Original Article

Gender Disparity in Hemodialysis Practices and Mortality: A Nationwide Cross-Sectional Observational Study

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Abstract:

Background: Disparities between genders are well documented in incidence, progression, and outcomes of chronic kidney disease (CKD). This study aimed to describe demographic characteristics, clinical and socio-economic factors among males and females on maintenance hemodialysis and to determine any association with mortality among males and females. **Materials and Methods:** A nationwide cross-sectional study was conducted in a hemodialysis network in India. All adult (>18 years) patients who died while receiving maintenance hemodialysis and an equal number of surviving control patients on maintenance hemodialysis (MHD) between January 1, 2021 to March 31, 2021 were included in the study. The demographic, socioeconomic, and hemodialysis factors were compared between both the genders. **Results:** A total of 1177 patients who died during the study period were included. The majority were males (824, 70.01%). Males were more educated than females ($P < 0.001$). The proportion of female patients dialysed with temporary catheters where more than males, who had definite vascular access such as AV fistula or AV graft ($P < 0.001$). More female patients required out-of-pocket expenditure ($P = 0.005$). Multivariate logistic regression demonstrated that lower educational status, hypoalbuminemia, previous history of hospitalization, and dialysis in centres run by Public Private Partnership (PPP) were associated with mortality in males. Lower educational status, heart failure and previous history of hospitalization were the factors associated with mortality in females. **Conclusion:** Males predominated on hemodialysis. Females were less educated and were less likely to be covered under public or private health insurance compared to males.

Keywords: *Gender, Hemodialysis, Mortality, Male, Female*

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Introduction

In the general population,[1] women tend to have higher survival rates than men, which may be attributable to their lower occurrence of cardiovascular risk factors and diseases.[2,3] Recognized physiological differences between genders may contribute to reported disparities in various diseases, including type 2 diabetes, cardiovascular disease, depression, and various stages of kidney disease.[4-13] The progression rate of numerous kidney disorders is influenced by gender, a topic that has been extensively examined in more comprehensive reviews.[14] The largest meta-analysis conducted to date, encompassing over 11,000 patients from 68 different studies, has shown that women with conditions such as polycystic kidney disease, IgA nephropathy, membranous nephropathy, and 'chronic kidney disease of unknown etiology' tend to experience a slower progression of kidney disease compared to men with matching blood pressure and lipid levels who have these conditions.[15] More recently, two additional population-based studies have also revealed that men exhibit a slower chronic kidney disease (CKD) progression compared to women.[16,17] Previous observational studies from the Dialysis Outcomes and Practice Patterns Study (DOPPS)[18] and the Austrian Dialysis Registry,[19] have shown no difference in survival between men and women. The present study aims to perform gender-specific analysis of maintenance hemodialysis (MHD) practices and mortality.

Materials and Methods

A nationwide cross-sectional study was conducted in India among patients

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Table 1: Region-wise distribution of centers

Region	Number of centers	Percentage
East	49	24.14
North	40	19.7
South	78	38.421
West	36	17.73
Grand total	203	100%

undergoing MHD in 203 centers provided by a single large network-Nephroplus. There were a total of 9 (4.43%) standalone centers and 194 (95.57%) were part of an institution/hospital. Region-wise distribution of centers is provided in Table 1. Data was collected retrospectively from the hospital management information system and electronic medical records. All adult (>18 years) patients receiving MHD from January 1, 2021 to March 31 2021 were included. Patients who died were identified and an equal number of survivors were randomly selected from the total dialysis population in the dialysis network. We excluded patients on HD for less than 90 days, aged less than 18 years, and deaths due to COVID-19 infection. The patients who died during this period were considered as cases and those who survived were taken as controls [Figure 1]. We stratified the non-survivors (cases) and survivors (controls) by gender to identify gender-specific risk factors for death.

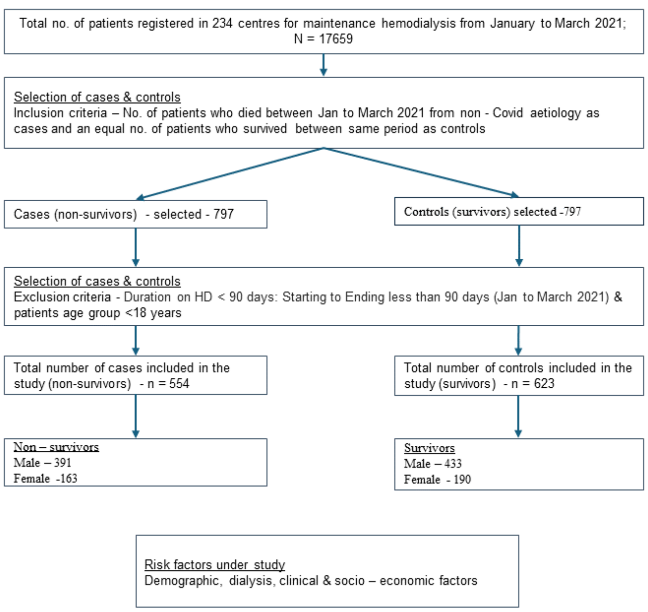

Figure 1: Methodology for selection of cases and controls for the study.

Data on demographic factors, dialysis, educational status, and dialysis payer type (public insurance, out-of-pocket payment, or private insurance) were collected. HD facilities were classified by funding model as public–private partnerships (PPP) or private. PPP is a setup where the government pays for HD in a private dialysis center. Dialysis-related factors included dialysis vintage, frequency of weekly HD sessions, vascular access type, dialysis adequacy (measured online in Fresenius 4008 S machines), hemoglobin, erythropoietin use, and serum albumin levels. Additionally, the cause of CKD (diabetic or non-diabetic), and comorbidities including hypertension, history of heart failure, and any hospitalizations in the past 3 months were also documented. Ethical approval for this study was waived by the Institutional Ethics Committee of The George Institute for Global Health India. This is due to our exclusive use of deidentified data from patients who had voluntarily consented to its use for clinical research at the time of registration at a NephroPlus centre, before any data was collected. A refusal to consent did not impact a patient's right to receive treatment, which was made clear to patients from the outset.

Statistical analysis

We report all continuous variables as mean ± standard deviation (SD). The differences between groups were tested using an independent sample *t*-test. Other variables are presented as numbers (*n*) and proportions (%). Following this, both univariate and multivariable logistic regression analyses were conducted to ascertain the death risk in terms of odds ratios, accompanied by a 95% confidence interval. All variables were subjected to univariate analysis and for the multivariable logistic analysis, all significant risk factors ($P < 0.05$) were included, applying a backward elimination approach to determine which factors to include in the model.

We analyzed the data using STATA software version 17.0. (Ref: StataCorp. STATA statistical software: Release 17. College section, TX; StataCorp LLC) The significance level was fixed at 5% (P value <0.05) with 95% confidence interval (CI).[20–24]

Among patients dialyzed across 203 centers, 554 patients who died from non-COVID etiologies were included as cases and 623 survivors as controls during the study period between January 1, 2021 and March 31, 2021 and were stratified based on gender. Males were 824 (70.01%) and 353 (29.99%) were females. All patients had received maintenance HD for a minimum period of 90 days. The selection of patients is illustrated in Figure 1. The comparison of demographic, HD, clinical, and socioeconomic characteristics between men and women is shown in Table 2.

The mean age was 55.16 ± 13.2 years in males and 55.14 ± 13.3 years in females. Females received less education (P = <0.001). More females were dialyzed with temporary catheters compared to AV fistulas at the time of initiation of HD ($P < 0.001$). Requirement of out-of-pocket expenditure was more common among females ($P = 0.005$). Hypertension and ischemic heart disease (IHD) were significantly more prevalent in males ($P = 0.02$), while diabetes as the cause of kidney failure was more prevalent in females ($P = 0.022$). However, there was no difference in body mass index (BMI) ($P = 0.36$), dialysis adequacy

Table 2: Demographic characteristics, dialysis, clinical, and socioeconomic factors among males and females on maintenance hemodialysis. Continuous variables are presented as mean, and standard deviation, others as total number (N) and proportions (%)

Characteristics	Males (*N* = 824)	Females (*N* = 353)	*P*-value
Demographic factors			
Age (years)	55.16 ± 13.2	55.14 ± 13.3	0.981
Education			
Illiterate	215 (26.1%)	136 (38.5%)	**0.00**
High school	230 (27.9%)	113 (32.0%)	
Higher secondary	161 (19.5%)	44 (12.5%)	
College	218 (26.5%)	60 (17.0%)	
BMI (Indian)	22.55 ± 4.2	22.82 ± 5.5	0.364
Zone			
North	173 (21.0%)	94 (26.6%)	0.092
East	122 (14.8%)	45 (12.7%)	
West	126 (15.3%)	61 (17.3%)	
South	403 (48.9%)	153 (43.3%)	
Dialysis factors			
HD duration (months)	22.72 ± 17.0	24.75 ± 17.8	0.065
HD frequency (per week)			
1X	15 (1.8%)	8 (2.3%)	
2X	434 (52.7%)	186 (52.7%)	**0.044**
3X	366 (44.4%)	156 (44.2%)	
Irregular/SOS	9 (1.1%)	3 (0.8%)	
Vascular access			
AVF/AVG	718 (87.1%)	278 (78.8%)	<0.001
Catheter	106 (12.9%)	75 (21.2%)	
Dialysis adequacy	1.26 ± 0.1	1.25 ± 0.1	0.338
Clinical factors			
Hb level g/dl	9.12 ± 1.6	8.95 ± 1.4	0.090
Serum albumin g/dl	3.53 ± 0.5	3.54 ± 0.5	0.860
EPO use			
Yes	786 (95.4%)	342 (96.9%)	0.239
No	38 (4.6%)	11 (3.1%)	
Cause of CKD			
No diabetes	552 (67.0%)	212 (60.1%)	**0.022**
Diabetes	272 (33.0%)	141 (39.9%)	
HTN			
Mean elevated systolic blood pressure (>/=140 mmHg)	153 ± 23.2	148 ± 23.7	**0.002**
Mean elevated diastolic blood pressure (>/=90 mmHg)	83 ± 11.5	81 ± 11.9	**0.027**
History of heart failure			
Yes	61 (7.4%)	16 (4.5%)	
No	763 (92.6%)	337 (95.5%)	0.068
History of ischemic heart disease			
Yes	68 (8.3%)	12 (3.4%)	**0.002**
No	756 (91.7%)	341 (96.6%)	
Hospitalization in previous 3 months			
Yes	186 (22.6%)	87 (24.6%)	0.440
No	638 (77.4%)	266 (75.4%)	
Outcome			
Survivors	433 (52.5%)	190 (53.8%)	0.688
Non-survivors	391 (47.5%)	163 (46.2%)	
Socio-economic factors			
Payer type			
Out-of-pocket	224 (27.2%)	121 (34.3%)	**0.013**
Private insurance	257 (31.2%)	104 (29.5%)	
Public insurance	337 (40.9%)	121 (34.3%)	
Mixed	6 (0.7%)	7 (2.0%)	
Type of center			
Public–private	371 (45.0%)	128 (36.3%)	**0.005**
Private hospital-based	453 (55.0%)	225 (63.7%)	

P value is considered significant if < 0.05. The values in bold are significant P values. BMI: Body mass index; HD: Hemodialysis; AVF/AVG: Arterio-venous fistula/Arterio-venous graft; HTN: Hypertension; CKD: Chronic kidney disease; Hb: Hemoglobin; EPO: Erythropoietin.

(*P* = 0.33), EPO use (*P* = 0.239), or hospitalization rates (*P* = 0.44) between the groups.

Among 824 males, 391 were non-survivors and 433 were survivors. Among 353 females, 163 were non-survivors and 190 were survivors. Table 3 shows the comparison between non-survivors and survivors of both genders. Among males, lower educational status, lower BMI, use of temporary HD catheters for initiation of dialysis, anemia, hypoalbuminemia, diabetes, hypertension, history of IHD, history of previous hospitalization, out-of-pocket expenditure and receiving dialysis in centers run through PPPs were significantly associated with death. Among females, lower educational status, anemia, hypoalbuminemia, history of IHD, history of previous hospitalization, out-of-pocket expenditure and receiving dialysis in centers run by PPPs were significantly associated with death [Table 3].

Univariate logistic regression analysis demonstrated that lower educational status, use of temporary HD catheters for initiation, lower BMI, lower dialysis adequacy, anemia, hypoalbuminemia, diabetes mellitus, history of hospitalization in the last 3 months, and HD centers run by PPP compared to only private HD centers were associated with mortality in males. Similarly, lower educational status, anemia, hypoalbuminemia, history of heart failure, hospitalization in the previous 3 months,

Table 3: Demographic characteristics, dialysis, clinical, and socioeconomic factors among males (survivors and non-survivors) and females (survivors and non-survivors) on maintenance hemodialysis

Variables	Males ($N = 824$)		*P*-value	Females ($N = 353$)		*P*-value
	S (433)	NS (391)		S (190)	NS (163)	
Demographic factors						
Age (years)	56.13 ± 12.6	54.52 ± 13.7	0.080	55.51 ± 12.9	53.63 ± 14.21	0.194
Education			<0.001			**0.000**
Illiterate	105 (24.2)	110 (28.1)		49 (25.8)	87 (53.4)	
High school	94 (21.7)	136 (34.8)		78 (41.1)	35 (21.5)	
Higher secondary	911 (21)	70 (17.9)		25 (13.2)	19 (11.7)	
College	43 (33)	75 (19.2)		38 (20)	22 (13.5)	
BMI (Indian)	22.98 ± 4.1	22.07 ± 4.3	**0.002**	22.65 ± 5.5	23.01 ± 5.5	0.537
Zone						
North	117 (27)	56 (14.3)	<0.001	54 (28.4)	40 (24.5)	**0.030**
East	58 (13.4)	64 (16.4)		25 (13.2)	20 (12.3)	
West	77 (17.84)	49 (12.5)		41 (21.6)	20 (12.3)	
South	181 (1.8)	222 (56.8)		70 (36.8)	83 (50.9)	
Dialysis factors						
HD duration (years)	23.91 ± 17.8	21.4 ± 16	**0.035**	26.56 ± 18.7	22.64 ± 16.4	**0.039**
HD frequency						0.486
1X	6 (1.4)	9 (2.3)	0.587	3 (1.6)	5 (3.1)	
2X	232 (53.6)	202 (51.7)		106 (55.8)	80 (49.1)	
3X	189 (43.6)	177 (45.3)		79 (41.6)	77 (47.2)	
Irregular/SOS	6 (1.4)	3 (0.8)		2 (1.1)	1 (0.6)	
Vascular access						
AVF/AVG	389 (89.8)	329 (84.1)	**0.015**	154 (81.1)	124 (76.1)	0.254
Catheter	44 (10.2)	62 (15.9)		36 (18.9)	39 (23.9)	
Dialysis adequacy (Kt/V)	1.05 ± 0.2	1.08 ± 0.2	0.073	1.06 ± 0.2	1.08 ± 0.2	0.527
Clinical factors						
Hemoglobin (g/d	9.38 ± 1.5	8.83 ± 1.6	<0.001	9.22 ± 1.4	8.62 ± 1.3	<0.001
Serum albumin (g/dl)	3.32 ± 0.4	1.57 ± 0.4	<0.001	3.33 ± 0.4	1.51 ± 0.5	**0.003**
EPO use						
Yes	409 (94.5)	377 (96.4)	0.180	183 (96.3)	159 (97.5)	0.507
No	24 (5.5)	14 (3.6)		7 (3.7)	4 (2.5)	
Cause of CKD						
Non-diabetic	304 (70.2)	248 (63.4)	**0.039**	117 (61.6)	95 (58.3)	0.528
Diabetic	129 (29.8)	143 (36.6)		73 (38.4)	68 (41.7)	
HTN						
Systolic blood pressure (>/=140 mmHg)	151 ± 20.5	155 ± 25.7	**0.015**	147 ± 20	149 ± 27.4	0.401
Diastolic blood pressure (>/=90 mmHg)	83 ± 10.7	83 ± 12.2	0.979	81 ± 11.6	82 ± 12.1	0.372
History of heart failure						
Yes	29 (6.7)	32 (8.2)	0.416	3 (1.6)	13 (8)	**0.004**
No	404 (93.3)	359 (91.8)		187 (98.4)	150 (92)	
History of ischemic heart disease						
Yes	23 (5.3)	45 (11.5)	**0.001**	2 (1.1)	10 (6.1)	**0.009**
No	410 (94.7)	346 (88.5)		188 (98.9)	153 (93.9)	
Hospitalization in previous 3 months						
Yes	43 (9.9)	143 (36.6)	<0.001	28 (14.7)	59 (36.2)	<0.001
No	390 (90.1)	248 (63.4)		162 (85.3)	104 (63.8)	

(*Continued*)

Table 3: Continued

Variables	Males (*N* = 824)		*P*-value	Females (*N* = 353)		*P*-value
	S (433)	NS (391)		S (190)	NS (163)	
Socioeconomic factors						
Payer type						
Out of pocket	120 (27.7)	104 (26.6)	<0.001	75 (39.5)	46 (28.2)	<0.001
Private insurance	174 (40.2)	83 (21.2)		69 (36.3)	35 (21.5)	
Public insurance	139 (32.1)	198 (50.6)		46 (24.2)	75 (46)	
Mixed	0	6 (1.5)		0	7 (4.3)	
Type of center						
Public–private partnership	165 (38.1)	206 (52.7)	<0.001	51 (26.8)	77 (47.2)	<0.001
Private hospital-based	268 (61.9)	185 (47.3)		139 (73.2)	86 (52.8)	

P value is considered significant if <0.05. The values in bold are significant P values.

Table 4: Univariate logistic regression for factors associated with mortality among male and female non-survivors on maintenance hemodialysis compared to survivors (showing only significant variables)

Characteristics	Males	*P*-value	Females	*P*-value
	Prevalence ratio (95% CI)		Prevalence ratio (95% CI)	
Demographic factors				
Education status				
Illiterate	1.487 (1.187, 1.862)	0.001	1.744 (1.222,2.489)	0.002
High school	1.718 (1.389,2.125)	<0.001	0.844 (0.548,1.300)	0.444
Higher secondary	1.263 (0.980, 1.629)	0.071	1.177 (0.732,1.893)	0.500
Dialysis factors				
Vascular access - Catheter	1.276 (1.067,1.526)	0.008	1.165 (0.904,1.502)	0.236
Dialysis adequacy < 1.2	1.262 (1.003,1.587)	0.046	1.139 (0.777,1.670)	0.504
Clinical factors				
Hb level g/dl				
>12	1.020 (0.639,1.627)	0.933	–	–
8–9.9	1.177 (0.969,1.429)	0.099	1.442 (1.051,1.980)	0.023
<8	1.588 (1.302,1.938)	<0.001	1.808 (1.288,2.538)	0.001
Serum albumin g/dl <3.5	1.707 (1.430,2.038)	<0.001	1.494 (1.144,1.950)	0.003
Cause of CKD - diabetic	1.170 (1.011,1.353)	0.035	1.076 (0.857,1.350)	0.526
History of heart failure	1.114 (0.867,1.432)	0.395	1.825 (1.402,2.376)	<0.001
History of ischemic heart disease	1.445 (1.199,1.742)	<0.001	1.857 (1.405,2.455)	<0.001
Hospitalization in previous 3 months	1.977 (1.745,2.241)	<0.001	1.734 (1.408,2.136)	<0.001
Socioeconomic factors				
Payer type				
Private insurance	0.695 (0.554,0.872)	0.002	0.885 (0.793,1.607)	0.498
Public insurance	1.265 (1.071,1.495)	0.006	1.630 (1.359,2.495)	<0.001
Type of center - Public–private	1.377 (1.191,1.591)	<0.001	0.616 (0.493,0.770)	<0.001

HD centers run by PPPs were associated with mortality in females [Table 4]. Multivariate analysis has demonstrated that lower educational status, hypoalbuminemia, previous history of hospitalization (last 3 months), and patients from HD centers run by PPPs were the factors associated with mortality in males. Lower educational status, heart failure, and previous history of hospitalization were the factors associated with mortality in females [Table 5].

Discussion

This is the first study from India, exploring factors associated with mortality among both the genders in patients undergoing maintenance hemodialysis. Earlier studies from dialysis cohorts[25,26] showed that the life expectancy of women is not higher than men. While men generally show higher death rates than women in the overall population, DOPPS[14] has shown equivalent mortality rates for both sexes, with the ratio near unity across all DOPPS countries, except Japan. Factors, including ethnic diversity, and disparities in healthcare access may influence the outcome.[27–29] The greater impact of a higher BMI on the survival of male dialysis patients compared to female patients may be attributed to men having more skeletal muscle mass and less fat mass due to male sex hormones.[30,31]

Table 5: Multivariate logistic regression for factors associated with mortality among male and female non-survivors on maintenance hemodialysis compared to survivors (showing only significant variables)

Characteristics	Males Adjusted prevalence ratio (95% CI)	*P*-value	Females Adjusted prevalence ratio (95% CI)	*P*-value
Education status				
Illiterate	1.386 (1.055, 1.819)	0.019	1.909 (1.240, 2.939)	0.003
High school	1.594 (1.259, 2.018)	<0.001	1.073 (0.704,1.633)	0.742
Higher secondary	1.298 (0.987,1.706)	0.062	1.287 (0.787, 2.104)	0.313
Clinical factors				
Serum albumin g/dl < 3.5	1.446 (1.223, 1.710)	<0.001	1.074 (0.819,1.408)	0.605
History of heart failure			1.764 (1.199,2.595)	0.004
Hospitalization in previous months	1.810 (1.541,2.124)	<0.001	2.056 (1.587, 2.663)	<0.001
Socioeconomic factors				
Type of center				
Public–private	1.387 (1.077, 1.787)	0.011	1.282 (0.847,1.943)	0.239

CI: confidence interval

Women had a significantly lower educational status than men and lower literacy level was associated with mortality in both genders. A systematic review of 29 studies showed that limited health literacy was found to be a significant and independent predictor of hospital admissions, emergency department visits, skipped dialysis treatments, cardiovascular incidents, and deaths.[32] Yet, when literacy levels are compared between genders, a significant disparity is evident, with a noticeable difference in literacy rates between men and women in India.[33,34]

The requirement of out-of-pocket expenditure and use of temporary access for initiation of HD are significantly higher in females. The outcomes of this research align with those found in previous studies on healthcare expenditure (HCE) in India and certain Asian nations,[34,35] but they diverge from findings in numerous developed and developing countries.[36,37] Typically, women in developed countries possess greater health awareness, make more use of health services and preventive measures, and consequently spend more on their health care compared to those from developing countries.[38] However, in nations like India and China, a tangled mix of poverty and societal stratification, often pushes women's health down the list of household priorities, leading women to allocate more time to domestic or non-income-generating work.[39] This could be the reason for women not being enrolled into state-sponsored or private insurance cover. Also, women may delay addressing their health needs to cater to the needs of the income-earning male members of the family and often give precedence to the health of males over their own[40] which may potentially result in loss to follow-up, unable to buy medications, non-compliant to medications, failure to create AV fistula before progressing to end stage kidney disease and ending up with the requirement of temporary access for initiation of HD (urgent start HD). Therefore, the gender disparity in HCE in India might be due to the intersection of socioeconomic factors and patriarchal traditions.[41]

In this study, IHD was significantly more common in men than women. This is in concordance with previous data. Typically, women have a lower occurrence of IHD than men, except those who are 65 years old and above. As women reach menopause, the disparity in IHD onset between genders narrows, leading to a higher incidence in older women. The post-poned development of IHD in women might be due to the protective effects of natural estrogen and the hormonal shifts associated with menopause.[42]

There was no difference with respect to serum albumin levels, dialysis duration, frequency, and adequacy between the genders. This suggests that there was no difference between the genders in the quality of treatment delivered, which is similar to previous studies.[43,44] These previous studies showed that there was no gender difference in self-care efficacy among HD population.

The current study is subject to a few limitations. Firstly, the findings of this study demonstrate a correlation between factors associated with mortality in dialysis patients, but they do not establish a cause-and-effect relationship. Secondly, it was a cross-sectional data collection. Hence, variables like BMI, comorbidity status, and lab results, may vary with time. Thirdly, the southern states of India consistently excel compared to the rest of the nation in terms of health, education, and economic prospects.[45] Disproportionately higher representation of the South Indian population in this study could have confounded the observations. Fourthly, the sample size of women being much smaller than the men is bound to have confounded association of some factors with mortality as in men in this population. Lastly, the sex of the participants was recorded from medical records, without accounting for transgender or non-binary individuals.

Conclusion

Males predominated on maintenance hemodialysis. Females were less educated, required temporary HD catheters for initiation, and less likely to be paid for by public or private health insurance cover compared to males. Hypertension and IHD were significantly more prevalent in males, while diabetes as the cause of kidney failure was more prevalent in females. Multivariate analysis demonstrated that lower educational status, hypoalbuminemia, previous history of hospitalization (last 3 months), and dialysis in centers run by PPP were associated with mortality in males. Lower educational status, heart failure, and previous history of hospitalization were associated with mortality in females.

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Conflicts of interest

There are no conflicts of interest.

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