the inclusion of rehabilitation specialists, such as physiotherapists [4], in the multidisciplinary team.

In end stage kidney disease, evaluation of functional status is even more challenging due to clinical and organizational barriers, resulting in under-detection and consequently in under-treatment [5]. Nevertheless, hemodialysis sessions could represent an opportunity to assess functional status, with the aim to plan and monitor long-term physical exercise, and to improve quality of life and physical performance. The most frequent functional tests used in intervention trials are related to balance, endurance, strength, and quality of life domains [6, 7].

The Rehabilitation in Hemodialysis Area Centro Toscana (REACT) study was designed to provide an individualized physical activity/reactivation program for dialysis patients and involved three main steps: (1) baseline multidimensional assessment of the dialytic population, in order to stratify it based on functional status and to assess specific impairments and activity limitations; (2) implementation of a tailored reactivation/rehabilitation program related both to functional level and individual impaired performances, and (3) assessment of the interventions effects. Therefore, as the first step of the REACT study, we investigated the functional status among a cohort of dialysis patients through physical function tests commonly used in the multidimensional assessment as a basis for reactivation/rehabilitation interventions.

Materials and Methods

The "Dialysis Exercise Team" Model

A functional assessment of the entire dialysis population in the central Tuscany area was carried out using a multidisciplinary care approach: the "Dialysis Exercise Team" model. Nephrologist, physiotherapist, and dialysis nurse together developed a structured physical assessment program. Our Dialysis Exercise Team was developed by on-site training in 8 hemodialysis centers of local health authority (Azienda USL Toscana Centro), involving 299 healthcare providers (240 nurses, 48 nephrologists, and 11 physiotherapists). Within the team, nephrologists were the case managers of patients, nurses carried out all the assessments, and physiotherapists trained nurses before the start of the study and supervised the assessments while the study was ongoing.

Study Design

The study population of this observational cross-sectional study consisted of 557 patients from the cited hemodialysis centers. Eligibility criteria included the informed consent and the ability to perform the assessment test battery. The study was approved by Tuscany Region Ethics Committee "Area Vasta Centro": Clinical Trial Task Force (approval number 25540_OSS) and written informed consent was obtained from all the participants enrolled in the study.

Assessment Tools

Enrolled patients were assessed using a battery of measurement tools including Short Physical Performance Battery (SPPB) as primary tool aimed to stratify the cohort, and Short Form Health Survey (SF12), Elderly Falls Screening Test (EFST), and Handgrip Strength Test (HST) as additional assessments, aimed to identify specific impairments to customize a tailored intervention.

Physical Performance Battery

Physical performance was assessed using the SPPB [8]. This tool explores balance, endurance, and strength. Each item is scored from 0 to 4 and total score ranges between 0 (very poor performance) and 12 (maximal performance). The SPPB allows the stratification of the tested individuals into 3 groups according to the achieved total score: poor performers when score <6, moderate performers when score 7–9, and good performers when score >9 [8]. SPPB has already been shown to be useful to assess the functional ability of patients on dialysis [9].

Short Form Health Survey

The SF12 is a 12-item short form survey, adopted to assess health-related quality of life, in terms of physical and mental self-perceived health. The SF12 has high reliability, internal consistency, and structural validity in dialysis population [10].

Elderly Falls Screening Test

The EFST [11], originally developed for elderly population, which is at risk of falls, is a simple questionnaire aimed to screen the risk of falling which consists of 5 items including questions about overall gait performance, previous falls or problems with balance, standing, and walking. This test was chosen since dialysis patients have a higher risk of falls [12] and frailty [13], compared to the general population.

Handgrip Strength Test

HST is a widely used tool for the assessment of muscle strength [14], performed at both arms using a dynamometer (Jamar® Plus+ hydraulic hand dynamometer) in a sitting position, with the arm along the trunk, the elbow flexed at approximately 90 degrees and the forearm in neutral position. Both SPPB and HST were performed before the beginning of the dialysis session [15].

All the assessment tools were administered by nursing staff with the support of a physiotherapist, in dialysis rooms adequately equipped for the assessments. Patients were invited to arrive 30 min earlier on their first hemodialysis session after the short interdialytic period to perform the physical tests, while the questionnaires were provided during the dialytic sessions.

Statistical Analysis

The results were expressed as mean values (±SD) for continuous variables and as frequency for nominal variables. The *t* test for independent variables was used to compare age and dialytic vintage between gender groups. One-way analysis of variance (ANOVA) was applied to compare the three SPPB groups. χ^2 test was used to analyze gender differences between groups.

A multivariate analysis model was used to compare poor performers and moderate performers according to SPPB score, with good performers as a control group. The level of statistical significance (*p* value) was set at 0.05. Data analyses were performed using the SPSS statistical package 20.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

From a population of 557 patients, 38 (6%) were excluded due to lack of consent, and 78 (14%) were excluded because unable to perform the physical tests. Therefore, 446 patients (80%) were included in the study: 176 females and 270 males, aged 67.5 ± 14.1 years. Out of the 446 patients, 260 patients (58%) were older than 65 years and 78 (17%) older than 80 years. Females were younger than males (65.4 ± 14.0 vs. 68.7 ± 14.2 years, respectively, $p = 0.022$). Mean dialysis vintage was 62 ± 72 months and significantly higher in females than in males (73.4 ± 76.0 vs. 54.0 ± 67.7 months, respectively, $p = 0.007$). The dialysis vintage was <1 year in 22.6% of patients, >5 years in 31.4% and >10 years in 14.8%.

The assessment scores are shown in Table 1. The whole assessment battery performance required about 20 min, and no adverse event occurred during assessment. The SPPB correlated significantly with age, dominant arm strength, non-dominant arm strength, EFST, SF12 physical and mental component, while no differences were found for gender and dialytic vintage.

At the multivariate analysis, after correction for age, dialytic vintage, and gender, in comparison to good performers, the independent predictors of moderate physical performance were SF12 physical health, dominant arm HST, and EFST. Moreover, only SF12 physical health and EFST were independent predictors of poor physical performance (Table 2).

Discussion

Our investigation aimed to implement a multidisciplinary perspective for the assessment of physical function to promote physical activity for dialysis patients. Only few programs provide physical function assessment and exercise training in kidney care [16] and physiotherapists are rarely involved. On the other hand, the multidisciplinary team, including physiotherapist and nurses – the so-called "exercise team," has been shown to provide positive effects on sustaining physical functioning in hemodialysis patients [17].

The implementation of an exercise team in clinical practice is challenging because it implies a change of attitude for involved professionals. Despite this issue and a number of other barriers [18, 19], all healthcare professionals concurred to the implementation of this project [20].

Our study enrolled and assessed 446 dialysis patients, representing, at our knowledge, one of the largest cohorts screened for physical function reported in the literature [21, 22]. The exclusion of 78 patients (14%) due to inability to perform the SPPB reveals the high level of frailty of hemodialysis patients.

We chose to stratify our population according to SPPB, a validated battery test to assess functional status [23] because it is simple, easy, and quick to perform. The stratification through SPPB outlined that more than half of the study population shows a poor or moderate

Table 1. Patients'characteristics by groups according to SPPB scores

Variables	Poor performers (*n* = 119, 26.7%)	Moderate performers (*n* = 119, 26.7%)	Good performers (*n* = 208, 46.6%)	*p* value	All
Age, years	75.1±9.8	72.4±10.0	60.2±14.7	<0.001	67.5±14.1
Males/females, *n*	62/57	75/44	132/76	0.087	270/176
Dialytic vintage, months	59.0±64.3	58.9±66.6	64.8±79.2	0.702	61.5±72.1
Handgrip strength dominant, kg	21.7±11.5	26.1±13.9	31.1±15.0	<0.001	27.3±14.4
Handgrip strength non-dominant, kg	18.2±10.5	21.9±13.5	26.2±14.5	<0.001	23.0±13.7
Elderly Falls Screening Test (score)	2.3±1.4	1.23±1.6	0.7±1.0	<0.001	1.3±1.5
SF12 physical health (score)	32.8±9.8	38.92±9.9	44.0±9.5	<0.001	39.7±10.7
SF12 mental health (score)	46.0±12.3	46.92±12.0	49.2±11.2	0.045	47.8±11.7

Continuous variables are reported as mean ± SD. SPPB, Short Physical Performance Battery.

Table 2. Independent predictors of physical impairment according to SPPB score in the multivariate analysis

SPPB Score Group	Sig	HR	95% CI	
			lower	upper
Moderate performers				
Age, years	0.000	1.078	1.051	1.105
Gender (F/M)	0.520	1.223	0.663	2.257
Dialytic vintage, months	0.719	0.999	0.996	1.003
Handgrip strength dominant arm, kg	0.040	0.955	0.914	0.998
SF12 physical health (score)	0.003	0.959	0.933	0.986
SF12 mental health (score)	0.412	0.991	0.969	1.013
Elderly Falls Screening Test (score)	0.028	1.289	1.027	1.618
Poor performers				
Age, years	0.000	1.107	1.073	1.143
Gender (F/M)	0.218	1.573	0.765	3.236
Dialytic vintage, months	0.692	0.999	0.995	1.004
Handgrip strength dominant arm, kg	0.270	0.973	0.926	1.022
SF12 physical health (score)	0.000	0.923	0.893	0.953
SF12 mental health (score)	0.585	0.993	0.967	1.019
Elderly Falls Screening Test (score)	0.000	1.887	1.480	2.407

Control group: good performers. SPPB, Short Physical Performance Battery.

physical performance (Table 1) and mean SPPB values are lower than normative values recently reported in literature [24–27].

Moreover, this finding is even more relevant because SPPB values of our patients aged 67.5 ± 14.1 years were similar to those of the general population older than 80 years. This difference is maintained for all age groups that show performances similar to those of 10 years and older (Table 3). On the whole, performance of dialytic patients assessed by SPPB is so poor that comparison with the general population points out the tendency to a floor effect of SPPB in the dialytic population in contrast to a ceiling effect of the same assessment in the general population [28].

Table 3. SPPB scores among age groups found in the present study and published normative data

Río et al. [24], 2021		Ramírez-Vélez et al. [26], 2020		Bergland and Strand [27], 2019			Lee et al. [25], 2021			REACT	
age groups	SPPB score (mean±SD)	age groups	SPPB score (mean±SD)	age groups	SPPB score (mean±SD)		age groups	SPPB score (mean±SD)		age groups	SPPB score (mean±SD)
					males	females		males	females		
							21–30	12.0±0.2	12.0±0.2	21–30	12±00
							31–40	12.0±0.2	11.9±0.5	31–40	11.7±0.6
							41–50	12.0±0.2	12.0±0.0	41–50	10.8±2.5
				40–59	11.9±0.6	11.8±0.6	51–60	11.9±0.3	11.8±0.4	51–60	9.7±3.1
60–64	10.8 (1.0)	60–69	9.8±1.7	60–69	11.7±0.8	11.4±1.1	61–65	11.8±0.6	11.6±1.2	61–70	8.6±3.0
65–69	10.5 (1.2)						66–70	11.9±0.3	11.6±1.2		
70–74	10.3 (1.5)	70–79	8.9±1.9	70–74	11.4±1.1	10.8±1.6	71–75	11.3±1.1	11.6±0.8	71–80	7.7±3.2
75–79	10.1 (1.4)			75–79	10.8±1.5	10.2±1.9	76–80	11.2±1.0	11.0±1.4		
80–84	9.5 (1.6)	80+	7.5±2.2	80+	10.1±2.3	9.5±2.5	>80	10.2±2.3	10.4±2.1	>80	6.1±3.3
85–89	8.6 (2.1)										
90–94	7.8 (2.1)										
>95	8.0 (–)										

SPPB, Short Physical Performance Battery; SD, standard deviation.

Expectedly, physical performance assessed by SPPB was influenced by age and significantly correlated with all the other tests, suggesting a consistency of the multidimensional evaluation among the different domains. Interestingly, our results confirm SPPB as a reliable tool to stratify a dialytic population into three homogeneous groups of patients for physical function classes. Nevertheless, SPPB test should be integrated by the other multidimensional tests to improve the global assessment.

In our cohort, SF12 physical health, EFST and dominant arm HST showed a strong predictivity of frailty and should be included in the multidimensional evaluation of physical status. Self-perceived quality of physical function by SF12 was similar to performance assessed through SPPB suggesting a good awareness of physical health status [10] by patients, and was a reliable predictor of both moderate and severe physical impairment.

The HST was significantly different among the three groups for both arms, with a better score for the dominant arm than for the non-dominant. At multivariate analysis dominant hand, HST was a significant predictor only for moderate impairment, probably due to inability to complete the test by the poor performers.

In addition, EFST independently predicted the risk to belong to moderate or poor performance groups. To our knowledge, this is the first time EFST is applied in dialytic population, and our data suggest further investigations to support its validation. This issue seems to be relevant since recent longitudinal studies in elderly population also found that the increase in one SPPB score decreased the probability of falls by 15% and of recurrent falls by 17% over a 2-years period [29].

Perspectives

SPPB can be used to identify different levels of physical function of patients, while the other tests can be useful to plan tailored rehabilitation treatment on the basis of personal strengths and weakness. Specifically, a reduction of muscle strength, assessed by handgrip, may suggest the need of introduce strength exercises as well as the identification of a risk of falls suggest the implementation of a preventive program. SPPB score allows the balance of face-to-face interventions and self-management programs for each patient. Once completed the physical function evaluation, a group of standardized and simple exercises during dialysis session and at home are prescribed, to be performed at low-moderate intensity with the aim to improve the physical function and related clinical outcome. This project was planned in agreement with a recent systematic review, which shows the benefits from supervised physical activity provided 3 times weekly at moderate intensity [22].

In addition, patients will be addressed to different exercise programs according to the SPPB stratification: SPPB poor performers will follow only a basic mobilization program. The SPPB moderate performers will be evaluated by physiotherapist to start a tailored rehabilitation program according to the other tests scoring, to be performed under supervision; the SPPB good performers will be addressed to a program of higher intensity physical activity without supervision. Evaluation of outcomes in our study population is in progress. The implementation of the assessment of physical function and physical activity in dialysis patients aimed to make focused rehabilitation intervention in order to preserve quality of life and improve survival.

Strength and Limitation of the Study

The strength of the study is the large cohort of dialysis population studied, and the comprehensive evaluation with different tests used for assessment of physical functioning. The key points for the success of this program are the involvement of different professional actors within the multidisciplinary team and the high compliance of patients. The limitations of our studies involve the cross-sectional study design, the lack of a control group, and the lack of additional clinical and biochemical data, which could contribute to a more comprehensive assessment of health status.

Conclusions

The assessment of a large multicenter cohort of dialysis patients confirmed the severe impairment of physical function in this population. SPPB test is an effective tool in stratifying the dialysis population on the basis of their physical performance. EFST, handgrip strength, and SF12 contribute to the definition of a tailored physical activity program based on patient characteristics. Evaluation of outcomes in our study population is in progress; further investigations are required to validate our multidimensional approach in kidney care.

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Statement of Ethics

The study was approved by the Tuscany Region Ethics Committee "Area Vasta Centro": Clinical Trial Task Force (approval No. 25540_OSS) and written informed consent was obtained from all the participants enrolled in the study.

Conflict of Interest Statement

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Author Contributions

A.C.: study design, conceptualization, and writing of the manuscript. F.R. and A.P.: data collection, data entry, and text review. M.P.: methodology, data analysis, and writing of the manuscript. G.F. and G.S.: text review. S.L.: data collection. A.R.: conceptualization and writing of the manuscript. All authors read and approved the final version of the manuscript.

Data Availability Statement

The datasets generated or analyzed during this study cannot be publicly shared due to ethical considerations. Access to the data can be requested to the corresponding author upon reasonable request.

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