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Prevalence, associated factors and clinical implications of subjective cognitive decline linked to frailty in patients receiving maintenance hemodialysis: a cross-sectional study

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Abstract

Background Subjective cognitive decline (SCD) significantly increases a patient's risk of long-term cognitive decline and is common in adults. However, few studies have evaluated patients with end-stage renal disease receiving maintenance hemodialysis (MHD). In addition, the relationship between frailty and SCD in MHD patients remains unclear. Therefore, this study aimed to assess the potential factors affecting SCD in MHD patients and to investigate the relationship between frailty and SCD.

Methods This was a cross-sectional study. From December 2023 to April 2024, via the convenience sampling method, a total of 171 patients from West China Hospital of Sichuan University were recruited to participate in this study. The demographic and sociological characteristics of the participants were assessed via a general information questionnaire. The subjective cognitive decline questionnaire 9 (SCD-Q9), the Tilburg frailty indicator (TFI), the subjective global nutritional assessment (SGA) and the grip dynamometer were used to assess the participants' subjective cognitive level, frailty, nutritional status, and grip strength, respectively. Univariate analyses were used to examine potential factors associated with SCD. Linear regression was used to analyze the relationships between these factors and SCD. Spearman's correlation was used to assess the association between SCD and frailty.

Results The average subjective cognitive decline score of the 171 MHD patients was 4.00 (2.00–7.00), and 95 patients (55.56%) with scores > 3 presented with SCD. Linear regression analysis revealed that sex, work status, grip strength, SGA, and frailty were influential factors in MHD patients, explaining 38.80% of the total variation in SCD. *Spearman's* analysis revealed that SCD was positively correlated with frailty in MHD patients ($r = 0.431$, $P < 0.001$).

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Conclusions The prevalence of SCD in MHD patients is common and correlates with certain patient characteristics, including sex, work status, grip strength, SGA, and frailty. Healthcare workers should pay attention to the assessment of subjective cognitive function in this population, remain aware of the risk factors for SCD, and take targeted interventions as early as possible, which can help improve the quality of survival and slow the occurrence of cognitive impairment.

Keywords Maintenance hemodialysis, Subjective cognitive decline, Frailty

Introduction

Chronic kidney disease (CKD) is a global public health problem [1, 2]. As kidney function deteriorates and progresses to end-stage renal disease (ESRD), individuals require renal replacement therapy, such as kidney transplantation or dialysis [3]. Maintenance hemodialysis (MHD), one of the primary renal replacement therapies [4], extends patient survival but is often accompanied by complications that adversely affect quality of life [5].

Among these complications, cognitive impairment (CI) is one of the most prevalent, and its prevalence is 10 – 40% [6], with rates significantly higher in ESRD patients compared to the general population [7]. CI refers to deficits in cognitive domains (e.g., orientation, attention, and executive function) ranging in severity from mild cognitive impairment (MCI) to dementia [8]. Studies have shown that a decreased glomerular filtration rate (GFR) and albuminuria are risk factors for CI, which may be present early in the course of CKD and cannot be completely reversed by renal dialysis [9]. In MHD patients, the lifetime risks of incident dementia and Alzheimer's disease (AD) are estimated to be ~ 20% and ~ 4%, respectively [10]. AD is associated with postdialysis functional disability, worse quality of life and even a greater risk of death [11]. Cognitive function is particularly important for ESRD patients, especially those receiving maintenance dialysis, which requires long-term diet control, adherence to medication and regular follow-up, all of which rely on high cognitive function. Consequently, early prevention becomes an important way to reduce the incidence of AD in MHD patients.

Subjective cognitive decline (SCD) refers to patients who report a decline in subjective cognitive capacity, while their results on neuropsychological tests are within the normal performance range, indicating adequate cognitive function [12]. There is growing evidence that patients with SCD have an increased risk of future pathological cognitive decline and dementia [13]. In view of this, SCD is regarded as a clinically asymptomatic prophase of AD and is considered to be the first symptomatic manifestation of AD [14]. Therefore, analyzing the factors influencing SCD at an early stage will help to identify an effective time window for the early diagnosis and treatment of AD.

However, previous studies have primarily examined the objective cognitive functions of patients with mental and behavioral disorders through standardized neuropsychological tests, with few studies addressing patients' subjective cognitive complaints [15]. Chan et al. [5] These findings suggest that SCD levels in these patients may fluctuate over time and that regular screening for SCD in dialysis settings could aid in identifying individuals at risk for unfavorable outcomes. These findings underscore the importance of conducting the current study.

Previous studies have shown a greater prevalence of CI in malnourished MHD patients than in well-nourished patients [16]. Moreover, nutrition has been shown to improve the level of frailty in MHD patients [17]. However, the relationship between the level of SCD and frailty in MHD patients has not been reported. As a result, the aim of this study was to assess the prevalence of SCD and its associated factors in Chinese MHD patients and to investigate the relationship between frailty and SCD.

Methods

Aims

The aim of our study was to examine whether sociological demographic characteristics, nutritional status and frailty are associated with SCD in MHD patients.

Design

A cross-sectional study.

Setting and participants

This study was conducted via convenience sampling. Data were collected from December 2023 to April 2024 at the Wenjiang Hemodialysis Center of West China Hospital of Sichuan University. The inclusion criteria were as follows: (1) ≥ 18 years of age and receiving hemodialysis for at least 3 months; (2) clear consciousness, normal cognition, and no communication barriers; (3) voluntary participation in the survey; (4)Mini mental statue examination (MMSE) ≥ 27; and (5) Clinical Dementia Rating (CDR) is 0 points. The exclusion criteria were as follows: (1) severe acute complications and psychiatric disorders, such as acute cardiovascular events, severe infections, or schizophrenia; (2) communication barriers; (3) current or previous engagement in medical and health-related work before retirement; and (4) MMSE and CDR scores consistent with a diagnosis of MCI, dementia.

Data collection and procedures

Before the beginning of the study, the researcher conducted a standardized training session for all surveyors and used a standardized instruction manual to explain the requirements to the participants. Two researchers (Jie Li and Yue Gao) collected the data by administering a one-on-one questionnaire to the participants while they were undergoing hemodialysis. After signing the informed consent form, the questionnaires were completed independently by the participants. For those participants with difficulties in writing and reading, the researchers read the entries one by one using nonsuggestive language and helped them fill in the answers. The questionnaires were collected and checked by the researcher on site, and participants were asked to complete them if they were missing or if the researcher looked for relevant information in the participant's medical records.

Measures

A general information questionnaire

We designed a general information questionnaire on the basis of the literature review. Sociodemographic characteristics included gender, age, body mass index (BMI), education level, marital status, residence area, work status, and nature of previous/current work. Lifestyle factors taken into account were smoking status (never/quitters and smokers), alcohol consumption status (never/occasional and regular drinkers), hours of sleep at night, and No. of physical activities/peer week. The factors influencing dialysis treatment included primary disease, dialysis vintage, frequency of dialysis, and number of comorbidities.

Subjective cognitive decline

Subjective cognitive decline was assessed via the subjective cognitive decline questionnaire-9 (SCD-Q9) by GIFFORD et al. [18] The scale consists of 2 dimensions, overall memory ability and daily activity ability, with a total of 9 items. If the patient answered yes, they received a score of 1 point; otherwise, they received 0 points. The total score was 9, with 0–3 indicating normal cognition and >3 indicating the presence of subjective cognitive decline. Higher scores indicate a more severe degree of subjective cognitive decline. The scale can be used to screen for subjective cognitive decline in dialysis patients and has proven to be an easy-to-apply tool. The Cronbach's α coefficient measured in this study was 0.845. The MMSE is primarily used to screen for cognitive dysfunction in six directions: verbal ability, attention, recall, orientation, memory, and numeracy, with a total score of ≥27 as no cognitive impairment; The CDR is primarily used for the diagnosis of AD and assesses six main areas: memory, spatial orientation, judgement and problem solving, social life, family and hobbies, and personal care, with a score of 0 indicating cognitive normalcy.

Frailty

The Chinese version of the Tilburg Frailty Indicator (TFI) was utilized to evaluate frailty, encompassing physical, psychological, and social frailty, with a total of 15 entries [19, 20]. Each question was scored as 1 for a "yes" response and 0 for a "no" response, with total scores ranging from 0 to 15. A score of 0–4 indicated nonfrailty, and a score of 5 indicated frailty. The Chinese version of the TFI scale has good reliability and validity, with a Cronbach's α coefficient of 0.686 for the total scale; the correlation coefficients between the subjective cognitive decline scores and the corresponding entries ranged from 0.205 to 0.620. This scale can be used to assess multidimensional debility in Chinese populations. The Cronbach's α coefficient measured in this study was 0.652.

Subjective global nutritional assessment

We choose the subjective global nutritional assessment (SGA) scale recommended by the National Kidney Foundation's Prognostic Quality Guidelines for Kidney Disease (K/DOQI) to assess the nutritional status of patients on maintenance hemodialysis [21]. The SGA scale includes 7 indicators, such as weight, diet, gastrointestinal symptoms, mobility, complications, subcutaneous fat measurement, and brachial muscle circumference, each of which is divided into 3 grades and scored from 1 to 3, and the 7 items are added together to obtain a total score. A score of 7 was classified as nutritionally normal; a score of 8–15 was classified as mild or moderate malnutrition; and a score of >16 was classified as severe malnutrition.

Grip strength

Before hemodialysis, the investigators used an electronic grip strength tester (Zhongshan Camry Electronic Co., Ltd.) to measure the participants' grip strength. The participant was asked to take a standing position, with their arms naturally hanging down and elbows straight, to tightly grip the tester with a noninternal fistula hand, and to perform three measurements at 1-min intervals. The strength of the patient was measured 3 times, with each time at an interval of 1 min, and the maximal value was recorded.

Ethical considerations

The study was conducted in accordance with local regulations and the established principles of the revised Declaration of Helsinki (2013). The Medical Ethics Committee of West China Hospital of Sichuan University (approval number: 2022–1093) approved the study, and written informed consent was obtained from all participants.

Statistical analysis

SPSS version 27.0 was used for the statistical analyses. Descriptive statistics were used to describe the baseline characteristics, subjective cognitive decline, frailty, and SGA of the MHD patients. Continuous variables with a normal distribution are statistically described in terms of the mean and standard deviation, whereas medians and quartiles are used to describe nonnormally distributed variables. Count variables are presented statistically as frequencies and percentages. Continuous variables with a normal distribution were analyzed via one-way ANOVA, whereas nonnormally distributed continuous variables were analyzed via the ***Mann–Whitney U*** test and ***the Kruskal–Wallis H*** test. Linear regression was employed to examine the factors associated with SCD in MHD patients. The correlation between SCD and multidimensional frailty was assessed by ***Spearman's*** correlation. $P < 0.05$ was considered statistically significant.

Results

Sociodemographic characteristics of the participants

In this study, a total of 171 questionnaires were distributed, and 171 valid questionnaires were recovered, with an effective recovery rate of 100%. A total of 171 MHD patients were included in this study, including 104 (60.82%) males and 67 (39.18%) females. The ages ranged from 26 to 91 years, with a mean age of 50.46 ± 12.08 years. The sociodemographic characteristics of the MHD participants are shown in Table 1.

SCD status in MHD patients

Table 2 shows the number of SCD and SCD-Q9 scores and the results of the univariate analysis of the determinants of SCD in 171 MHD patients. The median score was 4.00 (2.00–7.00). Among these participants, 95 (55.56%) MHD participants had subjective cognitive decline with SCD-Q9 scores > 3. Gender, education level, residence area, work status, nature of previous/current work, and dialysis vintage were associated with SCD ($P < 0.05$).

Correlation analysis of frailty, SGA, grip strength and SCD

Spearman's correlation analysis revealed that SCD in MHD patients was positively correlated with sex, SGA score and grip strength ($r = 0.239–0.431$, $P < 0.05$)

Linear regression analyses of factors affecting SCD in MHD patients

The SCD-Q9 score of MHD patients was used as the dependent variable, and the variables with statistical significance in univariate analysis, frailty, SGA and grip strength were used as independent variables for linear regression analysis. The results of linear regression analysis revealed that gender, working status, frailty, grip strength and SGA were statistically significant, and 38.80% of the total variation could be explained when all factors were included in the regression equation. In linear regression analysis, the greater the absolute value of the regression coefficient is, the greater the influence of the independent variable on the dependent variable. If the normalization coefficient is negative, the dependent variable decreases with increasing independent variable; if the normalization coefficient is positive, the dependent variable increases with increasing independent variable. In this study, frailty and SGA had a significant impact on the total score of the SCD-Q9, and the regression coefficient of frailty was 0.052, indicating that MHD patients with more severe frailty had higher total scores on the SCD-Q9 and higher SCD levels. The regression coefficient of the SGA score was 0.373, indicating that the total score on the SCD-Q9 was lower and the level of SCD was lower in MHD patients with good nutritional status. Table 3 shows the results of the linear regression analysis of factors influencing SCD in MHD participants.

Discussion

This study revealed the prevalence of SCD in MHD patients, with SCD present in more than one in two patients. The factors associated with SCD were female sex, employment, poor nutrition, frailty, and low grip strength. To the best of our knowledge, this is the first observational study to evaluate SCD in Chinese MHD patients to discuss the prevalence and associated factors of SCD and its link to frailty.

Prevalence of SCD in MHD patients

In this study, 55.56% of MHD patients had SCD, which was higher than that reported in a cross-sectional study conducted by Chinese scholars on peritoneal dialysis (PD) patients (42.9%) [22] but similar to the results of a previous meta-analysis on the subjective cognitive complaints of ESRD patients [15]. This may be related to the loss of acute vascular capacity during dialysis dehydration in MHD patients, which leads to decreased cerebrovascular pressure and reduced cerebral perfusion, thus affecting the cognitive function of MHD patients [23, 24]. However, compared with chan et al. [25] reported (26%), that the incidence of SCD was greater in MHD patients in this study. This may be due to the use of different assessment tools. Chan et al.'s study mainly used the Kidney Disease Quality of Life Cognitive Function subscale (KDQOL-CF) [26] to measure cognitive function, and its results are likely to be underestimated. This is mainly because the critical point of the KDQOL-CF is 60; despite its acceptable specificity, it has poor sensitivity in detecting CIs. Moreover, the scale contains only three items (namely, slow reaction time, poor concentration, and blurred consciousness) and therefore cannot

Table 1 Sociodemographic characteristics of the MHD participants ($N = 171$)

Characteristics	Groups	*N*(%)
Gender	male	104(60.82%)
	female	67(39.18%)
Age	<45	59(34.50%)
	45–60	70(40.94%)
	>60	42(24.56%)
BMI	<18.5	16(9.36%)
	18.5–24	87(50.88%)
	24–28	52(30.40%)
	≥ 28	16(9.36%)
Education level	Primary school or lower	17(9.94%)
	Junior high school	52(30.41%)
	Senior high school	37(21.64%)
	University or higher	65(38.01%)
Marital status	Married	142(83.04%)
	Single	13(7.60%)
	Divorced	16(9.36%)
Residence area	Urban	111(64.91%)
	Country	60(35.09%)
Work status	On job	50(29.24%)
	Retirement	50(29.24%)
	Others	71(41.52%)
Nature of previous/current work	Physical labor	40(23.39%)
	Mental labor	84(49.12%)
	Both	47(27.49%)
Smoking status	No	47(27.49%)
	Yes	124(72.51%)
Alcohol consumption status	No	12(7.02%)
	Yes	159(92.98%)
Hours of sleep at night	<5	35(20.47%)
	5–8	24(14.04%)
	>8	112(65.495)
No. of physical activities/peer week	≤ 2	109(63.74%)
	≥ 3	62(36.36%)
Primary disease	Hypertension	53(30.99%)
	Diabetes	24(14.04%)
	Chronic glomerulonephritis	64(37.43%)
	Others	30(17.54%)
Dialysis vintage(yrs)	<1	32(18.71%)
	1–5	62(36.26%)
	>5	77(45.03%)
Frequency of dialysis	2 times/peer week	9(5.26%)
	3 times/peer week	162(94.74%)
No. of comorbidities	0	11(6.43%)
	1	51(29.82%)
	2	57(33.33%)
	≥ 3	52(30.41%)
Frailty	Yes	65(38.01%)
	No	106(61.99%)
SGA	SGA-A	120(70.18%)
	SGA-B	41(23.98%)
	SGA-C	10(5.84%)

assess cognitive difficulties in key areas, such as memory and executive function, which have been shown to be most impaired in patients with end-stage renal disease. In contrast, the SCD-Q9 scale developed by GIFFORD et al. [18] and adapted by Hao et al. [27], adopted in this study, includes different domains of subjective cognitive decline, such as overall memory function and temporal comparison. Multiple studies have confirmed that the SCD-Q9 can be used to distinguish healthy people from those with early cognitive impairment [28–30]. This was also confirmed in the present study, where the Cronbach coefficient of the questionnaire was 0.845.

Most of the previous studies focused on SCD in elderly people in nursing institutions or communities. Little attention has been given to SCD in maintenance hemodialysis patients. Interestingly, we found that SCD occurred not only in older MHD patients but also in adults of all ages with MHD (the prevalence of SCD in young, middle-aged and older adults was 17.54%, 25.15% and 19.30%, respectively). Therefore, our study highlights the importance of actively screening MHD patients for SCD.

Factors influencing SCD in MHD patients

In our study, we found that the factors influencing the development of SCD in MHD patients were female sex, employment, poor nutrition, frailty, and low grip strength. Jessen et al. [31] Women are more concerned about their health than men are and more sensitive to changes in their body and the evolution of symptoms, so women have a better perception of symptoms and diseases [32]. Therefore, although there is no positive result in the objective test, the subjective cognitive complaints of women often provide valuable information. Moreover, SCD may be more predictive of future decline in females than in males [32]. Therefore, the sex differences in SCD among MHD patients should be explored in future studies.

In addition, those with MHD who are currently still working are more susceptible to the progression of AD. The reason may be that, in addition to receiving hemodialysis treatment three times per week, MHD patients also need to complete their daily work. They have less contact time with the outside world and fewer resources and opportunities to participate in various activities. As a result, patients' cognitive function is affected because their intelligence cannot be continuously stimulated throughout life. Research by Gavelin et al. [33] This study shows that joint physical–cognitive training can affect brain plasticity through different or complementary pathways. Physiological changes induced by physical exercise, such as the upregulation of brain-derived neurotrophic factor and stimulation of hippocampal neurogenesis, can promote cognitive engagement. Experience-dependent neuroplasticity effects. These findings

Table 2 The number of SCD and SCD-Q9 scores and the results of the univariate analysis of the determinants of SCD ($n=171$)

Variables	Groups	No. of SCD($N=95$)	SCD-Q9	Statistic	*P*
Gender	male	48	3.00(1.00, 6.00)	$Z=3.679$	<0.001*
	female	47	6.00(3.00, 7.00)		
Age	<45	30	4.00(1.00, 6.00)	$H=3.502$	0.174
	45–60	43	4.50(2.00, 7.00)		
	>60	21	4.00(2.00, 7.00)		
BMI	<18.5	9	5.00(2.00, 6.75)	$H=3.868$	0.276
	18.5–24	47	4.00(1.00, 7.00)		
	24–28	29	4.00(2.00, 6.00)		
	≥ 28	10	5.50(2.25, 8.75)		
Education level	Primary school or lower	23	6.00(3.50, 8.00)	$H=13.369$	0.004*
	Junior high school	41	4.50(2.00, 7.00)		
	Senior high school	18	4.00(2.00, 7.00)		
	University or higher	13	3.00(1.00, 5.50)		
Marital status	Married	77	4.00(2.00, 7.00)	$H=1.545$	0.462
	Single	7	4.00(0.00, 6.00)		
	Divorced	11	5.00(1.00, 7.75)		
Residence area	Urban	55	3.00(1.00, 6.00)	$Z=2.559$	0.010*
	Country	40	5.00(3.00, 7.00)		
Work status	On job	18	2.00(1.00, 4.25)	$H=15.024$	0.001*
	Retirement	30	4.00(2.00, 7.00)		
	Others	47	6.00(3.00, 7.00)		
Nature of previous/current work	Physical labor	27	6.00(3.00, 7.00)	$H=9.142$	0.010*
	Mental labor	38	3.00(1.00, 5.75)		
	Both	30	5.00(3.00, 7.00)		
Smoking status	No	22	3.00(1.00, 7.00)	$Z=0.779$	0.436
	Yes	73	4.00(2.00, 7.00)		
Alcohol consumption status	No	5	3.00(2.00, 4.75)	$Z=0.614$	0.539
	Yes	90	4.00(2.00, 7.00)		
Hours of sleep at night	<5	22	5.00(2.00, 7.00)	$H=3.707$	0.120
	5–8	10	3.00(1.25, 5.75)		
	>8	63	4.00(2.00, 7.00)		
No. of physical activities/peer week	≤ 2	61	3.50(1.00, 6.00)	$Z=-0.032$	0.974
	≥ 3	34	3.50(1.00, 6.00)		
Primary disease	Hypertension	25	3.00(1.50, 6.00)	$H=4.907$	0.179
	Diabetes	12	3.50(1.00, 5.75)		
	Chronic glomerulonephritis	37	5.00(2.00, 7.00)		
	Others	21	5.00(3.00, 7.00)		
Dialysis vintage(yrs)	<1	18	4.00(2.00, 5.75)	$H=9.719$	0.008*
	1–5	30	3.00(1.00, 6.00)		
	>5	47	5.00(2.50, 8.00)		
Frequency of dialysis	2 times/peer week	7	5.00(3.00, 8.00)	$Z=-1.015$	0.310
	3 times/peer week	88	4.00(2.00, 7.00)		
No. of comorbidities	0	2	2.00(1.00, 3.00)	$H=4.812$	0.186
	1	25	4.00(1.00, 7.00)		
	2	36	4.00(2.00, 7.00)		
	≥ 3	32	4.50(2.00, 7.00)		

*: $P<0.05$

suggest that for MHD patients with subjective cognitive and memory impairments, we should actively carry out combined body-cognitive training.

Our study also revealed that the nutritional status of MHD patients was significantly associated with SCD-positive symptoms. Our study showed the same results as theirs [34]. MHD patients usually suffer from malnutrition caused by insufficient protein intake due to the accumulation of uremic toxins in the GI tract, decreased appetite, dietary restriction, nutritional loss

Table 3 Linear regression analysis of factors influencing SCD in MHD participants ($n = 171$)

Variables	Unnormalized coefficient	standard error	Standardization coefficient	t	*p*
Constant term	-2.963	1.724		-1.719	0.088
Gender	1.130	0.446	0.186	2.4534	0.013*
Education level	−0.284	0.224	−0.098	-1.269	0.207
Residence area	0.001	0.483	0.000	0.002	0.998
Work status	0.630	0.267	0.180	2.356	0.020*
Nature of previous/current work	0.006	0.297	0.001	0.021	0.984
Dialysis vintage(yrs)	0.442	0.279	0.111	1.584	0.116
SGA	1.041	0.373	0.212	2.795	0.006*
Frailty	0.179	0.052	0.267	3.445	0.001*
Grip strength	0.080	0.036	0.158	2.231	0.005*

*: $P < 0.05$

during hemodialysis, and long-term microvascular inflammation. It is a common complication in MHD patients and can aggravate the functional decline of the heart, brain and other important organs. Additionally, malnutrition is closely related to osteoporosis, inflammation and carotid atherosclerosis in MHD patients [35], and these factors are strongly related to SCD [36]. These findings suggest that enhancing dietary protein and energy intake to improve nutritional status in MHD patients will help slow cognitive decline.

Our study also revealed that MHD patients with lower grip strength had higher SCD levels. Grip strength represents the strength of the upper body muscles and the health of the human body. A decrease in grip strength indicates that the breakdown of protein in the body is greater than the amount synthesized, which affects the normal metabolism of the body. There is a decrease in the body's ability to prevent and repair inflammation and oxidative stress, causing a decrease in neuroplasticity and ultimately a decrease in cognitive function. A meta-analysis of a longitudinal cohort study suggested that lower grip strength is associated with a greater risk of cognitive decline and dementia and that grip strength is predictive of the risk of cognitive impairment in older adults [37]. Thus, we should be vigilant in MHD patients with low grip strength. Moreover, grip strength, as a simple, noninvasive and efficient evaluation index, should be used as an indicator to evaluate SCD in MHD patients.

In our study, the incidence of frailty in MHD patients was 38.0%, which was high and similar to that reported in previous studies [25]. Frailty is affected by a series of physiological, psychological, social and other factors [38], which may lead to decreased physiological reserve or multisystem disorders and increase the risk of adverse events such as falls, delirium, disability and even death [39]. Frailty is an independent predictor of increased hospitalization and mortality in MHD patients [40]. However, if we can identify and intervene at an early stage, we can reverse or delay frailty in time. Therefore, dialysis professionals should pay attention to the screening of MHD patients with frailty, and early prevention and intervention can delay the process of patients with frailty and SCD.

This study is the first to show a strong correlation between SCD levels and frailty in MHD patients. In other words, the more debilitated the patient is, the more significant the positive symptoms of SCD. This is because frailty and SCD have common risk factors, such as advanced age, impaired kidney function, and poor nutrition [41]. With increasing age and prolonged dialysis time, patients' physiological function decreases, and their ability to visit the outside world weakens, which eventually leads to frailty. With increasing age, the incidence rate of SCD also increased sharply. Frailty and SCD may occur at the same time and interact with each other. In this study, 53 patients (30.99%) had frailty and SCD at the same time. Subjective cognitive decline includes two dimensions: overall memory ability and daily activity ability. Frail patients are prone to physical frailty, such as a decrease in daily activity ability, and psychological frailty, such as a decrease in memory ability, which may involve multidimensional interactions, and more in-depth research is needed to explore the relationships among these factors in the future. Moreover, health workers should pay close attention to the cognitive and frailty status of MHD patients to identify and prevent the occurrence of SCD and frailty at an early stage.

Limitations

There are several limitations of this study. First, there was no random sampling in this study, which may have resulted in selection bias and limited generalization of the findings. Second, this was a single-center, small sample study, and the generalizability of the results may be limited. Third, our study, like most cross-sectional studies, prevented us from determining a causal relationship between frailty and subjective cognitive decline in MHD patients. Finally, our study did not consider biochemical parameters that influence SCD in MHD patients, which may affect the extrapolation of the results of this study. To address these limitations, future studies should include cohort studies, with samples drawn randomly and large sample sizes conducted from multiple health centers and geographical areas. In addition, several potentially influential biochemical indicators were taken into account to explore the possible factors affecting the subjective cognitive decline of MHD patients.

Author contributions

Conceptualization, L.J. and G.Y.; Investigation, L.J. and G.Y.; Methodology, L.X.H. and Y. Y.H.; Resources, L.G.Y., Writing-original draft, L.X.H. and Y. Y.H.;

Writing-review and editing, Y.H.H. All authors have reviewd and agreed to the published version of the manuscript.

Data availability
The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The Medical Ethics Committee of West China Hospital of Sichuan University (approval number: 2022–1093) approved the study, and written informed consent was obtained from all participants.

Consent to publish
Not applicable.

Competing interests
The authors declare no competing interests.

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