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Impact of variables on recovery time in patients undergoing hemodialysis: an international survey

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Abstract

Background Dialysis recovery time (DRT) refers to the period during which fatigue and weakness subside following hemodialysis treatment, allowing patients to resume their daily routines. This study aimed to identify the factors influencing DRT in hemodialysis patients in Turkey and Portugal, where the prevalence of chronic kidney disease is notably high.

Methods A cross-sectional observational study was conducted in a private dialysis center in Turkey and three dialysis centers in Portugal. The study included hemodialysis patients aged 18 years or older who had been undergoing four-hour hemodialysis sessions three times a week for at least six months. Participants had no communication barriers and voluntarily agreed to take part in the study. Data were collected using a semi-structured questionnaire to gather descriptive characteristics and the Hospital Anxiety and Depression Scale. Logistic regression analysis was employed to identify independent variables influencing DRT.

Results A total of 294 patients participated in the study, including 187 from Turkey and 107 from Portugal. In Turkey, increased interdialytic weight gain ($P=0.043$) was associated with prolonged recovery time, while the use of high-flux dialyzers ($P=0.026$) was linked to shorter recovery times. In Portugal, older age ($P=0.020$) was found to extend recovery time.

Conclusion Recovery time after dialysis is influenced by varying factors across different countries. Further research with larger sample sizes is needed to deepen understanding of these factors and their implications.

Clinical trial number NCT04667741.

Keywords Dialysis, Chronic disease, Fatigue

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Introduction

Hemodialysis induces significant changes in the concentrations of small and medium-weight molecules, acid-base balance, and serum electrolyte levels. Additionally, rapid ultrafiltration (UF), an increase in ultrafiltration volume per unit of time, and a high rate of vascular refill are commonly observed during treatment [1]. These physiological changes and biochemical events can lead to symptoms during and for hours after dialysis treatment, significantly impacting patients' quality of life [2, 3].

Dialysis recovery time (DRT) refers to the period required for patients to recover from feelings of fatigue and weakness following hemodialysis and resume their daily routines. Most patients experience challenges in performing activities of daily living during this recovery period [4–6]. DRT is assessed by asking patients the question, *"How long does it take you to recover from a dialysis session?"* and recording their response in minutes. Studies have shown a statistically significant negative correlation between DRT and sub-dimensions of the Quality of Life Scale [6].

Research indicates that DRT varies among patients. For instance, one study reported that 52.1% of patients had a DRT of less than 2 h [7], while another found that 40% of patients recovered in under 4 h [2]. Conversely, a study revealed that 10% of patients had a DRT exceeding 12 h [8]. Furthermore, studies have demonstrated a relationship between prolonged DRT and increased mortality risk. For example, mortality was found to be 1.6 times higher in patients whose DRT exceeded 12 h [8]. DRT is influenced by both non-modifiable and modifiable risk factors. Non-modifiable factors include age, gender, serum albumin levels, diabetes, and psychiatric conditions [8]. Modifiable factors, on the other hand, include the sodium concentration in the dialysate, intradialytic weight loss, and the frequency of acute complications [9]. However, the precise pathophysiological mechanisms and risk factors contributing to prolonged DRT remain unclear [10]. Given the impact of prolonged recovery time on patients, healthcare professionals, and caregivers, there has been growing interest in identifying modifiable treatment-related factors in recent international studies [4, 7, 8, 10–15].

The prevalence of chronic kidney disease (CKD), a global public health concern, is increasing rapidly worldwide. In 2015, Portugal had the highest incidence of CKD in Europe [16], and by 2017, it ranked sixth among Western European countries [17]. In the same period, Turkey ranked first in CKD prevalence in the North African and Middle Eastern regions [17]. Hemodialysis is the initial renal replacement therapy for 89.54% of CKD patients in Portugal [16] and 76.93% in Turkey [18]. However, while only one study on DRT has been conducted in Turkey [19], no studies on this topic have been identified in Portugal.

Study objectives

This study aimed to identify the factors affecting DRT in hemodialysis patients in Turkey and Portugal, two countries with high prevalence rates of CKD. These factors included socio-demographic characteristics, clinical and biochemical variables, hemodialysis session features, and levels of depression and anxiety.

Research question

- What are the socio-demographic variables affecting recovery time in patients undergoing hemodialysis in Turkey?
- What are the clinical, biochemical variables, and hemodialysis sessions' features affecting recovery time in patients undergoing hemodialysis in Turkey?
- What are the socio-demographic variables affecting recovery time in patients undergoing hemodialysis in Portugal?
- What are the clinical, biochemical variables, and hemodialysis sessions' affecting recovery time in patients undergoing hemodialysis in Portugal?

Methods

Study design and participants

This cross-sectional observational study was conducted with patients who were treated with hemodialysis between October 2020 and May 2022.

The study population consisted of hemodialysis patients receiving treatment at a private dialysis center in Turkey and three dialysis centers in Portugal. Conducting the research in two different countries allowed for a comparison of similarities and differences in practices. The study sample included patients aged 18 years or older who had been undergoing hemodialysis for four hours per session, three times a week, for at least six months, with no communication barriers, and who voluntarily agreed to participate. Patients with psychiatric or cognitive disorders that impaired communication, or those unable to hear or comprehend the questions, were classified as having communication problems and were excluded from the study. Data were collected from the patients' medical records.

The dialysis center in Turkey treated a total of 221 patients. However, 11 patients were excluded as they had just begun treatment at the center in mid-October 2020, when the study was conducted. This left 210 patients in the study population. Among them, 19 patients were excluded due to inability to communicate in Turkish (3 patients), communication issues caused by physical disabilities (2 patients), and hearing or perception problems

(14 patients). After applying the inclusion criteria, the sample comprised 191 patients. During the data collection, an additional 5 patients were excluded due to hospitalization (2 patients), death (1 patient), and incomplete questionnaire responses (2 patients). Ultimately, the study was completed with 187 patients (89.04%. In Portugal, 160 patients across three dialysis centers formed the study population. However, 53 patients were excluded due to cognitive impairments, leaving a final sample of 107 patients, which constituted 66.87% of the original population. This study was registered on ClinicalTrials.gov and reported following the STROBE checklist.

Outcomes

Dialysis recovery time

Dialysis Recovery Time was assessed using the method described by Lindsay et al. [6]. This measure is straightforward to interpret and respond to and has shown statistically significant negative correlations with all but one subscale of the Short Form 36 Health Survey [6]. Participants were asked about their recovery time following the first dialysis session of the month. Specifically, researchers posed the question: *"Over the last month, how long, on average, did it take for you to recover from your dialysis sessions and resume your normal, usual activities?"* Responses were recorded in minutes.

Patients were monitored for 12 dialysis sessions (one month). At the end of the month, patients were asked about their recovery time for the monitored month. There is no specific cut-off value to categorize patients with hemodialysis treatments according to their recovery time. However, patients were categorized into two groups in which the ones with the closest numbers were put together in accordance with the studies that were reported previously [11, 19].

Ultrafiltration rate

Ultrafiltration rate (UFR) was calculated in milliliters per hour per kilogram (ml/h/kg) by dividing the UF volume by the dialysis session duration and the target body weight. Based on the available literature [10, 21, 22], UFR was categorized into three groups: ≤10 ml/h/kg, 10–13 ml/h/kg, and > 13 ml/h/kg. A single UFR value for each patient was determined by averaging the UFR values from 12 hemodialysis sessions.

Interdialytic weight gain

Interdialytic Weight Gain (IDWG) was defined as the difference between the predialysis weight of the current dialysis session and the postdialysis weight from the previous session. The average IDWG over 12 hemodialysis sessions was also calculated [23]. This measurement was assessed over the one-month duration of the study.

Cannulation methods

The cannulation method was defined by the researchers and documented in the data collection form. The *area puncture* method involves cannulating within the same general area for each session. The *rope-ladder technique* requires rotating the needle placement sites along the entire length of the cannulation segment with each dialysis session. In the *buttonhole method*, needles are inserted at the same site, angle, and depth for consecutive dialysis sessions [20].

Hemodialysis sessions' features

Data from the patients' 12 hemodialysis sessions were recorded, and the values for each variable were averaged. These variables included: travel time to the dialysis unit (minutes), time spent waiting before dialysis began upon arrival (minutes), dialysate bicarbonate concentration (mmol/L), dialysate sodium level (mEq/L), blood flow rate (ml/min), UF volume (ml), UFR (ml/h/kg), predialysis weight, and post-dialysis weight. The researchers collected this information by asking patients specific questions before the start of their dialysis sessions.

Depression and anxiety

Depression and anxiety were evaluated with the Hospital Anxiety and Depression Scale (HADS) by the researchers [24, 25].

Data collection and measurements

Data were collected using a semi-structured questionnaire developed by the researchers after reviewing the relevant literature. The questionnaire was developed specifically for use in this study (Supplement I). This form captured the subjects' socio-demographic and medical characteristics. Researchers completed the questionnaire through face-to-face interviews with patients during the second hour of their hemodialysis treatment. Completing the form, which consisted of 17 questions, took approximately 10 min. The questions covered topics such as age, weight, height, hemodialysis treatment details, transportation to dialysis, alcohol and smoking habits, comorbidities, vascular access type, and dialysis shift. After 12 hemodialysis sessions, researchers recorded the results of biochemical parameters obtained from routine monthly blood samples into the data form. These parameters included Kt/V, urea reduction ratio (URR), phosphorus, C-reactive protein (CRP), sodium, hematocrit (HCT), hemoglobin (HGB), parathormone (PTH), white blood cell count (WBC), albumin, predialysis creatinine, post-dialysis creatinine, bicarbonate, calcium, predialysis urea, and postdialysis urea.

Hospital anxiety and depression scale (HADS)

This scale was developed by Zigmond and Snaith [24] to identify the patient's risk of anxiety and depression and to measure their level and change in severity. The scale's validity and reliability in Turkey and in Portugal was assessed by Aydemir et al. [25] and Pais-Ribeiro et al. [26] respectively. It is used to detect anxiety and depression in a short time and to identify the risk group but not to diagnose these conditions in patients with a physical illness. Seven of the 14 questions of the scale measure anxiety and seven measure depression. The answers are scored in 4-point Likert form between 0 and 3. The score range is 0 to 21. The cutoff points of the Turkish version of the HADS were 10 and 7 for the anxiety and depression subscales, respectively [25]. The scale was completed by the researchers before treatment was started at the 1st hemodialysis sessions. Completing the form took about 5 min.

Statistical analysis

Comparisons of normally distributed variables were performed using Student's t-test, while the Mann-Whitney U test was applied for non-normally distributed variables. Categorical variables were analyzed using the chi-square test. Logistic regression analysis was conducted to identify independent variables influencing post-dialysis recovery time. Variables identified in the previous analyses were included as predictors in the model. A *P*-value of < 0.05 was considered statistically significant.

Results

The study included a total of 294 patients, with 187 participants from Turkey and 107 from Portugal. The median age [IQR] of patients was 64 years [56–70] in Turkey and 69 years [62–76] in Portugal. Descriptive statistics for participants from both countries are presented in Table 1.

Details about the dialysis sessions and patients' biochemical parameters are provided in Table 2. In Turkey, 80.2% of patients were transported by the dialysis center's service vehicle, whereas in Portugal, 97.2% of patients were transported by ambulance. The median commute time from home to the dialysis center was 21.5 min [14.5–29.5] in Turkey and 17.77 min [10.33–25.83] in Portugal. The mean Kt/V values (± standard deviation) were 1.73 ± 0.25 in Turkey and 1.74 ± 0.33 in Portugal.

Results in Turkey

Recovery time was significantly longer for patients with comorbidities ($P = 0.016$), heart failure ($P = 0.010$), higher IDWG ($P = 0.049$), longer commuting times to the dialysis center ($P = 0.049$), and longer waiting times after arriving at the dialysis center ($P = 0.028$), in addition to those with end-stage renal disease. Additionally, patients who did not use a high-flux dialyzer experienced longer recovery times ($P = 0.013$) (Table 3). There is no statistically significant relationship between the other variables and DRT (Supplement II).

Results in Portugal

In the sample collected from Portugal, longer recovery times were observed for older patients ($P = 0.035$) and those with higher CRP levels ($P = 0.013$) and predialysis creatinine ($P = 0.045$). Conversely, recovery time was shorter for patients with higher Kt/V ($P = 0.023$), serum sodium ($P = 0.012$), and bicarbonate levels ($P < 0.001$). Additionally, longer recovery times were associated with longer commutes to the dialysis center ($P = 0.010$) and unemployment ($P = 0.022$) (Table 3). There is no statistically significant relationship between the other variables and DRT (Supplement II).

Logistic regression analysis results

A logistic regression analysis was performed to identify factors influencing post-dialysis recovery time, with the results presented in Table 4. In Turkey, patients with larger IDWG had longer recovery time (OR = 1.452, CI: 1.011–2.084; $P = 0.043$), whereas those using a high-flux dialyzer experienced shorter recovery time (OR = 0.418, CI: 0.194–0.889; $P = 0.026$). In Portugal, older age was associated with longer recovery times (OR = 1.070, CI: 1.010–1.132; $P = 0.020$). No other variables showed significant effects on post-dialysis recovery time ($P > 0.05$).

Discussion

We concluded that increased IDWG prolonged recovery time in patients undergoing hemodialysis in Turkey, while the use of a high-flux dialyzer shortened recovery time. In contrast, older age was associated with longer recovery time in Portugal.

Discussion of the results in Turkey

The presence of comorbidities in patients undergoing hemodialysis may affect their recovery time [27]. Previous studies have shown that patients with comorbidities experience longer recovery times [9, 28–30], while Harford et al. [7] have found no significant relationship between chronic diseases and recovery time. Rayner et al. [8] specifically noted longer recovery times for patients with diabetes, psychiatric diseases [8], and Davenport et al. [11] concluded that that patients with cancer, heart disease and diabetes had longer time. Patients with heart failure comorbidity tend to have longer recovery time compared to those without [9]. In our study, we also observed longer recovery times in patients with heart failure, consistent with existing literature [13, 29]. UF during hemodialysis can lead to reduced organ perfusion, potentially causing issues such as [31] reduced blood flow

Table 1 Patients' descriptive statistics (*n* = 294)

Variables	Turkey (n = 187)	Portugal (n = 107)	P value
Age	64 [70 – 56 = 14]	69 [76 – 62 = 14]	**< 0.001**
BMI (kg/m^2)	24.44 [28.54–21.75 = 6.79]	25.23 [29.29–22.27 = 7.02]	0.508
Gender			0.466
Female	78 (41.7)	40 (37.4)	
Male	109 (58.3)	67 (62.6)	
Education status			**< 0.001**
Illiterate	27 (14.4)	8 (7.5)	
Literate	2 (1.1)	65 (60.7)	
Elementary school	125 (66.8)	13 (12.1)	
High school	28 (15.0)	14 (13.1)	
University and above	5 (2.7)	7 (6.5)	
Marital status			**0.002**
Single	15 (8.1)	13 (12.1)	
Married	130 (69.5)	68 (63.6)	
Divorced	1 (0.5)	9 (8.4)	
Widow	41 (21.9)	17 (15.9)	
Employement status			**0.003**
Working	7 (3.7)	14 (13.1)	
Not working	180 (96.3)	93 (86.9)	
Income status			**< 0.001**
Less than expenses	5 (2.7)	17 (15.9)	
Equal to expenses	174 (93.0)	54 (50.5)	
Greater than expenses	8 (4.3)	36 (33.6)	
Comorbid chronic disease			0.368
Yes	165 (88.2)	98 (91.6)	
No	22 (11.8)	9 (8.4)	
Hypertension			0.152
Yes	123 (65.8)	79 (73.8)	
No	64 (34.2)	28 (26.2)	
Diabetes mellitus			0.311
Yes	83 (44.4)	41 (38.3)	
No	104 (55.6)	66 (61.7)	
Heart failure			0.651
Yes	65 (34.8)	40 (37.4)	
No	122 (65.2)	67 (62.6)	
Respiratory system diseases			0.057
Yes	21 (11.2)	5 (4.7)	
No	166 (88.8)	102 (95.3)	
Use of alcohol			**< 0.001**
Yes	7 (3.7)	29 (27.1)	
No	180 (96.3)	78 (72.9)	
Smoking status			0.76
Yes	27 (14.4)	8 (7.5)	
No	160 (85.6)	99 (92.5)	
Venous access route			0.975
AVF	152 (63.3)	88 (36.7)	
AVG	7 (63.6)	4 (36.4)	
CVC	28 (65.1)	15 (34.9)	
Dialysis shift			0.576
Morning	69 (36.9)	45 (42.1)	
Afternoon	65 (34.8)	37 (34.5)	
Evening	53 (28.3)	25 (23.4)	
Dialysis vintage (months)	60 [96 – 24 = 72]	30 [72 – 13 = 59]	0.019

Table 1 (continued)

Variables	Turkey (n = 187)	Portugal (n = 107)	P value
Dialysis recovery time (minute)	180 [420 – 120 = 300]	120 [360 – 60 = 300]	**< 0.001**
High-flux dialyzer use			**< 0.001**
Yes	122 (65.2)	107 (100)	
No	65 (34.8)	-	

Data are displayed as n (%) or median [IQR]. BMI: Body mass index; AVF: Arteriovenous fistula; AVG: Arteriovenous graft; CVC: Central venous catheter

Table 2 Hemodialysis sessions' features and biochemical variables – country results (*n* = 294)

Variables	Turkey (*n* = 187)	Portugal (n = 107)	P value
Transport from home to dialysis center			**< 0.001**
Own car	29 (15.5)	3 (2.8)	
Dialysis unit service vehicle	150 (80.2)	-	
Public transportation	3 (1.6)	-	
Ambulance	5 (2.7)	104 (97.2)	
Commuting time from home to dialysis center (minutes)	21.50 [29.50–14.50 = 15.0]	17.77 [25.83–10.33 = 15.5]	**0.002**
Waiting time upon arrival at the dialysis center (minutes)	6.25 [7.41–4.75 = 2.66]	13.66 [25.83–7.91 = 17.92]	**< 0.001**
Dialysate sodium concentration (mEq/L)	140 [140–140 = 0]	138 [140 – 138 = 2]	**< 0.001**
Dialysate bicarbonate concentration (mmol/L)	3 [3–3 = 0]	36 [36 – 32 = 4]	**< 0.001**
Blood flow rate (mL/min)	300 [350 – 300 = 50]	350 [400 – 307 = 93]	**< 0.001**
UFR (ml/h/kg)	10.37 ± 3.23	8.58 ± 2.84	**< 0.001**
IDWG (kg)	2.64 ± 0.94	2.06 ± 0.72	**< 0.001**
Hgb (g/dl)	11.01 ± 1.61	10.81 ± 1.01	0.178
Kt/V	1.73 ± 0.25	1.74 ± 0.33	0.798
Phosphor (mg/dl)	4.8 [5.9–3.9 = 2.0]	4.9 [5.7–3.9 = 1.8]	0.786
CRP (mg/dl)	7.2 [20.1–3.9 = 016.2]	1 [1.4–0.8 = 0.6]	**< 0.001**
Sodium (mEq/l)	137 [139 – 134 = 5]	138 [141 – 136 = 5]	**< 0.001**
HTC (%)	36 [40-32.1 = 7.9]	32.9 [35.3–31.2 = 4.1]	**< 0.001**
PTH (pg/dl)	283 [543 – 146 = 397]	375 [638.3–271 = 367.3]	**< 0.003**
WBC (103/µl)	3.64 [4.07–3.23 = 0.84]	5.87 [7.03–4.9 = 2.13]	**< 0.001**
Albumin (g/dl)	3.82 [4.04–3.6 = 0.44]	4.10 [4.3–3.8 = 0.5]	**< 0.001**
Predialysis Creatinine (mg/dl)	6.72 [8.17–5.51 = 2.66]	7.8 [9.2–6.5 = 2.7]	**< 0.001**
Postdialysis Creatinine (mg/dl)	2.30 [2.91–1.75 = 1.16]	2.3 [2.7–1.8 = 0.9]	0.873
Bicarbonate (mEg/l)	22 [25 – 20 = 5]	20.7 [22.1–19.3 = 2.8]	**< 0.001**
Calcium (mg/dl)	8.8 [9.3–8.4 = 0.9]	8.8 [9.4–8.4 = 1.0]	0.539
Predialysis Urea (mg/dl)	113.18 ± 32.17	114.04 ± 35.48	0.832
Postdialysis Urea (mg/dl)	29 [38 – 22 = 16]	25 [35 – 20 = 15]	**0.031**
Hospital Depression Scale			0.088
The depression risk is low (0–7)	120 (60.3)	79 (39.7)	
The depression risk is high (8–21)	67 (70.5)	28 (29.5)	
Hospital Anxiety Score			0.124
The anxiety risk is low (0–10)	134 (60.9)	86 (39.1)	
The anxiety risk is high (11–21)	53 (71.6)	21 (28.4)	

Descriptive measures displayed: n (%), mean ± standard deviation or median [IQR]. UFR: Ultrafiltration rate; IDWG: Interdialytic weight gain; Hgb: Haemoglobin; CRP: C-Reactive protein; HTC: Hematocrit; PTH: Parathyroid hormone; WBC: White blood cell count

to the heart, cognitive decline, and postdialysis hypotension, which can impact patient survival [32, 33]. Patients with heart failure may experience exacerbated symptoms post-hemodialysis due to the systemic effects of the condition on the dialysis process.

Consistent with previous research [8, 9, 14, 34, 35], our study observed that recovery time lengthens with increasing IDWG, in contrast to the findings of Bossola et al. [10] who reported no significant correlation between the two. It is widely recognized that patients with excessive IDWG typically receive a higher UFR [36]. Hemodialysis induces a rapid redistribution of electrolytes and fluids across cell membranes, potentially contributing to delayed recovery time [8, 34]. It is plausible that UFR levels may impact cytokine production or clearance, thereby influencing recovery time [10]. Müller-Steinhardt et al. [37] demonstrated that a gradual reduction in UFR from 40 to 46 to 7–10 mL/min led to a notable increase in

Table 3 Relationship of descriptive features with post-dialysis recovery time – country results (*n* = 294)

Variables	**TURKEY (*n* = 187)**			**PORTUGAL (n = 107)**		
	Recovery time	**Recovery time**	**P value**	**Recovery time**	**Recovery time**	**P value**
	< 180 minutes	**≥ 180 minutes**		**< 120 minutes**	**≥ 120 minutes**	
	n (%)	**n (%)**		**n (%)**	**n (%)**	
	60 (32.1)	**127 (67.9)**		**46 (43)**	**61 (57)**	
Comorbid chronic disease			**0.016***			**0.326***
Yes / No	**48 (29.1) /12 (54.5)**	**117 (70.9) / 10 (45.5)**		**41 (41.8) / 5 (55.6)**	**57 (58.2) / 4 (44.4)**	
Heart failure			**0.010***			**0.546**
Yes / No	**13 (20.0) /47 (38.5)**	**52 (80.0) / 75 (61.5)**		**19 (47.5) / 27 (40.3)**	**21 (52.5) / 40 (59.7)**	
Age (year)	62 [54.25-70]	64 [56–70]	0.218***	66 [57-72.25]	71 [64-78.50]	**0.035*****
Kt/V	1.74 ± 0.25	1.72 ± 0.25	0.594****	1.82 ± 0.34	1.68 ± 0.30	**0.023******
CRP (mg/dl)	7.85 [3.47–19.92]	7.1 [3.9–20.1]	0.734***	1 [0.8–1.1]	1.1 [0.9-4.0]	**0.016*****
Sodium (mEq/l)	137.5 [136–139]	137 [134–138]	0.147***	140 [137-141.25]	138 [135–141]	**0.012*****
Albumin (g/dl)	3.81 [3.52–4.08]	3.84 [3.62-4.0]	0.977***	4.05 [3.8–4.22]	4.2 [3.9–4.45]	**0.021*****
Predialysis creatinine (mg/dl)	6.95 [5.35–8.63]	6.67 [5.51–7.7]	0.317***	7.15 [6.2–8.92]	8.2 [6.8–9.95]	**0.045*****
Bicarbonate (mEg/l)	22 [19–25]	22 [20–25]	0.902***	21.55 [20.15–23.8]	20.1 [19.2–21.0]	**< 0.001*****
IDWG (kg)	2.44 ± 0.92	2.73 ± 0.94	**0.049******	2.02 ± 0.75	2.09 ± 0.70	0.630****
Commuting time from home to the dialysis center (minute)	18.08 [13.18–28.56]	22 [15.33–29.75]	**0.049*****	13.87 [9.50-23.25]	18.66 [12.62–29.08]	**0.010*****
Waiting time after arriving at the dialysis center (minute)	5.83 [4.16–7.16]	6.33 [4.91–7.58]	**0.028*****	12.16 [7.08–19.27]	15 [9-28.54]	0.083***
Employement status			0.214**			**0.022****
Working	4 (57.1)	3 (42.9)		10 (71.4)	4 (28.6)	
Unemployed	56 (31.1)	124 (68.9)		36 (38.7)	57 (61.3)	
High-flux dialyzer use			**0.013***	107 (100)		-
Yes / No	47 (38.5) / 13 (20)	75 (61.5) / 52 (80)				

Descriptive measures displayed: n (%), mean ± standard deviation or median [IQR]. *Chi-sqaure test, **Fisher's Exact Test, ***Mann-Whitney U Test, ****Independent Sample t Test. HD: Hemodialysis; Hgb: Hemoglobin; BMI: Body mass index; CRP: C-Reactive Protein; HTC: Hematocrit; PTH: Parathyroid hormone; WBC: White blood cell count; UF: Ultrafiltration

IL-10 concentrations ($P = 0.012$) and a decrease in Interleukin-1 beta (IL-1ß) concentrations. However, limited research exists on the relationship between UFR and cytokine modulation compared to studies on cytokine removal and hemodialysis filter types. Our study revealed that patients with high IDWG experienced prolonged recovery times.

We also discovered that patients who used a high-flux dialyzer had a shorter recovery time. A few studies in the literature examined the impact of high-flux dialyzer treatment on recovery time [38, 39]. There was no significant difference in recovery time between patients treated with high-flux hemodialysis and hemodiafiltration. Canseven [39] noted a decrease in post-dialysis fatigue in patients using a high-flux dialyzer. Low-flux dialyzers effectively eliminate small solutes through diffusion but have limited ability to remove middle-sized solutes, which are considered more toxic and challenging to eliminate through diffusion [40]. This limitation prompted the development of high-flux membrane dialyzers [41], which reduce beta-2 microglobulin levels more than low-flux dialyzers. Beta-2 microglobulin levels serve as an indicator of uremic toxins and other intermediate molecules with similar systemic or extracorporeal kinetics in dialysis patients. Therefore, it is possible that the shortened recovery time is due to the removal of toxic substances from the body through the use of a high-flux dialyzer [42].

The duration of the wait for patients to begin dialysis treatment after arriving at the unit is significant. This study found that a longer wait for treatment after arrival at the dialysis center also prolonged the overall treatment time. According to a national audit by the Scottish government, this accounted for nearly a quarter of the wasted time and affected patients regardless of whether they arrived by hospital transport or their own means [43]. Research has shown that transportation and waiting times in dialysis units not only impact the patient experience but also contribute to higher mortality rates

Table 4 Effect of variables on high post-dialysis recovery time – logistic regression model

Turkey (*n* = 187)						
Variables (reference)	**β**	**SE**	**Wald**	**P**	**OR**	**95% CI**
Comorbid disease (Yes)	0.617	0.501	1.512	0.219	1.852	0.693–4.948
Heart failure (Yes)	0.649	0.393	2.725	0.099	1.913	0.886–4.134
IDWG (kg)	0.373	0.185	4.080	**0.043**	1.452	1.011–2.084
High-flux dialyzer use (Yes)	-0.873	0.391	4.984	**0.026**	0.418	0.194–0.889
Commuting time from home to the dialysis center (minute)	0.003	0.019	0.030	0.863	1.003	0.967–1.041
Waiting time after arriving at the dialysis center (minute)	0.161	0.114	2.001	0.157	1.175	0.940–1.469
Constant	-1.413	0.840	2.827	0.093	0.243	
Portugal (*n* = 107)						
Variables (reference)	**β**	**SE**	**Wald**	**p**	**OR**	**95% CI**
Employment status (Working)	-0.186	0.899	0.043	0.836	0.830	0.143–4.830
Commuting time from home to the dialysis center (minute)	0.042	0.024	2.981	0.084	1.043	0.994–1.094
Kt/V	-0.878	0.745	1.386	0.239	0.416	0.906–1.792
Predialysis creatinine	0.199	0.122	2.667	0.102	1.220	0.961–1.550
Bicarbonate	-0.197	0.120	2.691	0.101	0.821	0.649–1.039
Sodium	-0.013	0.084	0.025	0.875	0.987	0.837–1.163
CRP	0.165	0.111	2.194	0.139	1.179	0.948–1.466
Age	0.067	0.029	5.372	**0.020**	1.070	1.010–1.132
Constant	0.489	11.684	0.002	0.967	1.631	

IDWG: Interdialytic weight gain; OR: Odds ratio, Nagelkerke $R^2=0.166$ (Turkey) and Nagelkerke $R^2=0.379$ (Portugal), Notes: High DRT means DRT larger than the median. All the regressor selection criteria tried led to the same (final) model. The criteria tried were Conditional forward selection, LR forward selection, Wald forward selection, Conditional backward selection, LR backward selection and Wald backward selection. The entry and removal probabilities were 5% and 10% respectively

and lower quality of life with longer wait and travel times [44]. The waiting time varies greatly among units, indicating that there is potential for dialysis units to reduce this time through improved organization.

Discussion of the results in Portugal

Some studies have shown that older patients tend to experience higher levels of fatigue after dialysis [5, 45], while in other cases, there is no clear relationship between age and recovery time [10, 13, 14]. Post-dialysis recovery time is more common among the elderly population [46–48]. According to Fitzpatrick et al. [30], individuals under 65 years of age have a shorter recovery time compared to those over 65. Rayner et al. [8] and Elsayed et al. [49] observed an increase in recovery time with age, while Kumar et al. [34] did not find a significant relationship between age and recovery time. One possible explanation is that older individuals may have more chronic health issues, slower recovery of bodily functions, and lower tolerance levels compared to younger individuals.

In individuals undergoing chronic hemodialysis, fatigue seems to be linked to the serum level of interleukin 6, indicating a role of inflammation [5]. Increased oxidative stress, a common feature in hemodialysis [50], has also been suggested as a significant factor in uremic myopathy and fatigue in renal failure [51]. The relationship between Kt/V level and recovery time has yielded varied results in the literature. While some studies found no correlation [8, 9, 34, 49], Canseven [39] reported that patients with high Kt/V had a longer recovery time. Our study showed that recovery time decreases as Kt/V increases, consistent with the findings of Guedes et al. [28]. Uremic toxins associated with uremia-related inflammation are typically large middle molecules that may be better cleared by high-flux membranes [52], potentially leading to improved inflammatory and oxidative stress status. As all patients in our study used high-flux dialyzers, the higher Kt/V levels suggest that the duration of dialysis recovery time may have been reduced. Jayanti et al. [13] found that unemployed patients had longer recovery time, while Rayner et al. [8] reported shorter recovery times for employed patients. In contrast, Kumar et al. [34] found no significant relationship between recovery time and working status. Our study revealed that employed patients had longer recovery times, possibly due to their higher activity levels compared to the unemployed. Returning to work and resuming daily activities after dialysis treatment could also contribute to extended recovery time.

Similar results for both countries

The travel burden for chronic dialysis patients living in rural areas can be particularly challenging, impacting their outcomes and quality of life. Studies have shown that longer travel distances are associated with increased mortality risk and higher rates of anemia among hemodialysis patients [53–55]. Living in rural areas and facing greater travel distances can also hinder access to necessary nutritional supplements, affecting protein balance. While existing research has not specifically examined the relationship between commuting time to dialysis centers and recovery time, our study suggests that longer commutes are linked to lengthier recovery periods. The time spent traveling to and from dialysis centers can be draining and time-consuming [44], contributing to a decline in patients' quality of life [44, 56, 57].

Strengths and limitations

The main strengths of our study include the novelty of being the first work on this subject in both Turkey and Portugal, as well as the international comparative analysis conducted on recovery time, which is a significant factor impacting patients' quality of life. However, there are limitations to our study. Like any observational study, there may be unmeasured confounding or other sources of bias affecting the observed associations. Some variables that could influence recovery time, such as intradialytic hypotension, medication use, and changes in glucose levels, were not assessed in this study. Additionally, the subjective nature of responses to the recovery time question, the assessment of recovery time at a single point in time rather than as a mean of repeated measures, and the potential difficulty in generalizing our results to all patients in the dialysis centers where the study was conducted are important considerations.

Conclusion

In summary, the recovery time following dialysis may vary depending on various factors in different countries. Our study revealed that factors such as chronic illness, high IDWG, and the use of high-flux dialyzers impact recovery time in Turkey, while working status, travel time to the dialysis center, and high Kt/V levels influence recovery time in Portugal. Additional research with larger sample sizes is needed to further explore this topic.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12882-024-03937-9.

Supplementary Material 1

Supplementary Material 2

Author contributions

Concept – NO, CNS; Design – NO, CNS, TE; Supervision – NO, BS, AG, AO, FF, LC, SC, JT, SCMM, OR; Resources – NO, CNS, TE; Materials - NO, CNS; Data Collection and/or Processing - BS, AG, AO, FF, LC, SC, JT, SCMM, OR; Analysis and/or Interpretation – NO, PT; Literature Search - NO; Writing Manuscript - NO, CNS, PT; Critical Review - NO, CNS, PT, TE.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committees in Turkey (Kapadokya University Scientific Research and Publication Ethics Committee, permission no: 2020.19, date: July 14, 2020) and Portugal (Escola Superior de Enfermagem do Porto, permission no: 8/2020, date: September 7, 2020). Informed consent was obtained from all subjects and the written permission was obtained from the institutions.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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