Mental health status and quality of life in patients with end-stage renal disease undergoing maintenance hemodialysis

Shao-Jun Ma^{1,2}, Wen-Ji Wang¹, Min Tang², Han Chen², Feng Ding¹

¹Department of Nephrology, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China; ²Department of Geriatrics, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

Contributions: (I) Conception and design: F Ding; (II) Administrative support: F Ding; (III) Provision of study materials or patients: SJ Ma, WJ Wang; (IV) Collection and assembly of data: SJ Ma, WJ Wang; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Feng Ding. Department of Nephrology, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, No. 639, Zhizaoju Road, Shanghai 200011, China. Email: mashj@shsmu.edu.cn.

Background: This study aimed to identify the association of factors and poorer mental health status and examine the correlation between mental health status and quality of life (QOL) in patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis.

Methods: A total of 190 patients were included in this observational, cross-sectional study. Psychological states of ESRD patients undergoing maintenance hemodialysis were evaluated by the Chinese version symptom checklist-90 (SCL-90) and QOL was assessed using the Chinese Version Kidney Disease Quality of Life-Short Form (KDQOL-SF).

Results: A total of 190 patients with a mean age of 61.68 (13.39) years were included in this study. Multiple stepwise linear regression analyses suggested that when controlling for the confounding variables, prealbumin had the significant influence on average positive factors (Coef., -0.647; 95% CI: -1.314, 0.020; P=0.057), somatization (Coef., -1.334; 95% CI: -2.451, -0.217; P=0.020), obsessive-compulsive (Coef., -1.396; 95% CI: -2.255, -0.537; P=0.002), depression (Coef., -1.241; 95% CI: -2.252, -0.229; P=0.017), phobic anxiety (Coef., -2.576; 95% CI: -3.786, -1.367; P<0.001). In the correlation analysis, the score of average positive factors was significantly correlated with the score of the overall health rating (Coef., -0.343; P<0.001), symptom/problem (Coef., -0.337; P<0.001), effects of kidney disease on daily life (Coef., -0.198; P=0.006), burden of kidney disease (Coef., -0.233; P=0.001), cognitive function (Coef., 0.363; P<0.001), quality of social interaction (Coef., 0.292; P<0.001), social support (Coef., 0.237; P=0.001), physical functioning (Coef., -0.339; P<0.001), pain (Coef., 0.362; P<0.001), general health (Coef., -0.332; P<0.001), mental health (Coef., -0.537; P<0.001), social functioning (Coef., 0.202; P=0.005), vitality (Coef., -0.478; P<0.001), respectively.

Conclusions: In our study, prealbumin, type 2 diabetes mellitus, heart rate, educational level, duration of hemodialysis, coronary artery disease, heart failure, marital status, hemoglobin A1C, hemoglobin were significantly associated with poorer mental health status of ESRD patients undergoing maintenance hemodialysis, and patients with poorer psychological states were more significantly associated with decreased QOL. The results may help clinicians to adopt an effective treatment for early interventions, thus improving the QOL in such population.

Keywords: Maintenance hemodialysis; psychological states; symptom checklist-90; Chinese; quality of life (QOL)

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Introduction

Maintenance hemodialysis is one of the main replacement treatments for end-stage renal disease (ESRD) and has prolonged patient life (1). Due to that the chronic kidney diseases (CKD) increase gradually, the number of patients who require dialysis increase annually (2). However, hemodialysis is a time-consuming procedure and may cause psychological distress, despite the good condition of their physical health (3). Previous study indicated that psychological problems were common among ESRD patients undergoing maintenance hemodialysis, especially depression (4). A high frequency of depression has been reported in patients treated for ESRD with dialysis (5), which is independently related with significantly increasing risk of both morbidity and mortality (6). Psychological problems have affected the progression and outcome of patients with chronic kidney disease (7-9), which is a more prominent problem among ESRD patients with maintenance dialysis (10).

Furthermore, ESRD has contributed to high medical costs, which becomes a heavy burden of public health (11). Psychological issues represent one of the most common health problems affecting the survival in patients undergoing maintenance hemodialysis (12). Identifying the relative factors of psychological issues in such population and then adopting treatments may help improve treatment outcomes for those patients, therefore, reducing the costs of national burden. Previous study indicated diabetic patients with CKD were more likely to have a major depressive episode when comparing with nondiabetic patients with CKD (5). However, limited researches on identifying relative factors of poor mental health status among such patients.

Many studies have showed that the survival rate of ESRD patients undergoing maintenance hemodialysis had improved (13-15), but when compared with the general population, the quality of life (QOL) of ESRD patients undergoing maintenance hemodialysis remained poor (16). QOL is the patient's subjective experience of physical, mental, and social health, and reflects the state of the patient's health, determines prognoses, and guides clinical practice (17). ESRD patients undergoing maintenance hemodialysis suffer from severe disease symptoms and psychological burdens that can have a profound impact on QOL (18). Psychological issues represent one of the most common health problems affecting the QOL in patients undergoing maintenance hemodialysis (12). Therefore, improving the mental health status may help to improve the

QOL among such population.

Currently, several studies have used the Chinese version symptom checklist-90 (SCL-90), the multidimensional psychological self-rated scale to measure psychological health among the population (19). Chinese version SCL-90 is a 90-item symptom scale that focus on feeling, thinking, behavior, interpersonal relationships, living habits, diet, sleep, and other relevant aspects (20). The main purpose is to assess whether a person has a certain psychological symptom, and how severe it is.

We conducted an observational, cross-sectional study to identify the relative factors of poorer mental health status and examine the correlation between mental health status and QOL among ESRD patients undergoing maintenance hemodialysis.

We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/apm-20-2211>).

Methods

Study design and population

This study is a cross-sectional, observational one. Those who were aged over 18 years and undergoing maintenance hemodialysis for over 3 months at the time of the study were examined. Patients were excluded if they (I) had an indwelling catheter; (II) had untreated malignant tumors; (III) had some form of cognitive impairment; (IV) were unable to complete the scale; and (V) provided incomplete clinical data. Finally, a total of 190 patients were collected from a single center of hemodialysis in the Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine. The study was conducted between August and December 2019.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Medical Ethics Committee of the Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine (Ethics No. SH9H-2019-T143-1), and was registered with the Chinese Clinical Trials Registry (No. ChiCTR1900028275). All patients in this study signed informed consent forms after thoroughly reading and accepting its contents.

Measures and data collection

Each patient had a face-to-face interview which lasted 30–45 min in a private room. All interviews for all patients were using the Chinese version of SCL-90 and the Chinese version KDQOL-SF questionnaire, and all interviews were made by Shao-Jun Ma who was trained by professionals.

We collected the patients' self-reported sociodemographic data, medical history and laboratory data from electronic medical records. A set of the following clinical parameters was analyzed: age, sex (male or female), educational level (under high school or high school or above), marital status (married or widowed or bachelor), duration of hemodialysis (<2 or ≥2 years), pre-dialysis systolic pressure, pre-dialysis diastolic pressure, heart rate; laboratory data of serum: prealbumin, albumin, pre-dialysis blood urea nitrogen, sodium, potassium, chlorine, calcium, phosphorus, magnesium, hemoglobin, total cholesterol, triglyceride, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, hemoglobin A_{1C}; medical history: presence or absence of stroke, presence or absence of coronary artery disease, presence or absence of type 2 diabetes mellitus, presence or absence of hypertension, presence or absence of heart failure, kinds of anti-hypertension drugs and use of psychotropic medicine (no or yes).

Chinese version SCL-90

Chinese version SCL-90 comprises 10 psychiatric factors, namely depression, anxiety, somatization, phobic, paranoid, obsessive compulsive, interpersonal sensitivity, hostility, psychoticism, and other factors such as sleep and diet (20). Each item was scored using a 5-point scale (0 = none, 1 = slight, 2 = mild, 3 = moderate, 4 = severe) (21). This scale suggested the score of a positive item was more than 2, which may indicate potential mental health issues (20).

Chinese version kidney disease quality of life-short form (KDQOL-SF, Version 1.3)

We used the Chinese version KDQOL-SF, Version 1.3 (22) to assess the patient's QOL in two parts. One part of this scale evaluates the QOL across 12 fields in kidney disease-targeted areas (KDTA). Another part assesses the general QOL across 8 fields using a 36-item health survey (SF-36). The KDTA covered the following areas: symptoms/problems, effects of kidney disease on daily life (EKD), burden of kidney disease, work status, cognitive function,

quality of social interaction, sleep, social support, sexual function, dialysis staff encouragement, patient satisfaction, and overall health rating. The SF-36 scale covered physical functioning, role limitations-physical health, bodily pain, general health perception, social functioning, role limitations-emotional, mental health, and vitality. The physical component summary (PCS) included physical functioning, role limitations-physical health, bodily pain and general health perception; the mental component summary (MCS) included social functioning, role limitations-emotional, mental health, and vitality. The scoring standard and method of KDQOL-SF, Version 1.3 referenced the scoring criteria in Hays *et al.* (23). The scores on each scale range from 0 to 100. The higher the scores, the better the QOL. The overall health rating item allowed patients to rate their health on a response scale ranging from 0 ("worst possible health") to 10 ("best possible health") (23).

Statistical analysis

Statistical analyses were performed using IBM SPSS 24.0. The data were displayed in the format of a number (%) or mean (standard deviation), and the counting data were expressed by frequency. The t test was used for the continuous variables. The associations were examined by using multiple stepwise linear regression analyses, and the coefficients and 95% confidence interval (CI) for each significant variable were determined. The variables including patients' age, sex, educational level, marital status, duration of hemodialysis, pre-dialysis systolic pressure, pre-dialysis diastolic pressure, heart rate, prealbumin, albumin, pre-dialysis blood urea nitrogen, sodium, potassium, chlorine, calcium, phosphorus, magnesium, hemoglobin, total cholesterol, triglyceride, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, hemoglobin A_{1C}, stroke, coronary artery disease, type 2 diabetes mellitus, hypertension, heart failure, kinds of anti-hypertension drugs and use of psychotropic medicine were entered in all multiple stepwise linear regression analyses. Pearson correlation analysis was used for correlation analysis, $P < 0.05$ was considered statistically significant.

Results

Among the 200 patients, 10 dropped out while filling the forms, and 190 completed the Chinese version SCL-90, the Chinese version KDQOL-SF (Figure 1). Most patients did

Figure 1 Flow chart of the study.

not respond to the Chinese version KDQOL-SF questions on sexual function, dialysis staff encouragement, and patient satisfaction for they may have thought that the above items were private. Values of these scales were reported as missing data, according to the KDQOL-SF scoring instructions. The average age in the total patients was 61.68 (13.39) years and the gender ratio (male/ female) was 117/ 73. The demographic characteristics of the patients are presented in *Table 1*.

In univariate analysis, the average positive factors were 1.75 (0.46) and 1.58 (0.33) for participants with and without type 2 diabetes mellitus, respectively ($P=0.010$); the scores of depression factor were 2.12 (0.65) and 1.78 (0.54) for participants with and without type 2 diabetes mellitus, respectively ($P<0.001$); the scores of phobic anxiety factor were 1.81 (0.87) and 1.43 (0.64) for participants with and without type 2 diabetes mellitus, respectively ($P=0.002$). The results of univariate analyses are shown in *Table 2*, *Tables S1-S4*.

Multiple stepwise linear regression analyses suggested that when controlling for the confounding variables, prealbumin had the significant influence on average positive factors (Coef., -0.647 ; 95% CI: $-1.314, 0.020$; $P=0.057$), somatization (Coef., -1.334 ; 95% CI: $-2.451, -0.217$; $P=0.020$), obsessive-compulsive (Coef., -1.396 ; 95% CI: $-2.255, -0.537$; $P=0.002$), depression (Coef., -1.241 ; 95% CI: $-2.252, -0.229$; $P=0.017$), phobic anxiety (Coef., -2.576 ; 95% CI: $-3.786, -1.367$; $P<0.001$); comorbid type 2 diabetes mellitus had the significant influence on average positive factors (Coef., 0.131 ; 95% CI: $0.015, 0.248$; $P=0.027$), depression (Coef., 0.283 ; 95% CI: $0.105, 0.460$; $P=0.002$), interpersonal sensitivity (Coef., 0.156 ; 95%

CI: $0.008, 0.304$; $P=0.039$); heart rate had the significant influence on average positive factors (Coef., 0.005 ; 95% CI: $0.001, 0.010$; $P=0.023$), obsessive-compulsive (Coef., 0.006 ; 95% CI: $0.000, 0.013$; $P=0.003$), interpersonal sensitivity (Coef., 0.010 ; 95% CI: $0.003, 0.016$; $P=0.003$), depression (Coef., 0.008 ; 95% CI: $0.001, 0.015$; $P=0.028$), anxiety (Coef., 0.009 ; 95% CI: $0.004, 0.015$; $P=0.001$); educational level had the significant influence on average positive factors (Coef., -0.131 ; 95% CI: $-0.257, -0.005$; $P=0.041$), obsessive-compulsive (Coef., -0.245 ; 95% CI: $-0.414, -0.076$; $P=0.005$), interpersonal sensitivity (Coef., -0.175 ; 95% CI: $-0.341, -0.009$; $P=0.039$); comorbid coronary artery disease had the significant influence on somatization (Coef., 0.231 ; 95% CI: $0.035, 0.426$; $P=0.021$); duration of hemodialysis had the significant influence on somatization (Coef., 0.247 ; 95% CI: $0.058, 0.436$; $P=0.011$); comorbid heart failure had the significant influence on somatization (Coef., 0.241 ; 95% CI: $0.010, 0.472$; $P=0.041$); marital status had the significant influence on depression (Coef., -0.280 ; 95% CI: $-0.544, -0.015$; $P=0.038$); hemoglobin A_{1C} had the significant influence on phobic anxiety (Coef., 0.102 ; 95% CI: $0.020, 0.185$; $P=0.015$); hemoglobin had the significant influence on paranoid ideation (Coef., -0.003 ; 95% CI: $-0.006, 0.000$; $P=0.035$). The results of multiple stepwise linear regression analyses are presented in *Tables 3,4*.

Table 5 and *Table S5* listed the correlation between each score of the Chinese version SCL-90 and the Chinese version KDQOL-SF. The score of average positive factors was significantly correlated with the score of the overall health rating (Coef., -0.343 ; $P<0.001$), symptom/problem (Coef., -0.337 ; $P<0.001$), effects of kidney disease

Table 1 Demographic characteristics of the ESRD patients undergoing maintenance hemodialysis (N=190)

Demographic characteristic	Number
Age (years)	61.68 (13.39)
Systolic pressure (mmHg)	143.77 (23.79)
Diastolic pressure (mmHg)	79.32 (13.44)
Heart rate (times/min)	76.62 (11.51)
Urea nitrogen (mmol/L)	24.78 (8.73)
Calcium (mmol/L)	2.18 (0.25)
Phosphorus (mmol/L)	1.93 (0.67)
Hemoglobin (g/L)	107.83 (22.82)
Pre-albumin (g/L)	0.32 (0.08)
Serum albumin (g/L)	37.77 (4.84)
Hemoglobin A1c (%)	5.89 (1.23)
Sex	
Male	117 (61.6)
Female	73 (38.4)
Educational level	
Under high school	114 (75.8)
High school or above	46 (24.2)
Marital status	
Widowed or bachelor	20 (10.5)
Married	170 (89.5)
Duration of hemodialysis	
<2 years	82 (43.2)
≥2 years	108 (56.8)
Stroke	
No	148 (77.9)
Yes	42 (22.1)
Type 2 diabetes mellitus	
No	124 (65.3)
Yes	66 (34.7)
Coronary artery disease	
No	123 (64.7)
Yes	67 (35.3)
Hypertension	
No	23 (12.1)
Yes	167 (87.9)
Heart failure	
No	148 (77.9)
Yes	42 (22.1)

Data were shown as mean (SD) or number (%).

on daily life (Coef., -0.198 ; $P=0.006$), burden of kidney disease (Coef., -0.233 ; $P=0.001$), cognitive function (Coef., 0.363 ; $P<0.001$), quality of social interaction (Coef., 0.292 ; $P<0.001$), social support (Coef., 0.237 ; $P=0.001$), physical functioning (Coef., -0.339 ; $P<0.001$), pain (Coef., 0.362 ; $P<0.001$), general health (Coef., -0.332 ; $P<0.001$), mental health (Coef., -0.537 ; $P<0.001$), social functioning (Coef., 0.202 ; $P=0.005$), vitality (Coef., -0.478 ; $P<0.001$), respectively. The description of categorical variables of ESRD patients undergoing maintenance hemodialysis is shown in the [Table S6](#). The scores of the Chinese version SCL-90 nine factors and Chinese version KDQOL-SF domains are shown in the [Tables S7](#) and [S8](#).

Discussion

Our findings suggested that prealbumin, type 2 diabetes mellitus, heart rate, educational level, duration of hemodialysis, coronary artery disease, heart failure, marital status, hemoglobin A_{1c} and hemoglobin were significantly related with poorer mental health status of ESRD patients undergoing maintenance hemodialysis, and patients with poorer psychological states were more significantly associated with decreased QOL. For the scores of SCL-90 nine factors, they were negatively correlated with the score of several KDQOL-SF fields respectively; higher scores of SCL-90 factors represented potential mental health issues. To the best of our knowledge, this is the first study to identify the relative factors of the psychological states and examine the association between the psychological states and QOL among ESRD patients undergoing maintenance hemodialysis.

Currently, approximately 3 million people worldwide have been taking renal replacement therapy mostly in the form of hemodialysis (24), which significantly improved the long-term survival of the ESRD patients. However, several studies have reported that the patients with hemodialysis have an unusual psychological state, which can cause severe depression (25,26).

Previous studies indicated that about one third of patients undergoing maintenance hemodialysis had depressive symptoms, which effective treatments need to be identified (27,28). Therefore, identifying the relative factors of psychological symptoms among such patients may help clinicians to adopt an effective treatment for early interventions. In our results, comorbid type 2 diabetes mellitus had the negative influence on average positive

Table 2 Compare the scores of SCL-90 factors in ESRD patients undergoing maintenance hemodialysis patients with type 2 DM and without type 2 DM (N=190)

Variables	Number (%)	Type 2 DM (N=66; 34.7%)	No Type 2 DM (N=124; 65.3%)	P value
Somatization	190 (100%)	2.06 (0.68)	1.98 (0.69)	0.451
Obsessive-compulsive	190 (100%)	1.66 (0.53)	1.53 (0.52)	0.107
Interpersonal sensitivity	190 (100%)	1.52 (0.64)	1.36 (0.42)	0.069
Depression	190 (100%)	2.12 (0.65)	1.78 (0.54)	<0.001
Anxiety	190 (100%)	1.54 (0.54)	1.45 (0.40)	0.194
Hostility	190 (100%)	1.53 (0.77)	1.47 (0.54)	0.631
Phobic anxiety	190 (100%)	1.81 (0.87)	1.43 (0.64)	0.002
Paranoid ideation	190 (100%)	1.33 (0.56)	1.28 (0.42)	0.454
Psychoticism	190 (100%)	1.49 (0.39)	1.41 (0.24)	0.165
Average positive factors	190 (100%)	1.75 (0.46)	1.58 (0.33)	0.010

Data were shown as mean (SD). Continuous variables used independent sample *t*-test.

factors, depression and interpersonal sensitivity of SCL-90, which was consistent with previous study indicating that diabetes was an independently risk factors for diabetic patients with CKD that were more likely to have a major depressive episode when comparing with nondiabetic patients with CKD (5). In addition, our study also found that for ESRD patients undergoing maintenance hemodialysis, prealbumin, hemoglobin, comorbid heart failure and comorbid coronary artery disease were significantly associated with the mental health status, respectively, which was consistent with previous studies (29,30). Besides, faster heart rate, longer duration of hemodialysis, educational level and patients married were significant relative factors, which may be a useful basis for clinical practice; our study indicated that hemoglobin A_{1C}, prealbumin and hemoglobin were statistically significant factors of poorer mental health, but lack the biological meaning.

QOL has become an important index for the comprehensive evaluation (31). Assessing the QOL of ESRD patients undergoing maintenance hemodialysis can help clinicians understand the general condition of patients, therefore, can guide administrations towards specific, context-sensitive, and appropriate interventions to promote this population' QOL, which could prevent the progress of psychological issues and ultimately improve the QOL. Several studies have shown that the

QOL of patients undergoing maintenance hemodialysis is generally lower than the general population (32,33). Published study indicated that emotional symptoms are related directly with impaired QOL in patients undergoing maintenance hemodialysis (34). Our study suggested that patients undergoing maintenance hemodialysis with poorer psychological states were more significantly associated with decreased QOL, which was consistent with previous studies. Therefore, to improve the QOL of such patients, it is necessary to adopt a standard assessment of symptoms into the care, which comprehensively reflects the possible psychological problems of patients and to select reasonable and appropriate measures for intervention.

However, our study has some limitations. First, our study was limited by its small sample size for the data were from a single hospital. Second, a cross-sectional design makes it impossible to infer the causal relationship among different mental health status and QOL; thus, longitudinal studies are needed to examine the relationship over time (17). Thirdly, almost all patients enrolled refused to answer the same 3 categories of questionnaire, which might exist some degree of interviewer bias. Finally, this is a questionnaire-based survey, personal fear or prejudice toward the evaluation may distort the data further; and the results might have been negatively affected by acquiescence bias and social desirability bias (35).

Table 3 Multiple linear regression analysis of the association between SCL-90 factors and variables in ESRD patients undergoing maintenance hemodialysis (N=190) (I)

Variable	Average positive factors			Somatization			Obsessive-compulsive			Interpersonal sensitivity			Depression		
	Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value	
Prealbumin	-0.647 (-1.314; 0.020)	0.057		-1.334 (-2.451; -0.217)	0.02		-1.396 (-2.255; -0.537)	0.002		-	-		-1.241 (-2.252; -0.229)	0.017	
Type 2 DM	0.131 (0.015; 0.248)	0.027		-	-		-	-		0.156 (0.008; 0.304)	0.039		0.283 (0.105; 0.460)	0.002	
Heart rate	0.005 (0.001; 0.010)	0.023		-	-		0.006 (0.000; 0.013)	0.003		0.010 (0.003; 0.016)	0.003		0.008 (0.001; 0.015)	0.028	
Educational level	-0.131 (-0.257; -0.005)	0.041		-	-		-0.245 (-0.414; -0.076)	0.005		-0.175 (-0.341; -0.009)	0.039		-	-	
CAD	-	-		0.231 (0.035; 0.426)	0.021		-	-		-	-		-	-	
Duration of hemodialysis	-	-		0.247 (0.058; 0.436)	0.011		-	-		-	-		-	-	
Heart failure	-	-		0.241 (0.010; 0.472)	0.041		-	-		-	-		-	-	
Marital status	-	-		-	-		-	-		-	-		-0.280 (-0.544; -0.015)	0.038	

Coef., coefficient; CI, confidence interval; type 2 DM, type 2 diabetes mellitus; CAD, coronary artery disease. Reference: marital status-widowed or bachelor; type 2 DM-no type 2 DM; coronary artery disease-no coronary artery disease; educational level-under high school; duration of hemodialysis-less than 2 years; heart failure-no heart failure.

Table 4 Multiple linear regression analysis of the association between SCL-90 factors and variables in ESRD patients undergoing maintenance hemodialysis (N=190) (II)

Variable	Anxiety			Hostility			Phobic anxiety			Paranoid ideation			Psychoticism		
	Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value		Coef. (95% CI)	P value	
Prealbumin	-	-		-	-		-2.576 (-3.786; -1.367)	<0.001		-	-		-	-	
Heart rate	0.009 (0.004; 0.015)	0.001		-	-		-	-		-	-		-	-	
Hemoglobin A1C	-	-		-	-		0.102 (0.020; 0.185)	0.015		-	-		-	-	
Hemoglobin	-	-		-	-		-	-		-0.003 (-0.006; 0.000)	0.035		-	-	

Coef., coefficient; CI, confidence interval; type 2 DM, type 2 diabetes mellitus; CAD, coronary artery disease. Reference: marital status-widowed or bachelor; type 2 DM-no type 2 DM; coronary artery disease-no coronary artery disease; educational level-under high school; duration of hemodialysis-less than 2 years; heart failure-no heart failure.

Table 5 Pearson's correlations (r value) of the Chinese KDQOL-SF scores with the Chinese version SCL-90 score in the study population (N=190)

Scale/subscale	Average positive factors	Somatization	Obsessive compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility	Phobic anxiety	Paranoid ideation	Psychoticism
Overall health rating	-0.343**	-0.318**	-0.122	-0.230**	-0.294**	-0.225**	-0.194**	-0.248**	-0.209**	-0.323**
Symptom/problem	-0.337**	-0.354**	-0.071	-0.235**	-0.255**	-0.356**	-0.275**	-0.237**	-0.096	-0.124
Effects of kidney disease on daily life	-0.198**	-0.181*	-0.020	-0.215**	-0.145*	-0.248**	-0.169*	-0.146*	-0.063	-0.085
Burden of kidney disease	-0.233**	-0.295**	-0.085	-0.237**	-0.139	-0.226**	-0.226**	-0.112	-0.119	-0.137
Cognitive function	0.363**	0.242**	0.339**	0.233**	0.327**	0.314**	0.294**	0.136	0.226**	0.182*
Quality of social interaction	0.292**	0.181*	0.160*	0.232**	0.292**	0.282**	0.308**	0.075	0.220**	0.212**
Sleep	-0.017	0.013	-0.120	0.108	0.046	-0.015	-0.008	0.123	-0.006	0.042
Social support	0.237**	0.051	0.208**	0.250**	0.211**	0.294**	0.222**	0.002	0.176*	0.253**
Work status	-0.126	-0.172*	0.006	-0.199**	-0.080	-0.187**	-0.106	-0.037	-0.065	-0.078
PCS										
Physical functioning	-0.339**	-0.360**	-0.188**	-0.234**	-0.265**	-0.175*	-0.149*	-0.300**	-0.177*	-0.159*
Role limitations-physical health	-0.114	-0.196**	0.039	-0.154*	-0.059	-0.185*	-0.168*	-0.013	-0.050	-0.122
Pain	0.362**	0.416**	0.265**	0.186*	0.242**	0.199**	0.195**	0.177*	0.237**	0.226**
General health	-0.332**	-0.360**	-0.101	-0.265**	-0.244**	-0.245**	-0.265**	-0.197**	-0.197**	-0.251**
MCS										
Mental health	-0.537**	-0.217**	-0.401**	-0.367**	-0.590**	-0.412**	-0.328**	-0.354**	-0.420**	-0.405**
Role limitations-emotional	-0.094	-0.222**	0.068	-0.091	-0.044	-0.192**	-0.139	-0.010	-0.042	-0.103
Social functioning	0.202**	0.063	0.175*	0.253**	0.178*	0.137	0.111	0.014	0.233**	0.206**
Vitality	-0.478**	-0.146*	-0.458**	-0.283**	-0.533**	-0.242**	-0.308**	-0.309**	-0.444**	-0.353**

PCS, physical component summary; MCS, mental component summary. **P<0.01, *P<0.05.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Medical Ethics Committee of the Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine (Ethics No. SH9H-2019-T143-1), and was registered with the Chinese Clinical Trials Registry (No. ChiCTR1900028275). All patients in this study signed informed consent forms after thoroughly reading and accepting its contents.

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Table S1 Compare the scores of SCL-90 factors in ESRD patients undergoing maintenance hemodialysis patients with stroke and without stroke (N=190)

Variables	Number (%)	Stroke (N=42;22.1%)	No stroke (N=148;77.9%)	P value
Somatization	190 (100%)	2.14 (0.75)	1.98 (0.66)	0.184
Obsessive-compulsive	190 (100%)	1.50 (0.44)	1.60 (0.55)	0.240
Interpersonal sensitivity	190 (100%)	1.37 (0.34)	1.42 (0.55)	0.535
Depression	190 (100%)	1.84 (0.47)	1.92 (0.64)	0.492
Anxiety	190 (100%)	1.38 (0.39)	1.51 (0.46)	0.109
Hostility	190 (100%)	1.62 (0.82)	1.46 (0.55)	0.221
Phobic anxiety	190 (100%)	1.71 (0.68)	1.52 (0.76)	0.149
Paranoid ideation	190 (100%)	1.31 (0.38)	1.30 (0.49)	0.907
Psychoticism	190 (100%)	1.44 (0.24)	1.44 (0.32)	0.958
Average positive factors	190 (100%)	1.65 (0.34)	1.64 (0.40)	0.843

Data were shown as mean (SD). Continuous variables used independent sample *t* test.

Table S2 Compare the scores of SCL-90 factors in ESRD patients undergoing maintenance hemodialysis patients with coronary artery disease and without coronary artery disease (N=190)

Variables	Number (%)	Coronary artery disease (N=67;35.3%)	No coronary artery disease (N=123;64.7%)	P value
Somatization	190 (100%)	2.21 (0.73)	1.90 (0.63)	0.003
Obsessive-compulsive	190 (100%)	1.61 (0.47)	1.56 (0.55)	0.494
Interpersonal sensitivity	190 (100%)	1.43 (0.43)	1.40 (0.55)	0.769
Depression	190 (100%)	1.94 (0.61)	1.88 (0.60)	0.476
Anxiety	190 (100%)	1.49 (0.41)	1.48 (0.47)	0.874
Hostility	190 (100%)	1.50 (0.56)	1.49 (0.66)	0.899
Phobic anxiety	190 (100%)	1.63 (0.74)	1.53 (0.75)	0.374
Paranoid ideation	190 (100%)	1.26 (0.37)	1.32 (0.52)	0.422
Psychoticism	190 (100%)	1.43 (0.23)	1.44 (0.34)	0.714
Average positive factors	190 (100%)	1.68 (0.37)	1.62 (0.40)	0.280

Data were shown as mean (SD). Continuous variables used independent sample *t* test.

Table S3 Compare the scores of SCL-90 factors in ESRD patients undergoing maintenance hemodialysis patients with hypertension and without hypertension (N=190)

Variables	Number (%)	Hypertension (N=167;87.9%)	No hypertension (N=23;12.1%)	P value
Somatization	190 (100%)	2.02 (0.70)	1.96 (0.54)	0.718
Obsessive-compulsive	190 (100%)	1.58 (0.53)	1.55 (0.48)	0.759
Interpersonal sensitivity	190 (100%)	1.42 (0.52)	1.37 (0.38)	0.686
Depression	190 (100%)	1.90 (0.62)	1.91 (0.53)	0.933
Anxiety	190 (100%)	1.49 (0.46)	1.41 (0.37)	0.453
Hostility	190 (100%)	1.48 (0.61)	1.55 (0.74)	0.634
Phobic anxiety	190 (100%)	1.56 (0.74)	1.61 (0.83)	0.755
Paranoid ideation	190 (100%)	1.31 (0.48)	1.25 (0.41)	0.572
Psychoticism	190 (100%)	1.44 (0.32)	1.46 (0.17)	0.755
Average positive factors	190 (100%)	1.64 (0.39)	1.61 (0.35)	0.718

Data were shown as mean (SD). Continuous variables used independent sample *t* test.

Table S4 Compare the scores of SCL-90 factors in ESRD patients undergoing maintenance hemodialysis patients with heart failure and without heart failure (N=190)

Variables	Number (%)	Heart failure (N=42;22.1%)	No heart failure (N=148;77.9%)	P value
Somatization	190 (100%)	2.25 (0.70)	1.95 (0.67)	0.011
Obsessive-compulsive	190 (100%)	1.60 (0.54)	1.57 (0.52)	0.725
Interpersonal sensitivity	190 (100%)	1.50 (0.67)	1.39 (0.45)	0.183
Depression	190 (100%)	1.98 (0.66)	1.88 (0.59)	0.376
Anxiety	190 (100%)	1.58 (0.43)	1.45 (0.45)	0.099
Hostility	190 (100%)	1.49 (0.60)	1.49 (0.63)	0.962
Phobic anxiety	190 (100%)	1.51 (0.76)	1.58 (0.74)	0.653
Paranoid ideation	190 (100%)	1.24 (0.40)	1.31 (0.49)	0.380
Psychoticism	190 (100%)	1.42 (0.31)	1.44 (0.31)	0.651
Average positive factors	190 (100%)	1.70 (0.44)	1.62 (0.37)	0.281

Data were shown as mean (SD). Continuous variables used independent sample *t* test.

Table S5 Pearson's correlations of the Chinese KDQOL-SF scores with the Chinese version SCL-90 score in the study population (N=190)-detailed version

Scale/subscale		Average positive factors	Somatization	Obsessive compulsive	Interpersonal sensitivity	Depression	Anxiety	Hostility	Phobic anxiety	Paranoid ideation	Psychoticism
Overall health rating	Coefficient	−0.343**	−0.318**	−0.122	−0.230**	−0.294**	−0.225**	−0.194**	−0.248**	−0.209**	−0.323**
	P value	<0.001	<0.001	0.093	0.001	<0.001	0.002	0.007	0.001	0.004	<0.001
Symptom/problem	Coefficient	−0.337**	−0.354**	−0.071	−0.235**	−0.255**	−0.356**	−0.275**	−0.237**	−0.096	−0.124
	P value	<0.001	<0.001	0.332	0.001	<0.001	<0.001	<0.001	0.001	0.185	0.088
Effects of kidney disease on daily life	Coefficient	−0.198**	−0.181*	−0.02	−0.215**	−0.145*	−0.248**	−0.169*	−0.146*	−0.063	−0.085
	P value	0.006	0.012	0.783	0.003	0.045	0.001	0.02	0.045	0.392	0.242
Burden of kidney disease	Coefficient	−0.233**	−0.295**	−0.085	−0.237**	−0.139	−0.226**	−0.226**	−0.112	−0.119	−0.137
	P value	0.001	<0.001	0.242	0.001	0.056	0.002	0.002	0.125	0.101	0.059
Cognitive function	Coefficient	0.363**	0.242**	0.339**	0.233**	0.327**	0.314**	0.294**	0.136	0.226**	0.182*
	P value	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.061	0.002	0.012
Quality of social interaction	Coefficient	0.292**	0.181*	0.160*	0.232**	0.292**	0.282**	0.308**	0.075	0.220**	0.212**
	P value	<0.001	0.012	0.027	0.001	<0.001	<0.001	<0.001	0.306	0.002	0.003
Sleep	Coefficient	−0.017	0.013	−0.12	0.108	0.046	−0.015	−0.008	0.123	−0.006	0.042
	P value	0.812	0.856	0.1	0.14	0.53	0.839	0.916	0.09	0.938	0.565
Social support	Coefficient	0.237**	0.051	0.208**	0.250**	0.211**	0.294**	0.222**	0.002	0.176*	0.253**
	P value	0.001	0.488	0.004	0.001	0.004	<0.001	0.002	0.973	0.015	<0.001
Work status	Coefficient	−0.126	−0.172*	0.006	−0.199**	−0.08	−0.187**	−0.106	−0.037	−0.065	−0.078
	P value	0.083	0.017	0.93	0.006	0.271	0.01	0.145	0.613	0.377	0.287
Physical functioning	Coefficient	−0.339**	−0.360**	−0.188**	−0.234**	−0.265**	−0.175*	−0.149*	−0.300**	−0.177*	−0.159*
	P value	<0.001	<0.001	0.009	0.001	<0.001	0.016	0.04	<0.001	0.015	0.029
Role limitations-physical health	Coefficient	−0.114	−0.196**	0.039	−0.154*	−0.059	−0.185*	−0.168*	−0.013	−0.05	−0.122
	P value	0.117	0.007	0.595	0.033	0.423	0.01	0.02	0.862	0.494	0.093
Pain	Coefficient	0.362**	0.416**	0.265**	0.186*	0.242**	0.199**	0.195**	0.177*	0.237**	0.226**
	P value	<0.001	<0.001	<0.001	0.01	0.001	0.006	0.007	0.015	0.001	0.002
General health	Coefficient	−0.332**	−0.360**	−0.101	−0.265**	−0.244**	−0.245**	−0.265**	−0.197**	−0.197**	−0.251**
	P value	<0.001	<0.001	0.166	<0.001	0.001	0.001	<0.001	0.007	0.006	<0.001
Mental health	Coefficient	−0.537**	−0.217**	−0.401**	−0.367**	−0.590**	−0.412**	−0.328**	−0.354**	−0.420**	−0.405**
	P value	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Role limitations-emotional	Coefficient	−0.094	−0.222**	0.068	−0.091	−0.044	−0.192**	−0.139	−0.01	−0.042	−0.103
	P value	0.195	0.002	0.348	0.212	0.544	0.008	0.057	0.887	0.561	0.156
Social functioning	Coefficient	0.202**	0.063	0.175*	0.253**	0.178*	0.137	0.111	0.014	0.233**	0.206**
	P value	0.005	0.387	0.016	<0.001	0.014	0.059	0.126	0.85	0.001	0.004
Vitality	Coefficient	−0.478**	−0.146*	−0.458**	−0.283**	−0.533**	−0.242**	−0.308**	−0.309**	−0.444**	−0.353**
	P value	<0.001	0.044	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001

**P<0.01, *P<0.05.

Table S6 Description of categorical variables of ESRD patients undergoing maintenance hemodialysis

Variable	Definition
Sex	Sex (Male/Female); reference: male.
Marital status	Marital status (Married/Widowed or bachelor); reference: widowed or bachelor.
Educational level	Educational level (Under high school/High school or above); reference: under high school.
Duration of hemodialysis	Duration of hemodialysis (<2 years/ $\geq$ 2 years); reference: <2 years
Coronary artery disease	Coronary artery disease (Yes/No); reference: no coronary artery disease.
Hypertension	Hypertension (Yes/No); reference: no hypertension.
Heart failure	Heart failure (Yes/No); reference: no heart failure.
Type 2 diabetes mellitus	Type 2 diabetes mellitus (Yes/No); reference: no type 2 diabetes mellitus
Stroke	History of stroke (Yes/No); reference: no stroke.

Table S7 The scores of the Chinese version SCL-90 in the study population (N=190)

Factor	MHD patients (N=190)	
	Mean	SD
Somatization	2.01	0.68
Depression	1.90	0.61
Anxiety	1.48	0.45
Obsessive compulsive	1.58	0.53
Hostility	1.49	0.62
Phobic anxiety	1.56	0.75
Paranoid ideation	1.30	0.47
Interpersonal sensitivity	1.41	0.51
Psychoticism	1.44	0.30
Average positive factors	1.64	0.39

Table S8 The Chinese KDQOL-SF scores in the study population (N=190)

Scale/subscale	Mean	SD
Overall health	37.89	19.37
Symptom/problem	76.51	15.85
Effects of kidney disease on daily life	60.87	18.56
Burden of kidney disease	48.26	23.92
Cognitive function	32.81	10.31
Quality of social interaction	29.16	11.48
Sleep	68.72	13.63
Social support	26.67	31.56
Work status	12.63	30.40
PCS		
Physical functioning	72.05	25.82
Role limitations-physical health	13.95	31.65
Pain	28.55	19.70
General health	38.24	23.58
MCS		
Mental health	66.36	12.32
Role limitations-emotional	14.91	32.62
Social functioning	44.74	13.19
Vitality	64.21	12.43

PCS, physical component summary; MCS, mental component summary.