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Association between social isolation and dialysis initiation in older patients with pre-dialysis chronic kidney disease: A single-center prospective cohort study

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Abstract

Background

Preventing dialysis initiation in older patients with chronic kidney disease (CKD) is an important clinical challenge. Although clinical factors such as renal function and nutritional status are known to influence dialysis initiation, the impact of social isolation in older patients with pre-dialysis CKD remains unclear. We examined factors associated with dialysis initiation in older patients with pre-dialysis CKD, focusing on social isolation in addition to conventional clinical risk factors.

Methods

In this single-center prospective cohort study, patients aged ≥ 65 years with pre-dialysis CKD hospitalized for CKD education were enrolled and followed until dialysis initiation or the end of follow-up. Social isolation was assessed using the Lubben Social Network Scale-6 (LSNS-6), with scores < 12 indicating social isolation. Kaplan–Meier analysis and Cox proportional hazards models were used to identify factors associated with dialysis initiation.

Results

Among 165 patients (median follow-up, 726 days), 57 (34.5%) initiated dialysis. Social isolation was significantly associated with dialysis initiation and remained an independent predictor after adjustment for confounders. Lower estimated glomerular filtration rate and poorer nutritional status assessed by the Geriatric Nutritional Risk Index were also significantly associated with dialysis initiation.

Conclusions

Social isolation and nutritional status were independently associated with dialysis initiation in older patients with pre-dialysis CKD. Screening for social isolation and addressing nutritional risk may help prevent or delay dialysis initiation in this population.

Introduction

The number of older patients with chronic kidney disease (CKD) has been increasing steadily in Japan [1]. As CKD progresses, patients eventually reach a stage at which renal replacement therapy (RRT) must be considered, with dialysis therapy being one of the major treatment options. Although dialysis therapy is essential for maintaining survival, it is also associated with increased social costs due to greater utilization of medical resources [2] and requires substantial adaptation to treatment-related lifestyle changes, which may adversely affect patients' lifestyles and health-related quality of life (HRQOL) [3]. Therefore, identifying factors related to CKD progression and dialysis initiation is crucial for reducing

social costs, maintaining HRQOL, and supporting appropriate treatment selection and future decision-making regarding dialysis initiation.

Older patients with pre-dialysis CKD are at particularly high risk for dialysis initiation because of age-related physiological changes and the complex pathophysiology associated with CKD. Accordingly, it is necessary to investigate factors associated with dialysis initiation in this population to establish appropriate preventive strategies. However, current evidence remains limited, and optimal management and care strategies have not been fully established. Previous studies have reported that dialysis initiation in patients with pre-dialysis CKD is influenced by various factors, including age, obesity, diabetes mellitus, nutritional status, inflammation, and physical function [4–7]. Nevertheless, most prior studies examining dialysis initiation have focused on adults or middle-aged populations [8], and factors associated with dialysis initiation specifically among older patients with pre-dialysis CKD have not been sufficiently investigated. A comprehensive evaluation of factors related to dialysis initiation, considering the multifactorial nature of aging and CKD, may contribute to the identification of factors unique to older CKD patients and inform the development of targeted intervention strategies.

Social isolation represents a potentially important but underexplored factor associated with dialysis initiation in older patients with pre-dialysis CKD. Social isolation has been defined as the lack of weekly direct contact with family, friends, or neighbors [9], and its prevalence has been increasing among older adults in recent years. Previous studies have demonstrated that social isolation among community-dwelling older adults is associated with an increased risk of cardiovascular disease [10] and poorer survival [11]. Furthermore, social isolation has also been reported to be associated with decline in renal function [12]. In older patients with pre-dialysis CKD, social isolation may contribute to dialysis initiation through reduced physical activity [13], lower health literacy [14], and chronic inflammation [15]. However, factors associated with dialysis initiation in older patients with pre-dialysis CKD have not been sufficiently examined from a comprehensive perspective that includes social factors such as social isolation.

Therefore, the aim of this study was to investigate factors associated with dialysis initiation in older patients with pre-dialysis CKD by incorporating social isolation in addition to established clinical and functional factors. Clarifying factors related to dialysis initiation in this population may provide valuable evidence to support the development of preventive interventions aimed at delaying dialysis initiation in older patients with pre-dialysis CKD.

Materials and Methods

Study Design and Participants

This study was a single-center prospective cohort study. Participants were older patients aged ≥ 65 years with pre-dialysis CKD who were admitted to our hospital for CKD education between July 2020 and August 2024. The exclusion criteria were as follows: patients with cardiac disease requiring exercise

restriction; patients with poorly controlled blood pressure; patients with dementia or those with orthopedic or central nervous system disorders that made physical assessment difficult; patients who underwent renal biopsy during hospitalization; and patients with difficulty in follow-up. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Seirei Sakura Citizen Hospital (approval number: 2024020). All participants received verbal and written explanations and provided informed consent prior to participation.

Measurements

The study variables included patient background characteristics obtained from medical records and indicators of social isolation. As the study outcome, dialysis initiation was defined as the initiation of hemodialysis or peritoneal dialysis during the follow-up period from hospital admission to the end of follow-up (April 18, 2025), based on medical records. Participants were classified into two groups according to dialysis initiation: the dialysis group and the non-dialysis group. Deaths occurring during follow-up were treated as censored at the date of death in the time-to-event analysis.

Patient characteristics

The following variables were collected: age, sex, body mass index (BMI), smoking status, alcohol consumption, marital status, Number of children, number of cohabiting family members, living alone, comorbidities, including diabetes mellitus, hypertension, dyslipidemia, and cardiovascular disease, and primary kidney disease.

Laboratory data included serum albumin (Alb), blood urea nitrogen (BUN), serum creatinine (Cr), estimated glomerular filtration rate (eGFR), sodium (Na), potassium (K), hemoglobin (Hb), and C-reactive protein (CRP), which were obtained from medical records.

The Geriatric Nutritional Risk Index (GNRI) was calculated according to the formula proposed by Bouillanne et al. [16]:

GNRI = [14.89 × albumin (g/dL)] + [41.7 × (body weight/ideal body weight)]

Body weight/ideal body weight was set to 1 when the patient’s body weight exceeded the ideal body weight.

The short physical performance battery (SPPB), 10-m walk test, and grip strength test were used to measure physical function. The SPPB consisted of three sub-items: balance, a 4-m walk test, and a chair stand test. The balance test included three 10-s standing balance tasks: side-by-side, semi-tandem, and tandem standing. The 4-m walk test measures the time required to walk comfortably along a 4-m course. In the chair-stand test, patients were required to rise five times from a seated position on a 40-cm armless chair with their arms crossed and stand fully upright with knees and hips fully extended.

Each of the three sub-items of the SPPB was scored on a scale from 0 to 4 points, resulting in a total score range of 0–12 points. Lower SPPB scores indicated restricted physical function [17]. In the 10-m walk test, the time required to walk comfortably along a 10-m path was recorded. Grip strength was measured using a grip strength meter (Grip D Digital Grip Strength Meter [Takei Scientific Instruments Co., Ltd., Niigata, Japan]) in an upright standing position. The highest grip strength value for each hand was used for analysis. All physical function assessments were conducted in the rehabilitation room by three physical therapists experienced in data collection during the CKD education hospitalization period, and the data were extracted from medical records.

Social isolation

Social isolation was assessed using the Japanese version of the Lubben Social Network Scale–6 (LSNS-6) [18]. The LSNS-6 consists of six items evaluating the size of social networks, including three items related to family networks and three items related to non-family networks (e.g., friends and neighbors). Each item is scored on a 6-point scale ranging from 0 to 5, resulting in a total score ranging from 0 to 30, with higher scores indicating larger social networks. Based on previous studies, social isolation was defined as an LSNS-6 score < 12 [18].

Statistical analysis

The Shapiro–Wilk test was employed to assess the normality of all variables. Differences between the dialysis and non-dialysis groups were examined using the chi-square test, unpaired t-test, or Mann–Whitney U test, as appropriate. Kaplan–Meier survival analysis was performed to compare the incidence of dialysis initiation between participants with and without social isolation, and differences were evaluated using the log-rank test. Cox proportional hazards regression analysis was conducted to identify factors associated with dialysis initiation. The dependent variable was dialysis initiation, and the primary independent variable was social isolation. Covariates included clinically relevant confounders identified in previous studies [4–7], including nutritional status, anemia, inflammation, and physical function. In the Cox proportional hazards models, the primary exposure was social isolation defined as LSNS-6 < 12 and was entered as a binary variable (yes/no). Model 1 adjusted for age, sex, BMI, smoking status, and diabetes mellitus. Model 2 adjusted for eGFR, Hb, CRP, GNRI, and grip strength. A two-sided p value < 0.05 was considered statistically significant.

Results

Among 192 eligible patients, 27 were excluded due to poorly controlled blood pressure (n = 4), dementia (n = 4), orthopedic or central nervous system disorders (n = 7), renal biopsy during hospitalization (n = 4), or lack of informed consent (n = 8). Therefore, 165 participants were included in the final analysis. The median follow-up duration was 726.0 days (interquartile range: 451.0–1168.0 days). During the follow-up period, 57 participants (34.5%) initiated dialysis. Among them, 50 patients (87.7%) initiated hemodialysis

and 7 patients (12.3%) initiated peritoneal dialysis. In addition, 6 participants died and 17 were censored due to loss to follow-up during the follow-up period.

Table 1 presents the baseline characteristics of participants stratified by dialysis initiation status. Significant differences between the dialysis and non-dialysis groups were observed in BMI, serum albumin, BUN, serum creatinine, eGFR, Hb, and GNRI ($p < 0.05$).

Table 1
Patient characteristics

		Dialysis initiation		p
	All (n = 165)	Yes (n = 57)	No (n = 108)	
Age (year)	75.6 ± 6.2	75.8 ± 6.0	75.6 ± 6.1	0.79
Male/Female, n	110/55	37/20	73/35	0.73
BMI (kg/□)	23.8 ± 3.3	22.9 ± 3.2	24.2 ± 3.3	0.02
Alcohol use, n (%)	83 (50.3)	33 (57.9)	50 (46.3)	0.16
Ever smokers, n (%)	83 (50.3)	28 (49.1)	55 (50.9)	0.83
Comorbidity, n (%)				
Diabetes mellitus	67 (40.6)	24 (42.1)	43 (39.8)	0.78
Hypertension	136 (82.4)	47 (82.5)	89 (82.4)	0.99
Dyslipidemia	70 (42.4)	20 (35.1)	50 (46.3)	0.17
Cardiovascular disease	21 (12.7)	7 (12.3)	14 (13.0)	0.90
Primary renal disease, n (%)				
Chronic glomerulonephritis	17 (10.3)	6 (10.5)	11 (10.2)	0.95
Diabetic nephropathy	48 (29.1)	19 (33.3)	29 (26.9)	0.38
Nephrosclerosis	65 (39.4)	19 (33.3)	46 (42.6)	0.25
Unclear, others	35 (21.2)	13 (22.8)	22 (20.4)	0.72
Laboratory data				
Alb (g/dL)	3.8 ± 0.6	3.5 ± 0.4	3.9 ± 0.4	< 0.001
BUN (mg/dL)	35.0 [24.0–46.0]	46.5 [38.5–61.8]	27.0 [21.0–37.0]	< 0.001
Cr (mg/dL)	2.1 [1.5–3.2]	3.3 [2.8–4.3]	1.6 [1.3–2.2]	< 0.001
eGFR (mL/min/1.73 m²)	24.3 ± 11.9	13.8 ± 5.4	29.8 ± 10.8	< 0.001
Na (mEq/L)	138.7 ± 2.5	138.7 ± 2.6	138.7 ± 2.5	0.93
K (mEq/L)	4.7 ± 0.6	4.8 ± 0.7	4.6 ± 0.6	0.11
Hb (g/dL)	12.0 ± 1.7	11.1 ± 1.6	12.4 ± 1.5	< 0.001

BMI: Body Mass Index, Alb: albumin, BUN: blood urea nitrogen, Cr: creatinine, eGFR: estimated glomerular filtration rate, Na: sodium, K: potassium, Hb: hemoglobin, CRP: C-reactive protein levels, GNRI: Geriatric Nutritional Risk Index, SPPB: short physical performance battery

		Dialysis initiation		p
	All (n = 165)	Yes (n = 57)	No (n = 108)	
CRP (mg/dL)	0.2 ± 0.5	0.3 ± 0.6	0.2 ± 0.5	0.20
GNRI	101.9 ± 10.2	96.4 ± 9.2	104.7 ± 9.5	< 0.001
Physical function				
Grip strength (kg)	28.8 ± 8.9	27.3 ± 8.3	29.9 ± 8.9	0.07
10-m walk test (m/s)	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	0.44
SPPB (score)	12 [11–12]	12 [10–12]	11 [8–12]	0.63

BMI: Body Mass Index, Alb: albumin, BUN: blood urea nitrogen, Cr: creatinine, eGFR: estimated glomerular filtration rate, Na: sodium, K: potassium, Hb: hemoglobin, CRP: C-reactive protein levels, GNRI: Geriatric Nutritional Risk Index, SPPB: short physical performance battery

Table 2 shows the comparison of social factors between the two groups. Social isolation status and LSNS-6 scores were significantly different between the groups ($p < 0.05$).

Table 2
Comparison of social factors by dialysis initiation

	All (n = 165)	Dialysis initiation		p
		Yes (n = 57)	No (n = 108)	
Married, n (%)	157 (95.2)	52 (91.2)	105 (97.2)	0.09
Number of children	1.9 ± 0.9	1.9 ± 1.1	1.9 ± 0.8	0.90
Number of cohabitants	2.2 ± 1.1	2.3 ± 1.1	2.2 ± 1.1	0.74
Living alone, n (%)	34 (20.6)	11 (19.3)	23 (21.3)	0.76
LSNS-6 (score)	13.9 ± 5.4	12.3 ± 5.4	14.8 ± 5.0	0.01
Social isolation, n (%)	63 (38.2)	30 (52.6)	33 (30.6)	< 0.001

LSNS-6: Lubben Social Network Scale-6

Note: Values are expressed as mean ± SD, or number (%)

Figure 1 shows the dialysis-free survival curves according to social isolation status. Participants with social isolation (LSNS-6 < 12) had a significantly higher incidence of dialysis initiation than those without social isolation (LSNS-6 ≥ 12; log-rank $p = 0.01$).

The results of the Cox proportional hazards regression analyses are shown in Fig. 2. In the univariable analyses, social isolation, BMI, eGFR, Hb, CRP, GNRI, and grip strength were significantly associated with

dialysis initiation ($p < 0.05$). In Model 1, social isolation (LSNS-6 < 12) (hazard ratio [HR] = 1.94, 95% confidence interval [CI] = 1.129–3.325) and BMI (HR = 0.89, 95% CI = 0.813–0.963) were independently associated with dialysis initiation. In Model 2, social isolation (HR = 2.05, 95% CI = 1.163–3.616), eGFR (HR = 0.84, 95% CI = 0.799–0.883), and GNRI (HR = 0.94, 95% CI = 0.914–0.976) remained significantly associated with dialysis initiation ($p < 0.05$).

Discussion

To our knowledge, this is the first prospective cohort study to investigate factors associated with dialysis initiation in older patients with pre-dialysis CKD by comprehensively evaluating social isolation in addition to conventional factors such as renal function, anemia, nutritional status, and physical function. Even after adjustment for potential confounders, social isolation assessed using the LSNS-6 was independently associated with dialysis initiation. These findings provide clinically meaningful evidence to inform preventive strategies against dialysis initiation in older patients with pre-dialysis CKD.

In the present study, social isolation evaluated using the LSNS-6 was identified as a significant factor associated with dialysis initiation. Social isolation among community-dwelling older adults has been shown to be associated with reduced physical activity [13], and declines in physical activity have been linked to worsening renal function [19]. Furthermore, social isolation has been associated with lower health literacy and impaired self-management ability [14, 20], which may adversely affect essential CKD self-management behaviors, including dietary adherence, medication management, and healthcare utilization. Social isolation has also been linked to chronic inflammation [15], and sustained psychosocial stress and loneliness are reported to influence immune regulation through activation of the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis, resulting in elevated inflammatory cytokines [21]. Taken together, social isolation in older patients with pre-dialysis CKD may exacerbate renal function decline through reduced physical activity, impaired self-management, and promotion of chronic inflammation, thereby increasing the risk of dialysis initiation. These findings highlight the importance of screening for social isolation and implementing interventions that promote social connectedness as part of dialysis prevention strategies.

Nutritional status, as reflected by BMI and GNRI, was also identified as a factor associated with dialysis initiation. Previous studies have reported that GNRI is an independent predictor of renal prognosis in patients with pre-dialysis CKD [5], and our findings are consistent with this evidence. Older patients with pre-dialysis CKD are particularly vulnerable to malnutrition due to CKD-specific factors such as uremic symptoms, chronic inflammation, and dietary restrictions, in addition to geriatric syndromes [19]. Low BMI in patients with pre-dialysis CKD has been associated with increased mortality and poor renal outcomes and is considered a simple indicator of insufficient energy and protein intake [22]. Although the obesity paradox has been described in patients with CKD, whereby higher BMI is not necessarily associated with worse prognosis [23], its influence appears to be less pronounced in the pre-dialysis phase, where low BMI and weight loss may exert a stronger adverse effect on outcomes [24]. In the present study, low BMI, similar to GNRI, may have reflected a state of malnutrition that contributed to a

higher risk of dialysis initiation. Previous studies have shown that malnutrition in patients with pre-dialysis CKD promotes renal function decline through increased susceptibility to infection due to impaired immune function [25], progression of sarcopenia [26], and frailty [27]. In addition, malnutrition has been associated with inflammatory markers [28] and Hb levels [29], and the progression of chronic inflammation and anemia has been reported to contribute to worsening renal function [30, 31]. These findings suggest that preventive strategies against dialysis initiation should address not only social isolation and physical function, but also nutritional status.

At present, effective interventions to prevent dialysis initiation in older patients with pre-dialysis CKD are not well established. Previous studies examining interventions targeting social isolation in older adults have reported improvements in social isolation following instructor-led exercise programs combined with chronic disease self-management after six months [32]. Qualitative studies have also suggested that group-based exercise programs enhance social motivation and reduce feelings of isolation [33]. Moreover, recent multicenter cohort studies have shown that multidisciplinary interventions are associated with better renal function preservation, and involvement of registered dietitians and physical therapists has been linked to reduced risk of composite outcomes including all-cause mortality and initiation of RRT [34]. These findings indicate that comprehensive, multidisciplinary interventions incorporating social connectedness, nutritional management, and exercise therapy may be essential for preventing dialysis initiation in older patients with pre-dialysis CKD. However, the effects of comprehensive interventions targeting social isolation, nutritional status, and anemia on delaying dialysis initiation and improving renal prognosis remain insufficiently investigated, underscoring the need for future interventional studies.

Several limitations of this study should be acknowledged. First, the relatively small sample size limited the ability to fully adjust for potential confounders. Second, social isolation was assessed only once at baseline; therefore, changes in social circumstances during follow-up were not captured. Third, this was a single-center study limited to patients hospitalized for CKD education, which may restrict the generalizability of the findings to the broader outpatient CKD population. Further studies with larger sample sizes are needed to address these limitations.

Conclusion

Social isolation, in addition to nutritional status, may be associated with dialysis initiation in older patients with pre-dialysis CKD. These findings support the potential value of screening for social isolation when identifying patients at higher risk of earlier dialysis initiation.

Abbreviations

CKD
chronic kidney disease
RRT

renal replacement therapy
HRQOL
health-related quality of life
BMI
body mass index
Alb
albumin
BUN
blood urea nitrogen
Cr
serum creatinine
eGFR
estimated glomerular filtration rate
Na
sodium
K
potassium
Hb
hemoglobin
CRP
C-reactive protein
GNRI
Geriatric Nutritional Risk Index
SPPB
short physical performance battery
LSNS-6
Lubben Social Network Scale–6.

Declarations

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Authors' contribution statements

AT, TK, and SO contributed to material preparation, data collection, and data analysis. AT and HY drafted the manuscript. YM, TY, and TF critically reviewed the manuscript and approved the final version.

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Availability of data and material

All data in this case are available upon request.

Ethics approval statement

The Ethics Committee of Seirei Sakura Citizen Hospital approved all procedures performed in this study (approval number: 2024020).

Consent for publication

Not applicable.

Conflict of interest

The authors have declared that no conflict of interest exists.

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Figures

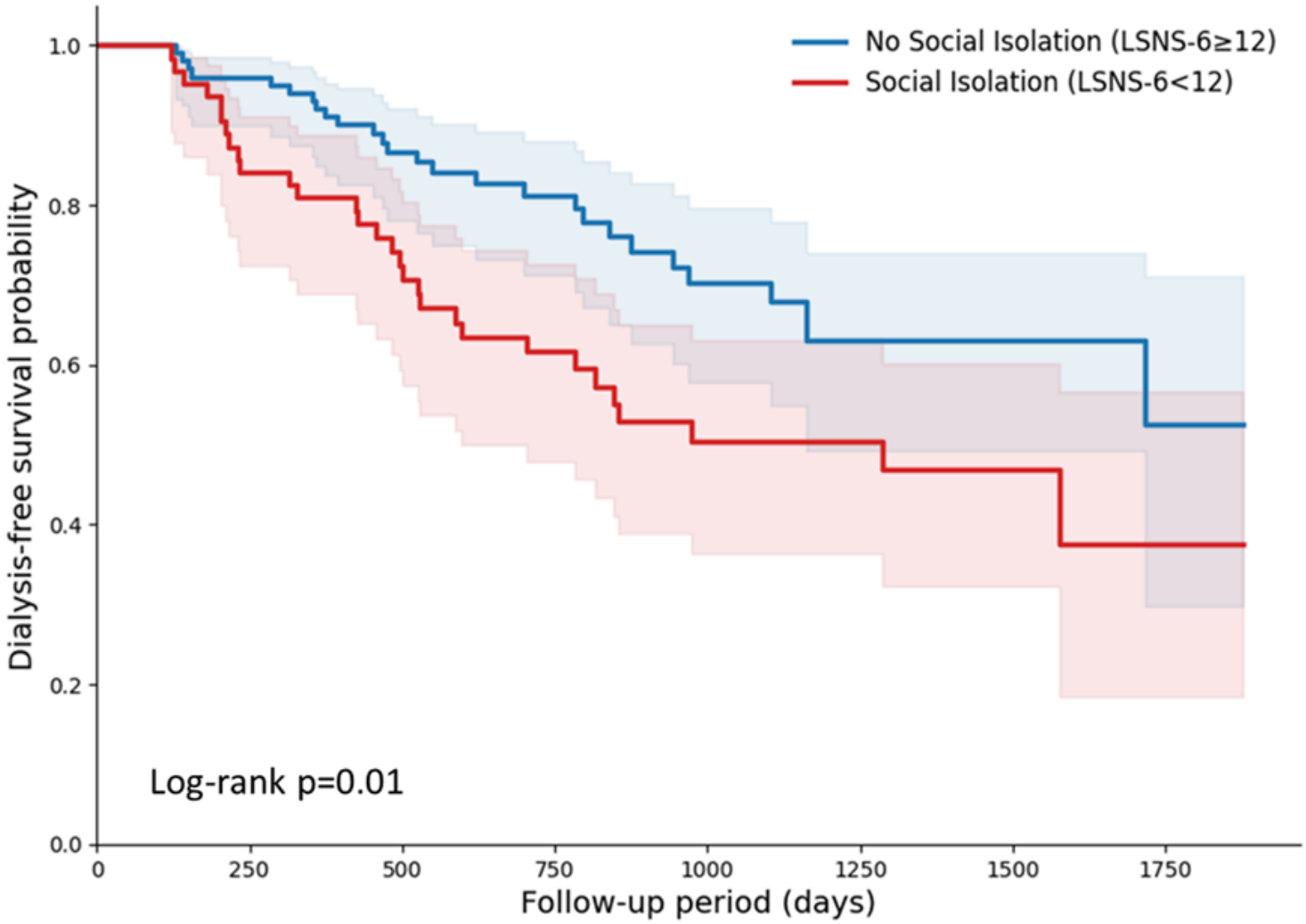
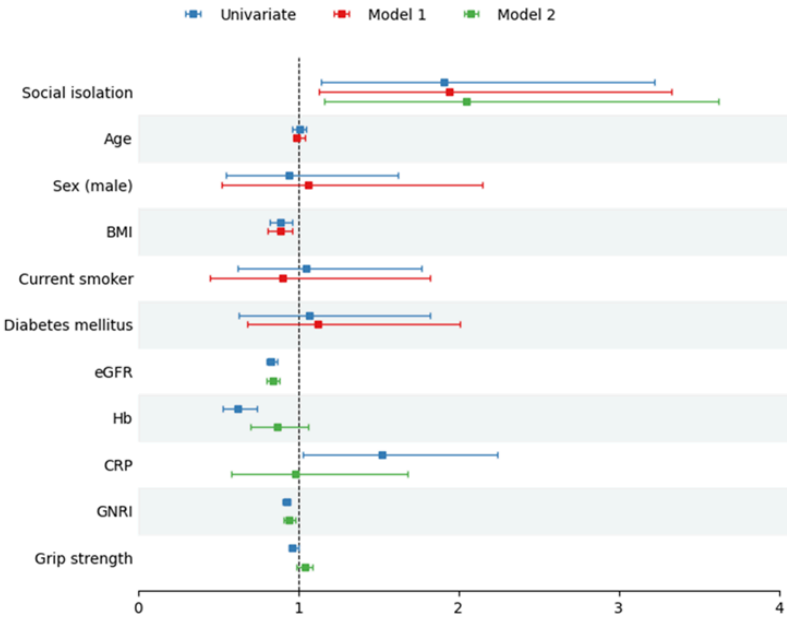


Figure 1

Dialysis-free survival according to social isolation status



	Univariate HR (95% CI)	p	Model 1 HR (95% CI)	p	Model 2 HR (95% CI)	p
Social isolation	1.91 (1.14-3.22)	0.02	1.94 (1.13-3.33)	0.02	2.05 (1.16-3.62)	0.01
Age	1.01 (0.96-1.05)	0.75	0.99 (0.99-1.04)	0.80		
Sex (male)	0.94 (0.55-1.62)	0.94	1.06 (0.52-2.15)	0.68		
BMI	0.89 (0.82-0.96)	<.001	0.89 (0.81-0.96)	0.01		
Current smoker	1.05 (0.62-1.77)	0.86	0.90 (0.45-1.82)	0.77		
Diabetes mellitus	1.07 (0.63-1.82)	0.79	1.12 (0.68-2.01)	0.58		
eGFR	0.83 (0.80-0.87)	<.001			0.84 (0.80-0.88)	<.001
Hb	0.62 (0.53-0.74)	<.001			0.87 (0.70-1.06)	0.16
CRP	1.52 (1.03-2.24)	0.03			0.98 (0.58-1.68)	0.95
GNRI	0.93 (0.90-0.95)	<.001			0.94 (0.91-0.98)	<.001
Grip strength	0.96 (0.94-1.00)	0.03			1.04 (0.99-1.09)	0.16

Figure 2

Univariable and multivariable Cox proportional hazards models for dialysis initiation

HR: hazard ratio, CI: confidence interval, LSNS-6: Lubben Social Network Scale-6, BMI: Body Mass Index, eGFR: estimated glomerular filtration rate, Hb: hemoglobin, CRP: C-reactive protein levels, GNRI: Geriatric Nutritional Risk Index

Model 1 was adjusted for age, sex, BMI, Current smoker, and diabetes mellitus.

Model 2 was adjusted for eGFR, Hb, CRP, GNRI, and grip strength.

Social isolation defined as LSNS-6<12.