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Research

Nutritional evaluation in relation to adequacy of peritoneal dialysis

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Background
Dialysis adequacy and nutritional status are pivotal for the prognosis of patients undergoing peritoneal dialysis (PD).

Objective
This study investigated the predictive factors of dialysis adequacy, with a special focus on the normalized protein catabolic rate (nPCR), a promising marker of protein intake and nutritional status.

Methods
This is a retrospective, descriptive and analytical study carried out between June 2006 and January 2024; it included 151 patients on PD. Patients were categorized into two groups based on total Kt/V: Group A (inadequate dialysis: Kt/V < 1.7) and Group B (adequate dialysis: Kt/V ⩾ 1.7). Nutritional and biochemical markers were analyzed, including body mass index (BMI), albumin, hemoglobin, ferritin, triglycerides, and nPCR. Statistical comparisons used t-test, Welch's test, ANOVA, chi-square, or binomial tests; $P < 0.05$ was considered significant.

Results
Dialysis adequacy was significantly associated with higher residual kidney function (RKF), estimated glomerular filtration rate (eGFR), and nPCR levels, while it was negatively correlated with serum creatinine, urea, uric acid, and BMI. An nPCR < 0.8 g/kg/day and BMI ⩾ 25 kg/m² were identified as independent predictors of inadequate dialysis. Polycystic kidney disease was also associated with dialysis inadequacy.

Conclusions
Inadequate dialysis was significantly associated with poor nutritional indicators, particularly low nPCR and overweight. nPCR appeared to be a reliable marker for predicting dialysis adequacy. A multidimensional strategy emphasizing nutritional monitoring, weight control, and RKF preservation could enhance outcomes for PD patients.

INTRODUCTION
Dialysis adequacy and nutritional status are key elements influencing the prognosis of patients undergoing peritoneal dialysis (PD) (Qin et al. 2021). Increased morbidity and mortality have been associated with inadequate dialysis, but also with malnutrition, which is common in this population (Scarmignan et al. 2025). The malnutrition-inflammation complex syndrome, characterized by the coexistence of malnutrition and inflammation, has been shown to further worsen patient outcomes (Ali et al. 2024).

A prospective cohort study involving 680 patients commencing continuous peritoneal dialysis across 14 centers in Canada and the United States (Stolic et al. 2010) found that both inadequate dialysis and poor nutritional status were independent predictors of increased mortality and technique failure. Specifically, decreased serum albumin concentration and worsened nutritional status, as assessed by subjective global assessment and percentage lean body mass, were associated with higher relative risks of death. Among potential nutritional markers, the normalized protein catabolic rate (nPCR) has emerged as a promising

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tool to assess both protein intake and dialysis adequacy. It reflects the rate of protein catabolism normalized to body weight, providing insights into protein metabolism and dialysis efficiency. Qin et al. (2021) demonstrated that an nPCR <0.815 g/kg/day was associated with a higher risk of inadequate dialysis, suggesting that nPCR may serve as a more reliable predictor of adequacy than traditional markers such as serum albumin (Qin et al. 2021).

However, the relationship between dialysis adequacy and nutritional markers remains unclear, as studies have yielded contradictory findings (Ali et al. 2024; Stolic et al. 2010). The present study aimed to explore predictive factors of dialysis adequacy, with particular focus on the roles of nPCR and body mass index (BMI) in achieving adequate dialysis (Qin et al. 2021).

METHODS

This is a retrospective, descriptive, and analytical study conducted at the Peritoneal Dialysis Unit of Ibn Sina Hospital in Rabat, Morocco from June 2006 to January 2024. It involved patients undergoing peritoneal dialysis, all of whom were registered in the French-speaking Peritoneal Dialysis Registry.

A total of 235 patients who initiated PD for end-stage chronic kidney disease in the unit between June 2006 and January 2024 were initially included. Patients with missing data and patients who had been on PD for less than six months were excluded. Data from the remaining 151 patients were collected from paper records and analyzed.

Kt/V is a dimensionless parameter that quantifies the adequacy of dialysis. It represents the fraction of the total body water that is cleared of urea over a given dialysis period.

- **K:** Clearance of urea (how much blood is cleaned per minute by the dialyzer).
- **t:** Time (the duration of the dialysis session).
- **V:** Volume (the total body water volume from which waste is being removed).

Patients were categorized into two groups:

- **Group A:** 85 patients with inadequate dialysis with a Kt/V < 1.7
- **Group B:** 66 patients with adequate dialysis with a Kt/V ⩾ 1.7

The threshold of 1.7 for total weekly Kt/V was chosen based on guidelines recommending this value as the minimum target for adequate dialysis in peritoneal dialysis patients from the Kidney Disease Outcomes Quality Initiative (KDOQI) (KDOQI, 2006) and the International Society for Peritoneal Dialysis (ISPD) (National Kidney Foundation-KDOQI US 2020).

The following variables were analyzed: age, sex, socioeconomic level, underlying nephropathy, comorbidities (such as cardiovascular disease, hypertension, and diabetes), estimated glomerular filtration rate (eGFR) calculated using the modification of diet in renal disease formula, and sociodemographic factors such as the presence of assistance during PD exchanges, the preferred dialysis choice (e.g., personal preference or imposed option), and the type of PD used.

Comorbidities were also assessed using the Charlson Comorbidity Index (CCI), a validated tool that assigns weighted scores to 19 chronic conditions (including diabetes, cardiovascular disease, malignancy, and liver disease) based on their impact on mortality. The total CCI score reflects the overall comorbidity burden, with higher values indicating an increased risk of death or adverse outcomes (Charlson et al. 1987).

The duration of PD therapy, any prior hemodialysis (HD) treatment, and its duration, when applicable, were also documented. The start of Continuous Ambulatory Peritoneal Dialysis (CAPD) was defined as the point after catheter placement and patient education when patients began the standard 2-liter, four-times-per-day regimen. The start of Automated Peritoneal Dialysis (APD) was defined as the point at which patients began PD with the appropriate exchange volume of Dianeal dialysis solution, typically 2 to 3 weeks after catheter placement, with glucose concentrations adjusted according to patients' volume status and intraperitoneal pressure.

TIMING OF MEASUREMENTS

All clinical and biological variables were assessed at the most recent follow-up consultation, after a minimum of 6 months on stable peritoneal dialysis. Baseline data were also collected retrospectively at PD initiation, but analyses were based on long-term parameters representative of chronic dialysis adequacy.

Total daily urea clearance (peritoneal plus residual renal) as Kt/V and weekly creatinine clearance (WCC) were measured. WCC is expressed in liters per week per 1.73 m^2 of body surface area. It estimates total creatinine clearance from both residual kidney function (RKF) and dialysis, providing an integrated marker of solute removal over time. Systolic and diastolic blood pressure, daily urine volumes, and average daily ultrafiltration volumes were recorded at the beginning and at the final consultation. Residual kidney function was calculated using the formula: ((Urinary urea / Plasma urea) + (Urinary creatinine / Plasma creatinine) x Urine output/1400) /2.

The nutritional assessment markers used in the study included BMI (kg/m^2; weight/height^2), hemoglobin, ferritin, transferrin, albumin, triglycerides (TG), total cholesterol, and the normalized protein catabolic rate (nPCR; grams per kilogram per day). The nPCR was calculated using the formula proposed by Tattersall (Tattersall et al. 1996): nPCR (g/kg/day) = 149,7 × G/V + 0,17, where G/V = [(Uv × Uc) + (Dv × Dc)] / (1 440 × V), where Uv = volume of urine collected over 24 hours; Uc = concentration of urea in the urine collected over 24 hours; Dv = volume of used dialysate collected over 24 hours; and Dc = concentration of urea in the used dialysate collected over 24 hours.

The markers of clearance used in our study included serum levels of urea, creatinine, phosphorus, and uric acid, as well as Kt/V and WCC. C-reactive protein (CRP) was included as an inflammation marker.

LABORATORY ANALYSIS

Venous blood samples were collected after an overnight fast. Hemoglobin concentration was measured using an automated hematology analyzer (Sysmex XN series, Kobe, Japan). Ferritin, transferrin, albumin, and CRP were determined by immunoturbidimetric assays (Roche Cobas

6000, Basel, Switzerland). Serum triglycerides and total cholesterol were analyzed using enzymatic colorimetric methods (GPO-PAP and CHOD-PAP, respectively). All analyses were carried out in the central laboratory of Ibn Sina University Hospital, following standard operating procedures and routine internal and external quality controls.

STATISTICAL ANALYSIS

All quantitative variables were expressed as either mean ± standard deviation or median with interquartile range, depending on their distribution. The normality of distributions was assessed using the Shapiro–Wilk test and by visual inspection of histograms and Q–Q plots. The homogeneity of variances was evaluated using Levene's test. Depending on these assessments, comparisons between groups were performed using Student's t-test (for normally distributed variables with equal variances), Welch's t-test (for normally distributed variables with unequal variances), or appropriate non-parametric tests (Mann–Whitney U test or Kruskal–Wallis test) when normality assumptions were not met.

Categorical variables, representing groups or categories such as sex, presence of diabetes, or dialysis modality (CAPD or APD), were expressed as numbers (percentages) and compared using the chi-square test or a binomial test. A two-sided P value < 0.05 was considered statistically significant.

To identify factors associated with dialysis adequacy, relative risk (RR) analyses were performed, providing estimates with their corresponding 95% confidence intervals (95% CI). All data management and analyses were performed using Jamovi software, version 2.3.21.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

Over a period of 18 years, a final sample size of 235 patients was recruited at our peritoneal dialysis unit. Chronic glomerulonephritis (24.5%) was the most common cause of end-stage kidney disease (ESKD), followed by tubulo-interstitial nephropathy (17.8%) and diabetic nephropathy (17.8%). Of the 151 patients included, 85 (56.3%) had inadequate dialysis (Group A, Kt/V<1.7) and 66 (43.7%) achieved adequate dialysis (Group B, Kt/V≥1.7) as determined by their total weekly Kt/V. The demographic characteristics of the studied population, the primary cause of ESKD, the peritoneal dialysis technique, and the type of peritoneal transport (assessed in only 76 patients) are summarized in Table 1.

The average age of our patients was 45.1 ± 17 years, and the male-to-female ratio (M/F) was 1.18. Diabetes, hypertension, abdominal hernia, and a history of hemodialysis and renal transplantation prior to peritoneal dialysis were present in both groups (p > 0.05). The Charlson score median was 2 [2-3] in both groups (p > 0.05). There were also no significant differences between the two groups regarding age, sex, socioeconomic level, or patient autonomy.

CAPD was the most commonly used technique in both groups (more than 75% in each, p = 0.735), with no significant difference in peritoneal dialysis duration (p = 0.220). Polycystic kidney disease (PKD) was significantly more common in Group B (16.7% vs. 3.5%, p = 0.012).

Dialysis adequacy was positively associated with eGFR (p = 0.036) and RKF (p < 0.001) and negatively associated with serum creatinine, urea, and uric acid levels (p = 0.005, p < 0.001, and p = 0.019, respectively).

Regarding markers of mineral and bone disorders, Group A showed significantly higher serum phosphorus levels (p = 0.030). Still, there were no significant differences in calcium, vitamin D, or parathyroid hormone levels (p > 0.05).

Table 1: Demographic characteristics of the peritoneal dialysis population by groups at the Ibn Sina Hospital in Rabat, Morocco, 2006 to 2024.

	Total (n = 151)	Group A (inadequate,Kt/V<1.7) (n = 85)	Group B (adequate, Kt/V≥1.7) (n = 66)	P*
Age in years, mean ± SD	45.1 ± 17	47.4 ± 15.4	42.2 ± 18.5	0.061
Male, n (%)	82 (54.3%)	50 (58.8%)	32 (48.5%)	0.206
Initial Nephropathy, n (%)				
Glomerular	31 (20.5%)	17 (20.0%)	14 (21.2%)	0.855
Diabetic	27	18 (21.2%)	9 (13.6%)	0.230
Nephroangiosclerosis	17	12 (14.1%)	5 (7.6%)	0.207
Tubulo-interstitial	27	13 (15.3%)	14 (21.2%)	0.347
Polycystic Kidney Disease (PKD)	13	3 (3.5%)	11 (16.7%)	**0.006**
Indeterminate	33	20 (23.5%)	14 (21.2%)	0.735
Other	3	2 (2.4%)	1 (1.5%)	1.000
Good socio-economic status, n (%)	94 (62.2%)	52 (61.2%)	42 (63.6%)	0.810
Diabetes, n (%)	29 (19.2%)	18 (21.2%)	11 (16.7%)	0.485
Time on PD (months), median+IQR	37 [12.5 - 60.5]	39.5 [13 - 55]	46.5 [12.5 - 71.5]	0.220
Peritoneal transport type (N=76) **	55 FT/21ST	24 FT/8ST	31FT/13ST	0.715
Kt/V (mL/mn), mean ± SD	1.65 ± 0.675	1.25 ± 0.285	1.75 ± 0.784	**<0.001**
WCC (mL/mn), mean ± SD	78.1 ± 42.8	60.6 ± 27.4	102 ± 48.3	**<0.001**

	Total (n = 151)	Group A (inadequate,Kt/V<1.7) (n = 85)	Group B (adequate, Kt/V⩾1.7) (n = 66)	P*
RKF (m/Lmn), mean ± SD	3.75 ± 3.36	2.96 ± 2.68	4.84 ± 3.88	**<0.001**
eGFR (mL/mn), mean ± SD	6.62 ± 2.86	6.12 ± 2.72	7.26 ± 2.93	**0.036**
Blood urea (g/L), mean ± SD	1.29 ± 0.378	1.36 ± 0.366	1.21 ± 0.379	**0.005**
Blood creatinine (mg/L), mean ± SD	98 ± 34.9	107 ± 33.1	85.4 ± 33.6	**<0.001**
Phosphorus (mg/L), mean ± SD	*49.3 ± 16*	*51.4 ± 16.5*	*46.4 ± 14.9*	***0.030***

*Abbreviations : eGFR : estimated glomerular filtration rate; FT : Fast transport; IQR = interquartile range; Kt/V : Total daily urea clearance; PD = peritoneal dialysis; RKF : Residual kidney function; SD = standard deviation; ST : Slow transport; WCC : Weekly creatinine clearance. *Comparing Group A (inadequate dialysis) with Group B (adequate dialysis). Values are presented as median [interquartile range] or mean ± SD for continuous variables, and n (%) for categorical variables. Time on PD represents the duration of peritoneal dialysis. **Peritoneal transport types: It should be noted that not all patients underwent Peritoneal Equilibration Testing (PET). For those tested, transport types were classified as ST (slow solute transport across the peritoneal membrane) or FT (rapid solute transport).*

NUTRITIONAL PARAMETERS AND ADEQUACY

The associations between nutritional parameters and peritoneal dialysis adequacy are summarized in Table 2. Patients in Group A with inadequate dialysis had a higher BMI, lower nPCR, and higher TG levels ($p < 0.05$). Subgroup analysis revealed that overweight patients (⩾25 kg/m²) had a higher proportion of dialysis inadequacy than patients in other BMI categories ($p = 0.011$). No significant differences in albumin levels were observed between groups.

Table 2: Nutritional characteristics of the study population by groups at the Ibn Sina Hospital in Rabat, Morocco, 2006 to 2024.

Variable	Total (n = 151)	Group A (Kt/V<1.7) (n = 85)	Group B (Kt/V⩾1.7) (n = 66)	p
BMI (Kg/m²)	24.4 ± 5.01	25.8 ± 5.13	22.6 ± 4.26	0.018
< 18,5	*11 (7.3%)*	*3 (3.5%)*	*8 (12.1%)*	
18,5-24,9	*68 (45.0%)*	*34 (40.0%)*	*34 (51.5%)*	
25-30	*67 (44.3%)*	*45 (52.9%)*	*22 (33.3%)*	
>30	*5 (1.98%)*	*3 (3.52%)*	*2 (3.0%)*	
nPCR (g/Kg/day)	0.809 ± 0.259	0.720 ± 0.202	0.935 ± 0.280	<0.001
Albumin (g/L)	36.0 ± 6.13	36.3 ± 6.21	35.5 ± 6.05	0.436
Triglycerides (g/L)	1.60 ± 0.773	1.70 ± 0.812	1.46 ± 0.697	0.011

Abbreviations : BMI : Body mass index; nPCR : normalized proteïn catabolic rate.

BIOCHEMICAL AND INFLAMMATORY PARAMETERS

The biochemical and inflammatory characteristics of the study population are summarized in Table 3. Patients in Group A had lower hemoglobin and ferritin levels and higher uric acid levels ($p < 0.05$). No significant differences in transferrin or CRP levels were observed between the groups.

Table 3: Biochemical and inflammatory characteristics of the study population by groups at the Ibn Sina Hospital in Rabat, Morocco, 2006 to 2024.

Variable	Total (n = 151)	Group A (Kt/V<1.7) (n = 85)	Group B (Kt/V⩾1.7) (n = 66)	p
Anemia (Hb < 12 g/dL)	88 (58.3%)	56 (65.9%)	32 (48.5%)	**0.021**
Iron deficiency (Ferritin < 30 ng/mL)	39 (25.8%)	28 (32.9%)	11 (16.7%)	**0.016**
Inflammation (CRP > 5 mg/L)	54 (35.8%)	34 (40.0%)	20 (30.3%)	0.156

Abbreviations : CRP : C-reactive protein, Hb : Hemoglobin.

PREDICTIVE FACTORS AND CORRELATIONS INFLUENCING DIALYSIS ADEQUACY

Several clinical parameters were found to be significantly associated with dialysis adequacy. Patients with a higher normalized protein catabolic rate (nPCR ⩾ 0.8 g/kg/day) were

significantly more likely to achieve adequate dialysis (RR = 1.93; 95% CI [1.45–2.00]; p < 0.001). In contrast, a low estimated glomerular filtration rate (eGFR < 7 mL/min) was associated with reduced adequacy (RR = 0.694; 95% CI [0.522–0.925]; p = 0.008), likely reflecting the decline in solute clearance as residual kidney function decreases.

Overweight patients (BMI ⩾ 25 kg/m²) showed a lower likelihood of achieving adequate dialysis (RR = 0.69; 95% CI [0.52–0.91]; p = 0.005), suggesting that increased body mass may be associated with a greater distribution volume and higher solute load. Similarly, preserved residual kidney function (RKF ⩾ 4 mL/min) was associated with higher adequacy (RR = 1.34; 95% CI [1.02–1.77]; p = 0.030).

Finally, patients with PKD showed a trend toward greater adequacy (RR = 2.40; 95% CI [0.906–6.34]; p = 0.012), although the confidence interval was relatively wide, suggesting some uncertainty in this association (Table 4).

Table 4: Relative risk analysis for dialysis adequacy in PD patients with a Kt/V > 1.7

Variable	Univariate RR	95% CI	p
nPCR ⩾ 0.8 g/kg/day	1.930	[1.45-2.00]	<0.001
eGFR < 7 mL/mn	0.694	[0.522-0.925]	0.008
BMI ⩾ 25 Kg/m²	0.690	[0.52-0.91]	0.005
RKF ⩾ 4 mL/mn	1.340	[1.02-1.77]	0.030
PKD	2.40	[0.906-6.34]	0.012

Abbreviations : BMI : Body mass index; estimated glomerular filtration rate; nPCR : normalized proteïn catabolic rate; PKD : Polycystic kidney disease; RKF : Residual kidney function.

DISCUSSION

Dialysis adequacy in peritoneal dialysis (PD) is a significant determinant of PD patients' prognosis. However, the factors influencing its effectiveness remain poorly defined, and the link between nutritional status—particularly nutritional markers—and dialysis adequacy is still debated (Castrale et al. 2016; Issad et al. 2013).

In this context, this study highlights that the normalized protein catabolic rate (nPCR) was not only a key indicator of nutritional status but also strongly associated with PD effectiveness.

In the literature, nPCR is considered a useful indicator of dietary protein intake, with values below 0.8 g/kg/day considered a marker of malnutrition according to KDOQI guidelines (NKF-K/DOQI, 2000; KDOQI, 2020). Previous research has emphasized the role of nPCR as a nutritional marker, highlighting its effect on morbidity and mortality (Qin et al. 2021; Teta et al. 2006). Although nPCR is primarily used to assess nutritional status, several studies have also investigated its association with dialysis adequacy, supporting its potential role as an indicator of PD effectiveness (CANUSA Peritoneal Dialysis Study Group, 1996; Qin et al. 2021). In this study, an nPCR < 0.8 g/kg/day was identified as an independent risk factor for inadequate dialysis.

The present study found that 56.3% of patients were in a state of dialysis inadequacy. Dialysis adequacy was positively associated with a higher eGFR, better RKF, and higher nPCR. An nPCR ⩾ 0.8 g/kg/day was strongly associated with an optimal Kt/V ⩾ 1.7, and thus dialysis adequacy, suggesting that an nPCR below 0.8 g/kg/day is indicative of poor nutritional status in PD patients. In parallel, residual kidney function (RKF) has been consistently associated with improved volume control, better nutritional status, lower erythropoietin requirements, and decreased peritonitis rates in PD patients. For example, studies by Fung et al. (1996) and Mathew et al. (2016) demonstrated that patients with preserved RKF had significantly lower hospitalization rates and mortality compared to those without RKF (Fung et al. 1996; Mactier et al. 1993; Mathew et al. 2016; Okazaki et al. 2023). These findings align with our observations and emphasize the critical role of RKF in optimizing clinical outcomes in PD.

In this regard, patients with PKD were associated with improved dialysis adequacy. Benzouina et al. (2020) reported that RKF is maintained for a longer duration in these patients, contributing to enhanced dialysis efficiency. Although PKD has not been identified as a significant predictor of survival, the preservation of RKF has been shown to improve technical dialysis survival in PKD patients compared to non-PKD patients. Furthermore, mortality among PD patients with PKD was lower than that observed in patients without PKD, highlighting the role of RKF in maintaining quality of life and optimizing dialysis management (Benzouina et al. 2020; Choi et al. 2013; Davies et al. 2011).

Qin et al. (2021) concluded that nPCR is the most reliable and sensitive indicator for predicting PD dialysis adequacy in CAPD; an nPCR below 0.815 g/kg/day indicates dialysis inadequacy, and no significant differences were observed regarding traditional nutritional markers such as albumin, prealbumin, transferrin, and triglycerides (Qin et al. 2021). Albumin is both a nutritional and biochemical marker influenced by inflammation, and the variability of hypoalbuminemia can be affected by several factors, including hydration status, malnutrition, decreased hepatic synthesis, and organ stress (Heaf and Wehberg, 2014). Another study explored the role of hypoalbuminemia in worsening heart failure, suggesting that it is a powerful prognostic factor independent of age and clinical symptoms (Arques et al. 2020; Coulibaly Klinna et al. 2022).

Additionally, other biological nutritional markers at low levels were observed in patients with dialysis inadequacy, including hemoglobin (Hb), ferritin, and triglycerides. At the same time, a BMI greater than 25kg/m² was associated with dialysis inadequacy. Obesity is often linked to better outcomes in hemodialysis, but results in peritoneal dialysis are less clear. Generally, a higher BMI appears to have a neutral or even negative impact on PD efficiency, mainly due to increased fat mass. Risks are also higher in patients with a low BMI, suggesting that an optimal BMI for PD is between 20 and 25 kg/m² (Johnson, 2007).

The harmful effects of obesity in PD patients are explained by several factors, such as a higher peritonitis rate, increased inflammatory effects, and faster deterioration of residual kidney function in obese patients (Johnson, 2007). Although there is no direct evidence that weight reduction improves outcomes in PD patients, existing studies suggest

that cautious weight loss may be beneficial (Ng et al. 2022). Thus, for PD patients, it is crucial to manage their weight carefully, aiming for an optimal BMI to improve treatment success (Johnson, 2007; Ng et al. 2022; Johnson et al. 2000).

The LIBERTY study (2025) shows that prolonged hemodialysis, combined with a liberalized diet, improves survival, stabilizes nutritional status by maintaining BMI below 25 kg/m², and helps manage malnutrition in chronic hemodialysis patients, with a 5-year survival rate of 85% (Imaizumi et al. 2025).

In conclusion, our results underscore the importance of a multidimensional approach to managing PD patients. Nutritional management is essential for better clearance and quality of life in dialysis: a strategy combining careful nutritional monitoring, body weight control, and preservation of RKF could improve dialysis efficacy and technique survival.

CONCLUSION

In conclusion, the study confirms that dialysis inadequacy is associated with altered nutritional and metabolic parameters, particularly low nPCR and overweight. Monitoring and correcting these factors should be integrated into management protocols for PD patients to optimize their clinical status and quality of life.

AUTHOR CONTRIBUTIONS

HN contributed to the conceptualization and design of the study, data analysis, and manuscript writing. EN conducted the literature review, assisted in data interpretation, and contributed to the revision of the manuscript. ON wrote key sections of the manuscript, contributed to data collection, and revised the manuscript critically for important intellectual content. BL assisted in proofreading and final revisions, ensuring clarity and accuracy. All authors read and approved the final manuscript and gave consent for publication.

CONFLICT OF INTEREST

No conflict of interest to declare.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN SCIENTIFIC WRITING

ChatGPT (OpenAI) was used exclusively to assist with language editing and translation of certain terms in the manuscript. The authors drafted all scientific content, performed all analyses and interpretations, and are fully responsible for the accuracy and integrity of the final version.

DECLARATIONS

CONSENT TO PARTICIPATE: Verbal informed consent was obtained prior to the interviews.

CONSENT TO PUBLISH: All authors have read and approved the final version of the manuscript and consent to its submission and potential publication.

ETHICAL APPROVAL: Our institution does not require ethical approval for this type of study.

DATA AND/OR CODE AVAILABILITY: The datasets and/or code used and generated during the current study are available from the corresponding author upon reasonable request.

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