Blanco-Mavillard I, et al. https://doi.org/10.37551/S2254-28842025022

Impact of post-dialysis fatigue and recovery time in chronic haemodialysis patients: an exploratory observational study

Ian Blanco-Mavillard[1,4], Gregorio Bolaños-Herrezuelo[2], Cynthia Sánchez-Rojas[3], María del Mar Palmer Massanet[2], María Martínez-Nuévalos[2], Ismael Fernández-Fernández[2]

[1] Hospital Regional Universitario de Málaga, Málaga, Spain
[2] Hospital de Manacor. Manacor, Islas Baleares, Málaga, Spain
[3] Hospital QuironSalud Marbella, Málaga, Málaga, Spain
[4] C-13 Research Team, IBIMA plataforma-BIONAND, Málaga, Spain

Please cite this article in press as:
Blanco-Mavillard I, Bolaños-Herrezuelo G, Sánchez-Rojas C, Palmer Massanet MM, Martínez-Nuévalos M, Fernández-Fernández I. Impact of post-dialysis fatigue and recovery time in chronic haemodialysis patients: an exploratory observational study. Enferm Nefrol. 2025;28(3):209-215

Corresponding author:
Ian Blanco Mavillard
ian.blanco.sspa@juntadeandalucia.es

Reception: 08-01-25
Acceptance: 08-16-25
Publication: 09-30-25

ABSTRACT

Introduction: Haemodialysis is the most widely used renal replacement therapy in advanced stages of kidney disease, although it entails adverse effects that directly impact quality of life. Among these, post-dialysis fatigue stands out as a persistent sensation of exhaustion that may last for hours or even days, and whose impact has been scarcely documented.

Objectives: To estimate the frequency of post-dialysis fatigue and recovery time in patients undergoing chronic haemodialysis, analysing associated clinical, functional, and subjective variables.

Material and Method: We conducted a cross-sectional study from January through April 2023 in a Spanish public hospital. Patients with more than 3 months on treatment were included. Demographic, clinical, functional, technical, and self-reported health perception data were collected. Fatigue was defined by self-report. Descriptive and bivariate analyses were performed.

Results: A total of 43 patients were included, with a mean age of 67.4 years; 28% were women. Post-dialysis fatigue was reported by 53.5% of patients, with no significant differences by age or sex. Patients who experienced post-dialysis fatigue had a longer mean recovery time (467.9±194.4 *vs* 66.3±137.0 minutes; $p<0.001$), lower total protein levels (6.1 *vs* 6.5 g/L; $p=0.022$), and worse self-perceived health ($p=0.026$). No associations were found with other clinical or technical variables.

Conclusions: Post-dialysis fatigue is a frequent event and is associated with longer recovery time and both clinical and subjective markers of poorer general health. Its systematic evaluation could improve the comprehensive management of patients on haemodialysis.

Keywords: haemodialysis; post-dialysis fatigue; recovery time; quality of life.

RESUMEN

Impacto de la fatiga postdiálisis y el tiempo de recuperación en el paciente crónico en tratamiento de hemodiálisis: estudio observacional exploratorio

Introducción: La hemodiálisis es el tratamiento sustitutivo más empleado en fases avanzadas de enfermedad renal, aunque conlleva efectos adversos que afectan directamente la calidad de vida. Entre ellos destaca la fatiga postdiálisis, una sensación persistente de agotamiento que puede prolongarse durante horas o días, y cuyo impacto ha sido escasamente documentado.

Objetivos: Estimar la frecuencia de fatiga postdiálisis y el tiempo de recuperación en pacientes en hemodiálisis crónica, analizando variables clínicas, funcionales y subjetivas asociadas.

Material y Método: Estudio transversal realizado entre enero y abril de 2023 en un hospital público español. Se incluyeron pacientes con más de tres meses en tratamiento. Se recogieron datos demográficos, clínicos, funcionales, técnicos y percepciones de salud. La fatiga se definió por autorreporte. Se aplicaron análisis descriptivos y bivariantes.

Resultados: Se incluyeron 43 pacientes, con una edad media de 67,4 años, siendo .el 28% mujeres. El 53,5% reportaron fatiga postdiálisis, sin encontrar diferencias significativas por edad o sexo. Los pacientes que presentaron fatiga postdiálisis presentaron un mayor tiempo medio de recuperación (467,9±194,4 frente a 66,3±137,0 minutos; p<0,001), niveles más bajos de proteínas totales (6,1 frente a 6,5 g/L; p=0,022) y peor autopercepción de salud (p=0,026). No se hallaron asociaciones con otras variables clínicas ni técnicas.

Conclusiones: La fatiga postdiálisis es un evento frecuente y se asocia a mayor tiempo de recuperación y a marcadores clínicos y subjetivos de peor estado general. Su evaluación sistemática podría mejorar el abordaje integral del paciente en hemodiálisis.

Palabras clave: hemodiálisis; fatiga postdiálisis; tiempo de recuperación; calidad de vida.

INTRODUCTION

Currently, 700 million people worldwide suffer from chronic kidney disease (CKD), of whom approximately three million are on renal replacement therapy, with a prevalence between 7–12% depending on the world region[1-3]. Moreover, these numbers are expected to double by 2030[4], with hemodialysis being the most widely used life-support treatment[5-6]. However, chronic hemodialysis has a substantial impact on patient health[7]. Among the most frequent complications is symptomatic hypotension, which occurs in up to 30% of patients during hemodialysis and may even lead to premature termination of the dialysis session due to intradialytic symptoms[8]. In this regard, patients experiencing complications often report post-dialysis fatigue (PDF), with a prolonged post-dialysis recovery time (DRT)[9]. Recovery may occur within the first 30 minutes among incident dialysis patients with good tolerance[10], but may extend up to 12 hours after treatment in complex chronic patients with frailty symptoms[11]. Thus, DRT may be defined as the amount of time a patient needs to recover physically and psychologically after a hemodialysis session, allowing them to perform basic activities of daily living without limitations[12].

There is limited evidence on how DRT affects quality of life or how hemodialysis could be adapted to improve this indicator[13]. Several factors may influence recovery time in hemodialysis patients, including intradialytic complications, treatment type and dose, and patient comorbidities[7,10,14,15]. Although hemodialysis is a life-sustaining therapy, its adverse effects increase patient burden and may significantly reduce quality of life both during and after treatment. Understanding the extent to which PDF symptoms prolong DRT could clarify the magnitude of the problem and guide improvement strategies, serving as an innovative and clinically relevant indicator for the management and effectiveness of hemodialysis[7,15].

Quality of care for patients on dialysis is largely defined by quantifiable laboratory outcomes, including urea kinetics, anemia, and bone-mineral metabolism. A prolonged recovery time negatively affects clinical indicators, perceived fatigue and pain, sleep, and cognitive function[16], and is associated with higher hospitalization and mortality rates[13,17]. Moreover, PDF may severely limit a patient's ability to perform daily activities, directly affecting quality of life, employment capacity, and social relationships. Despite its prevalence and impact on perceived health among renal patients, these symptoms have not been systematically documented in the scientific literature[18] and the use of PROMs in clinical care remains very limited[19]. Therefore, the aim of this study was to estimate the prevalence of PDF and DRT in patients undergoing chronic hemodialysis, exploring associated clinical and functional variables related to both the patient and renal therapy.

MATERIAL AND METHOD

Study design and setting

We conducted an analytical, prospective observational study in September 2023, recruiting all participants from the Hemodialysis Unit of *Hospital de Manacor*, a secondary-level hospital integrated into the Health Service of the Balearic Islands (Spain) (IB-Salut). The hospital serves approximately 150,000 inhabitants, mainly from the Llevant region and part of the Pla de Mallorca. It provides specialized care in internal medicine, general surgery, pediatrics, gynecology and obstetrics, anesthesiology, intensive care, emergency medicine, and various other medical and surgical specialties.

Participants

A non-random intentional sampling strategy was used. The purpose and details of the study were communicated to all unit staff through email and an in-person presentation to ensure adherence during data collection. All patients undergoing chronic hemodialysis for more than 3 months at the time of the study and receiving treatment at *Hospital de Manacor* were recruited. Exclusion criteria included patients unaware of their illness or unable to clearly report their perceptions, and patients who did not provide informed consent.

Procedures / Data collection

Data collection occurred during September 2023. Patients were initially contacted and provided with study information and informed consent forms. Subsequently,

all sociodemographic variables, validated questionnaires (KDQOL-36 by Hays et al.[20]), Barthel Index, laboratory tests, and hemodialysis session variables were recorded. The new indicators included were PDF and DRT.

Variables

The primary variables were the presence of PDF and the time to recovery after dialysis (DRT). These variables were collected individually, documenting the presence of fatigue at the end of the dialysis session and the patient's perception of the time required to regain full function and the ability to perform basic activities of daily living since the previous dialysis session. Both PDF and DRT were recorded using a self-administered questionnaire completed by the nurse during each shift and entered into the REDCap platform during the hemodialysis session. Fatigue was assessed through a binary question (yes/no), and recovery time after the previous session was measured in hours.

The secondary variables were distributed into several categories:

- **Patient sociodemographic variables:** age, sex, BMI, duration of chronic treatment, presence of diabetes, modified Charlson comorbidity index, Barthel Index, and hospitalization within the previous month.
- **Dialysis-related variables:** dialysis shift and modality, type of vascular access, hemodialysis dose, ultrafiltration rate, total ultrafiltration volume, blood flow and dialysate flow, conductivity, patient temperature, Kt/V, Kt, and whether the patient slept during the session.
- **Analytical follow-up variables:** hemoglobin, 24-hour creatinine clearance (mL/min) and 24-hour urine output, total protein (g/L), and albumin (g/L).
- **Quality-of-life questionnaire variables:** KDQOL-36. The KDQOL-36 questionnaire is a health-related quality-of-life assessment instrument specifically designed for individuals with chronic kidney disease. It includes eight dimensions: (1) symptoms and problems of kidney disease; (2) effects of treatment; (3) burden of kidney disease; (4) physical function; (5) social function; (6) emotional function; (7) general health status; and (8) health-related quality of life.

Statistical analysis

A statistical analysis was performed using the variables exported from NefroLink, which were stored in an anonymous database created in an Excel spreadsheet (Microsoft Office 365). The dataset was subsequently cleaned and analyzed using IBM SPSS Statistics version 25.

Categorical data were summarized as proportions; continuous variables as mean, median, SD, and interquartile range. Quantitative methods were applied for primary and secondary outcomes. Bivariate analyses used parametric or non-parametric tests depending on distribution (correlation, ANOVA, chi-square). Missing primary outcome data (DRT) were not imputed. Statistical significance was set at $p<0.05$.

Ethical considerations

The study was approved by the Ethics and Research Committee of *Hospital de Manacor* and the Ethics Committee of the Balearic Islands. Written informed consent was obtained from each participant. Reference number CEI-IB 5170/23 PI.

RESULTS

General characteristics of the sample

A total of 43 patients were included; 27.9% (n=12) were women. Mean age was 67.4 years (SD, 12.8). Mean time on chronic hemodialysis was 38.3 months (SD, 37.4). Patients had a mean BMI of 47.2 kg/m² (SD, 10.6) and a modified Charlson comorbidity index of 5.3 (SD, 2.6). Most were functionally independent (Barthel score mean 88.4, SD, 17.8); 58.1% (n=25) had diabetes. Only 9.3% (n=4) had been hospitalized in the previous month.

Prevalence of PDF and Recovery Time

A total of 55.8% of patients (n=24) reported PDF. The mean DRT for the entire sample was 290.5 minutes (SD, 263.5). The frequency distribution showed that 41.9% recovered in <1 hour, 13.9% between 1 and 5 hours, and 44.2% between 5 and 10 hours.

Dialysis and Laboratory Characteristics

Regarding dialysis characteristics, most patients (74.4%) received online hemodiafiltration (OL-HDF) with a mean weekly dialysis duration of 11.6 hours (SD, 1.4). Native arteriovenous fistula was the most common vascular access (62.8%). For the technical parameters of dialysis, the mean blood flow rate was 329.7 mL/min (SD, 39.7) and the mean dialysate flow rate was 547.7 mL/min (SD, 71.5), with a mean conductivity of 14.0 mS/cm (SD, 0.1). Dialysate temperature remained constant at 36.5 °C (SD, 0.1). Additionally, most patients (65.1%) reported routinely sleeping during the session. Laboratory parameters showed a mean hemoglobin level of 11.3 g/dL (SD, 1.4) and mean albumin level of 3.8 g/dL (SD, 0.4). The remaining variables are shown in **table 1**.

KDQOL-36 Questionnaire

Analysis of the KDQOL-36 results showed a mean score of 50.5 (SD, 15.4) for the SF-12 physical and mental component. The perceived burden of kidney disease had a mean score of 53.7 (SD, 26.9). The symptom/problem dimension of CKD scored 80.4 (SD, 12.1), and the effects of CKD on daily life scored 68.0 (SD, 22.2).

Comparative Analysis in Relation to PDF

In the bivariate analysis, patients reporting PDF had a significantly longer recovery time than those without PDF (467.9 min [SD, 194.4] vs 66.3 min [SD, 137.0]; $p<0.001$). Regarding biochemical parameters, patients with PDF had significantly lower total protein levels (6.1 g/L vs 6.5 g/L; $p=0.022$), suggesting a possible association with nutritional status. Although albumin levels were also lower in the

Table 1. Sociodemographic characteristics of the sample.

Variable	Total/Value
Total number of patients	43 (100)
Age, mean (SD)	67.4 (12.8)
Sex, n (%)	
Female	12 (27.9)
Male	31 (72.1)
BMI, mean (SD)	47.2 (10.6)
Time on dialysis in months, mean (SD)	38.3 (37.4)
Charlson Index, mean (SD)	5.3 (2,6)
Barthel Index, mean (SD)	88.4 (17.8)
Diabetes, n (%)	
No	18 (41.9)
Yes	25 (58.1)
Hospitalization in the past month, n (%)	
No	39 (90.7)
Yes	4 (9.3)
Primary Outcomes	
Post-dialysis fatigue, n (%)	
No	19 (44.2)
Yes	24 (55.8)
Recovery time, mean (SD)	290.5 (263.5)
Recovery time categories, n (%)	
0–1 hour (0–60 min)	18 (41.9)
1–5 hours (61–300 min)	6 (13.9)
5-10 hours (301-600 min)	19 (44.2)
Dialysis Characteristics	
Vascular access type, n (%)	
Low-flux HD	4 (9.3)
High-flux HD	7 (16.3)
Online hemodiafiltration (HDF-OL)	32 (74.4)
Weekly dialysis dose (hours), mean (SD)	11.6 (1.4)
Tipo acceso vascular, n (%)	
CVC	16 (37.2)
Native AV fistula (FAVi)	27 (62.8)
Prosthetic AV fistula (pFAV)	0
Dialysis shift, n (%)	
Morning	25 (58.1)
Afternoon	18 (41.9)
Ultrafiltration rate per session (kg), mean (SD)	0.6 (0.4)
Total ultrafiltration (kg), mean (SD)	1.8 (1.0)
KT, mean (SD)	47.4 (12.5)
Kt/V, mean (SD)	1.3 (0.3)
Blood flow (mL/min), mean (SD)	329.7 (39.7)
Dialysate flow (mL/min), mean (SD)	547.7 (71.5)
Conductivity (mS/cm), mean (SD)	14.0 (0.1)
Temperature (°C), mean (SD)	36.5 (0.1)
Sleeps during dialysis, n (%)	
No	15 (34.9)
Yes	28 (65.1)
Analytical Characteristics	
Hemoglobin, mean (SD)	11.3 (1.4)
24h urine creatinine clearance (mL/min), mean (SD)	2.7 (4.0)
24h urine output, mean (SD)	302.9 (454.1)
Total proteins (g/L), mean (SD)	6.3 (0.6)
Albumin (g/L), mean (SD)	3.8 (0.4)
KDQOL-36	
SF-12 Physical & Mental Component, mean (SD)	50.5 (15.4)
Burden of kidney disease, mean (SD)	53.7 (26.9)
Symptoms / problems of CKD, mean (SD)	80.4 (12.1)
Effects of CKD on daily life, mean (SD)	68.0 (22.2)

PDF group (3.7 g/L vs 3.9 g/L), the difference did not reach statistical significance (p=0.064). KDQOL-36 analysis showed significantly lower scores in the PDF group in both the SF-12 physical and mental component (43.9 *vs* 58.8; p=0.001) and the perceived burden of kidney disease (44.9 *vs* 64.8; p=0.014). No statistically significant differences were observed between groups in the remaining sociodemographic, clinical, dialysis-related variables, or other KDQOL-36 domains. All findings are presented in **table 2**.

DISCUSSION

This study shows that more than half of the patients reported symptoms consistent with PDF, with 44% stating that they required more than five hours to recover physically, mentally, and socially after their dialysis session. It is estimated that between 43–81% of patients experience this symptomatology recurrently, consistent with findings in the scientific literature[21,22]. In our study, we observed a significantly longer DRT among patients presenting PDF vs those who did not. This finding not only validates DRT as a clinical marker but also reinforces the need for its systematic assessment in clinical practice. Therefore, both the detection of PDF and DRT could be proposed as indirect clinical outcomes of dialysis treatment tolerance, given that prolonged DRT—particularly beyond four hours—has been associated with poorer adherence to nutritional guidelines, worse attendance to dialysis sessions, and higher hospitalization rates[7,23,24]. The relevance of this finding extends beyond symptom severity, directly affecting quality of life, functional autonomy, and the potential for social and occupational reintegration. It also influences the patient's ability to plan basic daily activities[16], contributing to a vicious cycle of progressive deterioration[25,26].

Another relevant finding was the association between PDF and significantly lower total protein concentrations compared with patients without PDF (6.1 g/L *vs* 6.5 g/L; p=0.022). This is consistent with multiple investigations identifying nutritional

status as a key determinant of vitality in hemodialysis patients[26]. Protein–energy wasting is highly prevalent in this population due to protein losses inherent to dialysis, chronic low-grade inflammation, and decreased caloric intake. This condition has been consistently linked to lower functional capacity, greater frailty, and poorer overall prognosis[11,13]. In this context, PDF may represent an early clinical manifestation of nutritional deterioration, anticipating more severe stages such as the protein–energy wasting syndrome. These biochemical markers should be interpreted not only as indicators of nutritional status but also as a reflection of systemic functional reserve.

Regarding quality-of-life analysis, significant inter-group differences were observed: patients with PDF displayed lower scores on the physical and mental components of the SF-12, as well as a greater perceived burden of chronic kidney disease. These findings are consistent with the literature describing PDF as one of the dimensions with the greatest impact on quality of life among renal patients[13,14]. Several studies have validated that the physical and emotional domains of the KDQOL-36, including the SF-12, are sensitive to variations in symptoms such as fatigue, pain, and sleep disturbances[26]. In this regard, our findings reinforce that fatigue should not only be evaluated in terms of intensity or duration but also considered a cross-sectional component affecting overall well-being and daily functioning. These data open a promising avenue for developing combined assessment tools that incorporate both biomarkers and symptom indicators, acting as central modulators between clinical status and the subjective experience of illness. This perspective provides a strong argument for including systematic fatigue assessment as part of quality-of-life indicators in hemodialysis programs, on the same level as physiological variables such as Kt/V or hemoglobin. Incorporating such an indicator would enable a more holistic evaluation of patient status and the early identification of at-risk subgroups who could benefit from individualized intervention strategies, potentially reducing the human, social, and economic burden of this underestimated event in renal replacement therapy.

Our study presents methodological limitations that should be considered when interpreting the results. As this phenomenon is understudied and underestimated, preliminary data were not available in our context; therefore, a first exploratory approach was conducted in a controlled local setting using a cross-sectional observational design. This allowed us to determine the prevalence of PDF and DRT after each dialysis session. Future studies should propose an internationally agreed definition measurable through a specific and sensitive instrument capable of analyzing the relationship between PDF, DRT, patient characteristics, and quality of life, with the aim of identifying risk factors and establishing implementation strategies for patient-centered, adapted interventions.

Table 2. Comparative analysis of characteristics by post-dialysis fatigue.

Comparative Analysis	No post-HD fatigue n (%) 19 (44.2)	Post-HD fatigue n (%) 24 (55.8)	*p*-valor
Main variable			
Recovery time, mean (SD)	66.3 (137.0)	467.9 (194.4)	<0.001
Sociodemographic characteristics			
Age, mean (SD)	65.3 (15.3)	69.0 (10.6)	0.383
Sex, n (%)			0.373
Female	4 (21.1)	8 (33.3)	
Male	15 (78.9)	16 (66.7)	
BMI, mean (SD)	48,7 (12.0)	46.0 (9.4)	0.414
Time on dialysis in months mean (SD)	44.2 (32.4)	33.7 (41.0)	0.367
CharIson Index, mean (SD)	5.7 (2.7)	4.9 (2.4)	0.277
Barthel Index, mean (SD)	90.8 (19.7)	86.5 (16.3)	0.434
Diabetes, n (%)			0.977
No	8 (42.1)	10 (41.7)	
Yes	11 (57.9)	14 (58.3)	
Hospitalization in the last month, n (%)			0.062
No	19 (100)	20 (83.3)	
Yes	0	4 (16.7)	
Dialysis characteristics			
Dialysis type, n (%)			0.657
Low-flux HD	2 (10.5)	2 (8.3)	
High-flux HD	2 (10.5)	5 (20.8)	
HDF-OL	15 (78.9)	17 (70.8)	
Weekly dialysis dose (hours), mean (SD)	11.3 (2.0)	11.8 (0.5)	0.212
Dialysis shift, n (%)			0.224
Morning	13 (68.4)	12 (50.0)	
Afternoon	6 (31.6)	12 (50.0)	
Vascular access type, n (%)			0,189
CVC	5 (26.3)	11 (45.8)	
Native AVF (FAVi)	14 (73.7)	13 (54.2)	
Prosthetic AVF (pFAV)	0	0	
Mean UF rate per session (kg), mean (SD)	0.6 (0.4)	0.6 (0.4)	0.848
Total ultrafiltration (kg), mean (SD)	1.8 (1.1)	1.8 (0.9)	0.970
KT, mean (SD)	46.7 (11.0)	47.9 (13.9)	0.763
Kt/V, mean (SD)	1.3 (0.3)	1.4 (0.3)	0.430
Blood flow (mL/min), mean (SD)	330.8 (36.9)	328.7 (42.6)	0.870

Análisis comparativo	No post-HD fatigue n (%) 19 (44.2)	Post-HD fatigue n (%) 24 (55.8)	*p*-valor
Dialysate flow, mean (SD)	555.4 (72.3)	541.7 (71,7)	0.537
Conductivity, mean (SD)	14.0 (0.2)	14.0 (0.1)	0.959
Temperature, mean (SD)	36.4 (0.1)	36.5 (0.1)	0.123
Sleeps during dialysis, n (%)			0.377
No	8 (42.1)	7 (29.2)	
Yes	11 (57.9)	17 (70.8)	
Analytical Characteristics			
Hemoglobin, mean (SD)	11.7 (1.4)	11.0 (1.4)	0.125
24h urine creatinine clearance (mL/min), mean (SD)	3.4 (4.6)	2.1 (3.5)	0.296
24h urine output, mean (SD)	357.9 (434.4)	259.4 (473.7)	0.486
Total proteins (g/L), mean (SD)	6.5 (0.6)	6.1 (0.6)	0.022
Albumin (g/L), mean (SD)	3.9 (0.3)	3.7 (0.4)	0.064
KDQOL-36 Questionnaire			
SF-12 Physical & Mental Component, mean (SD)	58.8 (14.7)	43.9 (12.8)	0.001
Burden of kidney disease, mean (SD)	64.8 (26.2)	44.9 (24.5)	0.014
Symptoms / problems of CKD, mean (SD)	82.5 (12.6)	78.8 (11.7)	0.330
Effects of CKD on daily life, mean (SD)	73.5 (23.7)	63.6 (20.3)	0.149

Based on our findings, we conclude that PDF is a highly prevalent phenomenon in the chronic hemodialysis population, with more than half of the evaluated patients reporting its presence and a significant proportion requiring more than five hours to recover after treatment. These data support the consideration of PDF as a relevant clinical outcome whose monitoring could provide valuable information regarding treatment tolerance and risk of functional decline. PDF may serve as an early marker of malnutrition and frailty, given its association with lower total protein levels. Its relationship with poorer physical and mental quality of life and greater perceived disease burden further highlights the need for systematic assessment alongside other key dialysis indicators. Incorporating this event as a clinical indicator could facilitate early detection of vulnerable patients and contribute to the development of more personalized therapeutic strategies, with the potential to improve not only clinical outcomes but also the overall patient experience and well-being in hemodialysis.

Conflicts of interest
None declared.

Funding
None declared.

REFERENCES

1. Romagnani P, Remuzzi G, Glassock R, Levin A, Jager KJ, Tonelli M, et al. Chronic kidney disease. Nature Reviews Disease Primers. 2017;3. https://doi.org/10.1038/nrdp.2017.88

2. Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M, et al. Global, regional, and national burden of chronic kidney disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet. 2020;395:709-33. https://doi.org/10.1016/S0140-6736(20)30045-3

3. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, et al. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. PLoS One. 2016;11:e0158765. https://doi.org/10.1371/journal.pone.0158765

4. Liyanage T, Ninomiya T, Jha V, Neal B, Patrice HM, Okpechi I, et al. Worldwide access to treatment for end-stage kidney disease: A systematic review. The Lancet. 2015;385:1975–82. https://doi.org/10.1016/S0140-6736(14)61601-9

5. Himmelfarb J, Vanholder R, Mehrotra R, Tonelli M. The current and future landscape of dialysis. Nature Reviews Nephrology. 2020;16:573-85. https://doi.org/10.1038/s41581-020-0315-4

6. Johansen KL, Chertow GM, Foley RN, Gilbertson DT, Herzog CA, Ishani A, et al. US Renal Data System 2020 Annual Data Report: Epidemiology of Kidney Disease in the United States. American Journal of Kidney Diseases.2021;77:A7-8. https://doi.org/10.1053/j.ajkd.2021.01.002

7. Bolton S, Gair R, Nilsson L-G, Matthews M, Stewart L, McCullagh N. Clinical Assessment of Dialysis Recovery Time and Symptom Burden: Impact of Switching Hemodialysis Therapy Mode. Patient Relat Outcome Meas. 2021;Volume 12:315-21. https://doi.org/10.2147/prom.s325016

8. Daugirdas JT. Pathophysiology of dialysis hypotension: An update. American Journal of Kidney Diseases.2001;38:S11-7. https://doi.org/10.1053/ajkd.2001.28090

9. Lindsay RM, Heidenheim PA, Nesrallah G, Garg AX, Suri R. Minutes to Recovery after a Hemodialysis Session. Clinical Journal of the American Society of Nephrology. 2006;1:952-9. https://doi.org/10.2215/CJN.00040106

10. Guedes M, Pecoits-Filho R, Leme JEG, Jiao Y, Raimann JG, Wang Y, et al. Impacts of dialysis adequacy and intradialytic hypotension on changes in dialysis recovery time. BMC Nephrol. 2020;21. https://doi.org/10.1186/s12882-020-02187-9

11. Fitzpatrick J, Sozio SM, Jaar BG, Estrella MM, Segev DL, Shafi T, et al. Frailty, Age, and Postdialysis Recovery Time in a Population New to Hemodialysis. Kidney360. 2021;2:1455-62. https://doi.org/10.34067/kid.0001052021

12. Awuah KT, Afolalu BA, Hussein UT, Raducu RR, Bekui AM, Finkelstein FO. Time to recovery after a hemodialysis session: Impact of selected variables. Clin Kidney J. 2013;6:595-8. https://doi.org/10.1093/ckj/sft120

13. Rayner HC, Zepel L, Fuller DS, Morgenstern H, Karaboyas A, Culleton BF, et al. Recovery time, quality of life, and mortality in hemodialysis patients: The Dialysis Outcomes and Practice Patterns Study (DOPPS). American Journal of Kidney Diseases. 2014;64:86-94. https://doi.org/10.1053/j.ajkd.2014.01.014

14. Elsayed MM, Zeid MM, Hamza OMR, Elkholy NM. Dialysis recovery time: associated factors and its association with quality of life of hemodialysis patients. BMC Nephrol. 2022;23. https://doi.org/10.1186/s12882-022-02926-0

15. Hussein WF, Arramreddy R, Sun SJ, Reiterman M, Schiller B. Higher Ultrafiltration Rate Is Associated with Longer Dialysis Recovery Time in Patients Undergoing Conventional Hemodialysis. Am J Nephrol. 2017;46:3-10. https://doi.org/10.1159/000476076

16. Bossola M, Picca A, Monteburini T, Parodi E, Santarelli S, Cenerelli S, et al. Post-dialysis fatigue and survival in patients on chronic hemodialysis. Journal of Nephrology. 2021;34:2163-5. https://doi.org/10.1007/s40620-021-01141-8

17. Cohen L, Ruthazer R, Moss A, Al. E. Predicting six-month mortality for patients who are on maintenance hemodialysis. Clin J Am Soc Nephrol. 2010;5:72-9

18. Weldring T, Smith SMS. Article Commentary: Patient-Reported Outcomes (PROs) and Patient-Reported Outcome Measures (PROMs). Health Serv Insights. 2013;6:HSI.S11093. https://doi.org/10.4137/HSI.S11093

19. Guerraoui A, Prezelin-Reydit M, Kolko A, Lino-Daniel M, de Roque CD, Urena P, et al. Patient-reported outcome measures in hemodialysis patients: results of the first multicenter cross-sectional ePROMs study in France. BMC Nephrol. 2021;22. https://doi.org/10.1186/s12882-021-02551-3

20. Hays RD, Kallich JD, Mapes DL, Coons SJ, Carter WB. Development of the Kidney Disease Quality of Life (KDQOLTM) Instrument. Quality of Life Research. 1994;3:329-38. https://doi.org/10.1007/BF00451725

21. Dou J, Liu H, Ma Y, Wu Y, Tao X. Prevalence of post-dialysis fatigue: a systematic review and meta-analysis. BMJ Open. 2023;13:e064174. https://doi.org/10.1136/bmjopen-2022-064174

22. Bossola M, Tazza L. Postdialysis Fatigue: A Frequent and Debilitating Symptom. Semin Dial. 2016;29:222–7. https://doi.org/10.1111/sdi.12468

23. Bossola M, Di Stasio E, Monteburini T, Parodi E, Ippoliti F, Cenerelli S, et al. Recovery Time after Hemodialysis Is Inversely Associated with the Ultrafiltration Rate. Blood Purif. 2019;47:45-51. https://doi.org/10.1159/000492919

24. Bellin EY, Hellebrand AM, Kaplan SM, Ledvina JG, Markis WT, Levin NW, et al. Post-dialysis recovery time in ESRD patients receiving more frequent hemodialysis in skilled nursing facilities. Hemodialysis International. 2022;26:424-34. https://doi.org/10.1111/hdi.13012

25. Kodama H, Togari T, Konno Y, Tsuji A, Fujinoki A, Kuwabara S, et al. A new assessment scale for post-dialysis fatigue in hemodialysis patients. Ren Replace Ther. 2020;6:1. https://doi.org/10.1186/s41100-019-0252-5

26. Zhang Y, Yang N, Bai X, Liu Y, Li X, Yan M, et al. Factors affecting postdialysis fatigue among hemodialysis patients: a multi-group path analysis according to nutritional status. Front Med (Lausanne). 2025;12. https://doi.org/10.3389/fmed.2025.1553751