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Original Article

ORIGINAL ARTICLE

Sex disparities in the utilization of nurse-assisted peritoneal dialysis: a mediation analysis using data from the REIN registry

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ABSTRACT

Background. This study was carried out to evaluate the association between patient sex and the proportion of nurse-assisted peritoneal dialysis (PD) at dialysis initiation and to explore whether sex disparities in nurse-assisted PD utilization was explained by predialysis care and/or by social deprivation using mediation analysis.

Methods. This was a retrospective study using data from the Renal Epidemiology and Information Network (REIN) registry linked to the French National Healthcare Database (SNDS) of incident patients between 1 January 2017 and 30 June 2018. A regression logistic was used for statistical analysis. A mediation analysis explored the direct effect of sex on nurse-assisted PD proportion and the indirect effect through the European Deprivation Index (EDI), and the number of general practitioner (GP) and nephrologist visits before dialysis initiation.

Results. Among 1706 patients on PD, there were 637 women (37.3%) and 1069 men (62.7%). Nurse-assisted PD proportion was 332/610 (54.4%) for women vs 464/1036 (44.8%) for men. In the multivariable analysis women were more likely to be treated by nurse-assisted PD {odds ratio (OR) 1.92 [95% confidence interval (CI) 1.46–2.52]}. Nurse-assisted PD was associated with the median number of GP visits [OR 1.44 (95% CI 1.11–1.86)] and with the median number of nephrologist visits [OR 0.59 (95% CI 0.46–0.76)]. The mediation analysis showed a direct effect of sex on nurse-assisted PD [OR 1.90 (95% CI 1.80–2.01)] and an indirect effect through the median number of GP visits [OR 1.05 (95% CI 1.04–1.06], the median number of nephrologist visits [OR 1.02 (95% CI 1.02–1.03)] and quintile 5 of the EDI [OR 1.03 (95% CI 1.02–1.03)].

Conclusion. Women were more frequently treated by nurse-assisted PD than men. Differences between women and men in predialysis care and social deprivation could explain the greater utilization of nurse-assisted PD among women.

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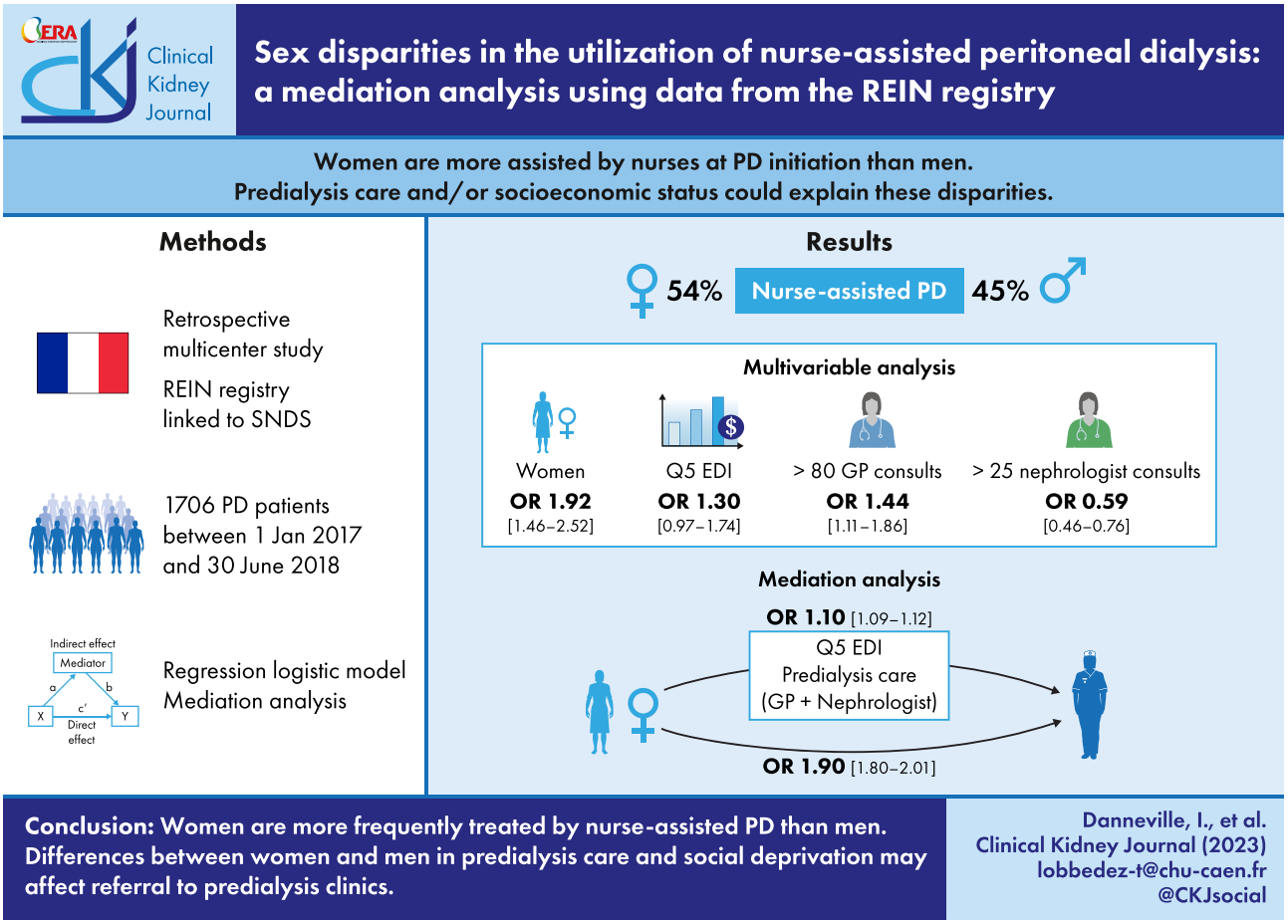
GRAPHICAL ABSTRACT



Keywords: assisted peritoneal dialysis, mediation analysis, peritoneal dialysis, predialysis care, sex

KEY LEARNING POINTS

What was known:

- Sex may influence the choice of dialysis modality in chronic kidney disease. There are sex differences regarding the outcome of peritoneal dialysis (PD) explained by nurse assistance with PD.
- There is no study available on the association between sex and nurse-assisted PD.

This study adds:

- Men are less frequently treated by nurse-assisted PD than women.
- Predialysis care and social deprivation are mediators in the causal pathway between sex and the utilization of nurse-assisted PD among women.

Potential impact:

- This raises the question of the assessment of the implementation of assisted PD for men.

INTRODUCTION

It has been suggested that patient sex could influence the choice of dialysis modality among individuals reaching end-stage kidney disease [1, 2]. Although the data in the literature are controversial, there are sex differences regarding the outcomes of peritoneal dialysis (PD), as studies have suggested that men have a greater risk of transfer to haemodialysis (HD) than women [1, 3]. In a mediation analysis, nurse assistance with PD partly explained the lower risk of transfer to HD among women [4]. This finding supports the results of previous works in which nurse-assisted PD patients had a lower likelihood of switching to HD [5]. Studies have observed that women are more frequently treated by nurse-assisted PD than men [6, 7]. The difference in life

expectancy between women and men may affect the rate of social isolation, which could lead to greater utilization of nurse assistance among women [8]. One may also argue that women are more prone than men to accept the help of nurses for PD. PD nurses' decision to provide help may also explain sex disparity in the rate of assisted PD utilization. However, men have a lower likelihood of nurse assistance than women even after adjustment for the subjective assessment by PD nurses of the inability to be treated by self-care PD [7]. In France, women are more frequently socially deprived than men, which can affect access to the healthcare system [9]. General practitioner (GP) involvement in chronic kidney disease (CKD) care, which encompasses referral to the renal clinic, may differ between men and women [10]. Late referral to the dialysis clinic negatively influences patient education and training, which may lead to a higher utilization of nurse assistance at PD initiation. Sex disparities are a matter of concern since efforts must be made to reduce inequity in care. To the best of our knowledge, no study has focused on sex disparities regarding nurse-assisted PD utilization at dialysis start.

This study was carried out to evaluate the association between patient sex and the proportion of nurse assistance with PD at dialysis initiation. The second objective was to explore whether sex disparities in nurse-assisted PD utilization could be explained by predialysis care and/or by socioeconomic status using mediation analysis.

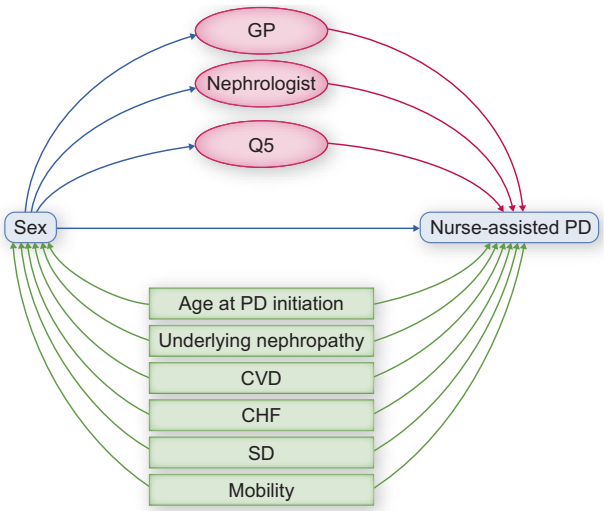


Figure 1: Directed acyclic graph describing causal assumptions in the relationship between sex and nurse-assisted. PD, mediators; GP, >80 general practitioner consultations; Nephrologist, >25 nephrologist consultations; Q5, the most deprived quintile of the EDI Cofounders, Age at PD initiation; Underlying nephropathy; CVD, cardiovascular disease; CHF, chronic heart failure; SD, severe disability and mobility.

MATERIALS AND METHODS

Study population

This was a retrospective study using data from the REIN registry, which does not contain information on the predialysis care trajectory. To obtain information on predialysis, the data of the REIN registry were linked to the French National Healthcare Database (SNDS). This administrative database covers 99% of the population and collects data on ambulatory care (GP and nephrologist consultations). In total, 1706 patients older than 18 years of age who started receiving PD in France between 1 January 2017 and 30 June 2018, and who were still on dialysis after 3 months of renal replacement therapy were included. The study period covered the 5 years before dialysis initiation.

Study variables

Event of interest

The event of interest was nurse-assisted PD, which was defined as continuous ambulatory PD (CAPD) or automated PD (APD) performed by a private nurse at the patient's home at dialysis initiation. In France, where nurse-assisted PD is fully covered by healthcare insurance, the ability to perform PD exchanges is evaluated by nurses from the dialysis centre and subsequently confirmed by the nephrologist in charge. Private nurses are trained by the nurses from the PD centre. Patients on self-care PD receive financial compensation from the healthcare insurance. The French Health Care regulation also allows nurses from the private sector to perform PD in nursing homes.

Patient characteristics

Data were obtained from the REIN registry: sex, age, underlying nephropathy divided into five groups (polycystic kidney disease, vascular or hypertensive nephropathy, diabetic nephropathy, glomerulonephritis, and other or unknown), comorbidities, including diabetes, cardiovascular disease (defined as peripheral vascular disease, abdominal aortic aneurysm, stroke or transient ischaemic attack, coronary heart disease or dysrhythmia), chronic heart failure, chronic respiratory disease, active cancer and tobacco use. Marital status, family support and location of living are not collected in the registry. Nutritional status was assessed by body mass index and serum albumin level. Predialysis anaemia care was estimated by haemoglobin level and erythropoiesis-stimulating agent (ESA) use at initiation and in the year before starting dialysis. Circumstances of dialysis initiation were collected: estimated glomerular filtration rate (eGFR) using the Chronic Kidney Disease Epidemiology Collaboration equation, and emergency start defined as a first dialysis initiation because of a life-threatening issue requiring dialysis within 24 h of diagnosis. Information regarding patient disability was extracted: severe disability (defined by severe vision impairment, paraplegia, hemiplegia or amputation), behaviour disorder and mobility. Using SNDS data, the total number of GP consults before starting dialysis up to 5 years and the total number of nephrology consults in the 4 years preceding the start of dialysis were collected, and they were divided into two groups according to their median.

Patients' social deprivation was estimated by the European Deprivation Index (EDI) [11]. The EDI is an ecological index constructed on subjective poverty based on fundamental needs identified by EU-SILCS (European Union—Statistics on Income and Living Conditions) and objective poverty. The score from the French EDI was calculated in 2011 for each neighborhood, called IRIS (Ilot Regroupé pour l'Information Statistique), which is the smallest geographical unit, to reduce ecological bias. EDI is separated into quintiles of the general population with quintile 5 corresponding to the most deprived category.

Potential confounders and mediators

Assumptions for potential confounders and mediators were based on a literature review (Supplementary Data S1). A direct acyclic graph was used to represent the hypothetical relationship among the exposure variable, the outcome variable, potential confounders and mediators (Fig. 1) [12, 13]. Patient sex was

defined as the exposure, and the mediators were the EDI, the median number of GP visits and the median number of nephrologist visits before dialysis initiation. The confounders were age, underlying nephropathy, comorbidities and disabilities.

There was no significant interaction between sex and the fifth quintile of the EDI or between sex and the median number of GP or nephrologist visits (Supplementary data, Table S1).

Statistical analysis

Continuous variables are described by the median values and the first and third quartiles. Categorical variables are described by frequencies and percentages. Continuous variables were separated into categories if there was no linear relationship between the predictor and the outcome with regression splines.

Logistic regression was used for the statistical analysis. The variance-inflated factor (VIF) was used to test collinearity between variables. To facilitate the regression logistic and mediation analyses, we dichotomized the EDI (quintile 5 versus other quintiles) and the total number of GP and nephrologist consultation variables based on the median (80 and 25 consults, respectively) and used them as binary variables. Multivariable analysis was performed with the confounders and subsequently with and without the mediators.

A mediation analysis with a counterfactual approach was performed to explore the direct effect of sex on nurse-assisted PD proportion at dialysis initiation and the indirect effect through mediators. Based on the observed data, two fictive datasets were created with a fictive exposure and fictive mediators. The counterfactual outcome was the outcome that would have been obtained if the subjects had been exposed to the fictive exposure and/or fictive mediator. The outcome was calculated by an imputation-based approach. A nonparametric bootstrap procedure was used to calculate the confidence intervals (CIs) of the odds ratios (ORs). As there were three potential mediators, a mediation analysis was performed by entering one mediator at a time and adjusting for the confounders. Then, a sequential analysis was performed by entering mediators according to their strength of association in the bivariate analysis in attempt to assess the effect of the causal pathway. The uncertainty of the results is expressed by the 95% CI of the estimator.

Sensitivity analysis

The E-value was employed to assess the robustness of the association. The E-value is defined as the minimum OR that an unmeasured confounder would need to have with both sex and the outcome to fully explain a specific exposure–outcome association. The more the E-value increases, the more robust the results [14, 15].

Missing data

Missing data were 'missing at random'. Multiple imputations by a chain equation were performed for all missing data. Twenty imputed datasets were created, and regression coefficients were obtained according to Rubin's rules [16]. Patient characteristics at dialysis initiation with imputed data are displayed in Supplementary data, Table S2.

Statistical analyses were performed using R, version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria) using the mice, medflex packages.

Ethical considerations

The REIN registry has the approval of the French National Ethics Committee (Commission Nationale de l'Informatique et des Libertés). This study was conducted within the framework of this authorization.

RESULTS

Patient characteristics

Among 1706 patients on PD, there were 637 women (37.3%) and 1069 men (62.7%). Of these 1706 individuals, 1172 (68.7%) were on CAPD and 534 (31.3%) were on APD. There was no difference between women and men regarding PD modality at dialysis start. The proportion of nurse assistance was 332/610 (54.4%) for women vs 464/1036 (44.8%) for men. The proportion of social deprivation was greater among women, as 214/598 (35.8%) belonged to the fifth quintile of the EDI compared with 262/1007 (26%) among men. Among women, 110/397 (27.7%) and 304/555 (54.8%) were treated with ESA in the year before starting dialysis and at dialysis initiation compared with 195/518 (37.6%) and 431/933 (46.2%) men, respectively. Women had more GP visits within the 5 years before starting dialysis than men (85 vs 73), whereas there was no difference in the number of nephrologist visits between women and men (24 vs 26).

There was no difference between women and men regarding median age at dialysis initiation or diabetes frequency; women had fewer comorbidities than men. Women were more often obese (24.9% vs 19.9%) and had more malnutrition than men (serum albumin <30 g/L: 17.1% vs 12.7%, respectively). Women had a lower haemoglobin level than men (haemoglobin ≤ 11 g/dL: 62.9% vs 52.8%, respectively) and a lower eGFR at dialysis start (eGFR below 8 mL/min/1.73 m^2: 46.6% vs 37.1%), and the proportion of emergency start was similar between men and women.

Patient and treatment characteristics are displayed in Table 1. Bivariate analyses are provided in Supplementary data, Tables S3 and S4.

Multivariable analysis

After adjustment for the confounders and mediators, women were more likely to be treated by nurse-assisted PD than men [OR 1.92 (95% CI 1.46–2.52)].

Nurse-assisted PD was associated with the median number of GP visits [OR 1.44 (95% CI 1.11–1.86)], whereas nurse assistance was negatively associated with the median number of nephrologist visits before starting dialysis [OR 0.59 (95% CI 0.46–0.76)]. Nurse assistance was not associated with quintile 5 of the EDI [OR 1.30 (95% CI 0.97–1.74)]. In both models (with and without mediators), age at PD initiation, comorbidities and severe disability were associated with nurse assistance.

The results of the multivariable analysis are displayed in Table 2.

Mediation analysis

The analysis performed with the mediators entered one at a time showed that there was a natural direct effect of sex on nurse-assisted PD [OR 1.90 (95% CI 1.80–2.01)].

There was an indirect effect of sex through the median number of GP visits [OR 1.05 (95% CI 1.04–1.06), ≤ 80 as reference class], the median number of nephrologist visits [OR 1.02 (95% CI

Table 1: Patient and treatment characteristics by sex.

Covariates	All patients (*N* = 1706)	Women (*N* = 637)		Men (*N* = 1069)		*P*-value
Nurse-assisted PD		332	54.4%	464	44.8%	.001
Missing	60	27		33		
Age at PD initiation (years), median (IQR)		69.8 (53.4–81.1)		70.2 (58.3–79.8)		NS
Underlying nephropathy						.005
Polycystic kidney disease		61	9.6%	74	6.9%	
Vascular or hypertensive nephropathy		141	22.0%	283	26.5%	
Diabetic nephropathy		101	15.9%	196	18.3%	
Glomerulonephritis		80	12.6%	161	15.1%	
Other or unknown		254	39.9%	355	33.2%	
Comorbidities						
Diabetes		239	37.8%	433	40.7%	NS
Missing	14	5		9		
Cardiovascular disease[a]		227	36.5%	559	54.1%	<.001
Missing	51	15		36		
Chronic heart failure		126	20.2%	312	30.0%	<.001
Missing	40	12		28		
Chronic respiratory disease		38	6.1%	122	11.7%	<.001
Missing	42	13		29		
Active cancer		30	4.8%	90	8.6%	.003
Missing	39	12		27		
Tobacco use						<.001
Nonsmoker		401	77.7%	402	44.8%	
Former smoker or current smoker		115	22.3%	495	55.2%	
Missing	**293**	121		172		
Nutritional status						
BMI						.030
<30 kg/m^2		402	75.1%	704	80.1%	
≥30 kg/m^2		133	24.9%	175	19.9%	
Missing	**292**	102		190		
Albuminemia						.030
<30 g/L		83	17.1%	101	12.7%	
≥30 g/L		401	82.9%	693	87.3%	
Missing	**428**	153		275		
Predialysis anaemia care						
Initial haemoglobin level						<.001
≤11 g/dL		366	62.9%	511	52.8%	
>11 g/dL		216	37.1%	456	47.2%	
Missing	157	55		102		
ESA at initiation		304	54.8%	431	46.2%	.001
Missing	218	82		136		
ESA in the year before starting dialysis		110	27.7%	195	37.6%	.002
Missing	**791**	240		551		
eGFR (CKD-EPI) at dialysis initiation, median (IQR)		8.27 (6.11–11.15)		9.04 (6.96–12.03)		<.001
eGFR ≤8 mL/min/1.73 m^2		276	46.6%	359	37.1%	
eGFR >8 mL/min/1.73 m^2		316	53.3%	609	62.9%	
Missing	146	45		101		
Emergency start		52	8.9%	90	9.0%	NS
Missing	120	49		71		
Assistance						
Severe disability[b]		77	12.8%	121	11.8%	NS
Missing	82	36		46		
Behaviour disorder		13	2.2%	12	1.2%	NS
Missing	113	47		66		
Mobility						NS
Walk without help		526	89.8%	904	92.1%	
Need assistance or totally dependent		60	10.2%	78	7.9%	
Missing	138	51		87		

Table 1: Continued

Covariates	All patients (N = 1706)	Women (N = 637)		Men (N = 1069)		P-value
EDI						<.001
Quintile 1		76	12.7%	167	16.6%	
Quintile 2		94	15.7%	180	17.9%	
Quintile 3		92	15.4%	197	19.6%	
Quintile 4		122	20.4%	201	19.9%	
Quintile 5		214	35.8%	262	26.0%	
Missing	101	39		62		
Total number of consults before starting dialysis, median (IQR)						
General practitioner (up to 5 years prior)		85 (51–134)		73 (36–113)		<.001
Nephrologist (up to 4 years prior)		24 (9–42)		26 (11–42)		NS

[a]Includes peripheral vascular disease, abdominal aortic aneurysm, stroke or transient ischaemic attack, coronary heart disease and dysrhythmia.
[b]Includes severe vision impairment, paraplegia, hemiplegia and amputation.
BMI: body mass index; IQR: interquartile range; NS: nonsignificant.
Values in bold correspond to missing data >10%.

1.02–1.03), ≤25 as reference class] and quintile 5 of the EDI [OR 1.03 (95% CI 1.02–1.03), other quintiles as reference class].

In the sequential analysis, the indirect effect of sex increased when two mediators [OR 1.07 (95% CI 1.07–1.09)] or three mediators [OR 1.10 (95% CI 1.09–1.12)] were entered into the model. The results of the mediation analysis are displayed in Table 3.

DISCUSSION

In two previous studies, women were more likely to be treated by PD than HD compared with men [1, 17]. Among the patients treated by PD, there was no difference between men and women in PD modality (CAPD, APD) [4]. However, our study showed that among PD patients, women had a greater chance of being assisted by a nurse than men.

Information regarding sex differences in the utilization of nurse are scarce. In Ontario, Canada, where nurse-assisted PD is also covered by healthcare insurance, the proportion of women in the group of patients treated by assisted PD (family or home care assistance) was 44% [18]. A single-centre study from British Columbia showed that 40% of the patients on assisted PD were women, whereas the proportion of women among the prevalent PD patients was 36% [19]. In one single-centre study from Taiwan that enrolled patients over 65 years, the proportion of women in the assisted PD group was 54%, compared with 32% in the self-care group; assistance was provided by non-healthcare professionals (family members or foreign domestic workers) [20]. Another single-centre report from China showed that the proportion of women was 50% in the family-assisted group, 72% in the home assistance PD groups and 58% in the self-care group [21]. In Brazil, among 30 patients starting assisted PD, the proportion of women was 50%, but there was no comparison with the sex ratio of patients on self-care PD [22]. In Denmark, a single-centre study showed that the proportion of women was similar between the nurse-assisted PD and self-care PD groups [23].

Women have a longer lifespan than men, leading to a higher rate of isolation which could influence nurse-assisted PD use. However, in a study which included only subjects younger than 65 years old, women had a greater likelihood than men of being treated by nurse-assisted PD; there was no association between sex and the chance of being treated by family-assisted PD [6].

The PD nurse evaluation to provide assistance may differ between women and men. However, one study has shown that the probability of being treated by nurse-assisted PD was lower for men compared with women even after adjustment for the nurse's subjective assessment of the patient's inability to be on self-care PD [7]. One may hypothesize that there are sex differences in the perception of the need to be assisted with the objective of avoiding placing a burden on family caregivers [24].

In our work, the mediation analysis showed that the role of sex in nurse-assisted PD utilization was partly explained by differences in predialysis care. There was an indirect effect of sex through the number of GP visits and the number of nephrology visits before the start of dialysis. Differences between women and men regarding care by GP could differ among subjects suffering from CKD. Among patients with CKD, women have more medical follow-ups with their GPs than men [25]. It has been suggested that women are more vigilant and self-reliant than men in an attempt to protect their families from the burden of the disease; women could be more proactive and vigilant in monitoring their health, which may postpone dialysis initiation but also delay referral to nephrology services [24]. A population-based study has reported a higher rate of health services used by women than by men [26]. Women are more likely to use primary care services, while men are more likely to use emergency and hospital services, which may reflect differences in health perceptions and attitudes [25, 27, 28]. Of note, in our study, the emergency start of dialysis was not influenced by the patient's sex. Despite greater service use, women have an increased risk for unmet healthcare needs compared with men [29]. The relationship between family physicians and CKD patients may also affect the referral to a dialysis clinic. According to KDIGO, family physicians must refer stage 4 CKD patients to the nephrologist when hypertension is not controlled, the eGFR decreases rapidly, in case of a high level of albuminuria or when there are multiple comorbid conditions [30]. Our study also showed that at the start of dialysis, women had fewer comorbidities than men, which could have influenced the timing of the referral to the nephrology clinic. A qualitative study demonstrated that before the start of dialysis, patients with CKD are generally followed by their family physician; GPs reported that the decision regarding patient management was based on individual patient factors such as multimorbidity [31].

The fact that in our study the number of GP visits was positively associated with nurse assistance whereas the number of

Table 2: Multivariable analysis of the factors associated with nurse-assisted PD based on imputed data.

	Model without mediators			Model with mediators		
Covariates	OR	95% CI	P-value	OR	95% CI	P-value
Sex (men as reference class)	2.07	1.58–2.71	<.001	1.92	1.46–2.52	<.001
Age at PD initiation						
≤70 years	Ref			Ref		
>70 years	7.37	5.63–9.65	<.001	7.09	5.37–9.35	<.001
Underlying nephropathy						
Polycystic kidney disease	Ref			Ref		
Vascular or hypertensive nephropathy	1.26	0.70–2.26	.400	1.17	0.65–2.09	.600
Diabetic nephropathy	1.28	0.67–2.46	.500	1.16	0.60–2.24	.700
Glomerulonephritis	0.76	0.41–1.43	.400	0.72	0.38–1.35	.300
Other or unknown	1.29	0.74–2.26	.400	1.16	0.68–2.08	.500
Comorbidities						
Diabetes	1.67	1.21–2.30	.005	1.59	1.15–2.21	.005
Cardiovascular disease[a]	1.43	1.06–1.92	.040	1.38	1.02–1.86	.040
Chronic heart failure	2.04	1.46–2.85	<.001	1.19	1.38–2.72	<.001
Nutritional status						
Albuminemia						
<30 g/L	Ref			Ref		
≥30 g/L	0.72	0.46–1.13	.200	0.72	0.46–1.15	.200
Predialysis anaemia care						
Initial haemoglobin level						
≤11 g/dL	Ref			Ref		
>11 g/dL	0.87	0.66–1.15	.300	0.93	0.70–1.23	.600
eGFR-CKD at dialysis initiation						
≤8 mL/min/1.73 m^2	Ref			Ref		
>8 mL/min/1.73 m^2	1.11	0.84–1.47	.500	1.06	0.79–1.40	.700
Emergency start	1.62	0.99–2.66	.060	1.15	0.92–2.54	.100
Assistance						
Severe disability[b]	3.89	2.52–6.01	<.001	4.08	2.63–6.34	<.001
Mobility						
Walk without help	Ref			Ref		
Need assistance or totally dependent	9.52	4.16–21.8	<.001	8.39	3.65–1.3	<.001
EDI						
Other quintiles				Ref		
Quintile 5				1.30	0.97–1.74	.080
Total number of consults before starting dialysis						
General practitioner (up to 5 years prior)						
≤80				Ref		
>80				1.44	1.11–1.86	.006
Nephrologist (up to 4 years prior)						
≤25				Ref		
>25				0.59	0.46–0.76	<.001

[a]Includes peripheral vascular disease, abdominal aortic aneurysm, stroke or transient ischaemic attack, coronary heart disease and dysrhythmia.
[b]Includes severe vision impairment, paraplegia, hemiplegia and amputation.

nephrologist visits was associated with a lower probability of being treated by nurse-assisted PD raises the question of sex differences in the referral to nephrology services. In support of this hypothesis, our work showed that ESAs were less frequently used among women than among men despite a higher degree of anaemia. It has been emphasized that the collaboration between GPs and nephrologists is suboptimal, with a lack of communication and unclear delineation of roles [32]. In contrast, in the USA, it has been observed that women have a greater likelihood than men of being followed in predialysis clinics [25]. Delpech *et al.* showed that female patients of male GPs may receive different care before dialysis [33]. Supporting this hypothesis, the practice patterns and opinions of nephrologists regarding the prescription of ESAs during the year before the start of dialysis or at dialysis initiation appear to differ between male and female CKD patients.

Social deprivation was a mediator of the sex effect on the utilization of nurse-assisted PD, in France, women are more exposed to social deprivation than men. In two studies the chance of being treated by self-care dialysis was lower among socially deprived patients [9, 17]. Social deprivation is associated with lower access to the healthcare system [34], which could affect access to predialysis clinics and jeopardize patient education and training for self-care dialysis. Furthermore, a socially deprived patient has a lower health literacy level which could negatively affect patient training and education [35].

The one-in-a-bloc mediation analysis raises the hypothesis that a causal pathway (social deprivation, predialysis care) could lead greater utilization of assisted PD among women.

Our results should be interpreted in light of its limitations—residual confounders might have affected the results. The use of

Table 3: Mediation analysis of the effect of sex disparities (natural direct effect) and via three mediators (natural indirect effect) on nurse-assisted PD.

Mediator	GP OR (95% CI)	Neph OR (95% CI)	Quintile 5 OR (95% CI)	GP + Neph OR (95% CI)	GP + Neph + Quintile 5 OR (95% CI)
Natural Direct Effect	1.99 (1.89–2.12)	2.05 (1.93–2.17)	2.03 (1.92–2.16)	1.93 (1.84–2.05)	1.90 (1.80–2.01)
E-value	2.17	2.22	2.20	2.12	2.10
Natural Indirect Effect	1.05 (1.04–1.06)	1.02 (1.02–1.03)	1.03 (1.02–1.03)	1.07 (1.07–1.09)	1.10 (1.09–1.12)
E-value	1.18	1.11	1.14	1.22	1.28

Analyses were adjusted for confounders: age at PD initiation, underlying nephropathy, cardiovascular disease, chronic heart failure, severe disability and mobility.
The higher the E-value is when compared with 1, the more robust the results of the analysis.
GP: total number of general practitioner consults, Ref ≤80; Neph: total number of nephrologist consults, Ref ≤25.

gender rather than sex is more appropriate, as it refers to a social construct to reflect roles and attitudes. The home address used to estimate the EDI may have changed after the start of dialysis. In addition, subjective assessment of nurse-assisted PD could have led to selection bias. The particularity of dialysis coverage by the French health care system may hamper the generalizability of the results of our study.

In conclusion, our results showed that women were more frequently treated by nurse-assisted PD than men. Differences between women and men in predialysis care and social deprivation may affect referral to predialysis clinics, which could explain the greater utilization of nurse-assisted PD among women. Our study also raises the question of the underutilization of nurse-assisted PD among men. Qualitative studies are needed to explore the utilization of nurse-assisted PD among patients reaching end-stage kidney disease.

SUPPLEMENTARY DATA

Supplementary data are available at *ckj* online.

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AUTHORS' CONTRIBUTIONS

I.D. designed the study, analysed and interpreted the data, and drafted the manuscript. M.B., A.B., V.C., E.M., S.E., A.L. and C.B. revised the manuscript for important intellectual content. T.L. designed the study and interpreted the data.

DATA AVAILABILITY STATEMENT

The data underlying this article cannot be shared publicly for ethical reasons.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest and that the results presented in this paper have not been published previously in whole or part, except in abstract format.

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