

# The prevalence of depression and the association between depression and kidney function and health-related quality of life in elderly patients with chronic kidney disease: a multicenter cross-sectional study

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**Purpose:** The prevalence of depression and the relationship between depression and kidney function and health-related quality of life (HRQOL) are not well understood in elderly patients with predialysis chronic kidney disease (CKD). This study aimed to evaluate the prevalence of depression and the association between depression and kidney function and HRQOL.

**Patients and methods:** In this cross-sectional study, 1079 elderly participants with CKD were recruited at 32 clinical centers located within 26 cities throughout 24 provinces in China. Demographic information and laboratory analyses were collected. Symptoms of depression were assessed using the 15-item Geriatric Depression Scale (GDS-15). HRQOL was evaluated using the Kidney Disease Quality of Life-36 (KDQOL-36) instrument.

**Results:** The prevalence of depression was 23.0%. The estimated glomerular filtration rate (eGFR) was negatively correlated with the GDS score whether it was treated as a categorical variable ( $r=-0.097$ ,  $P=0.001$ ) or as a continuous variable ( $r=-0.100$ ,  $P=0.001$ ). Marital status, education level, history of CVD and diabetes, CKD stage and proteinuria confirmed to be independent and significant predictors of depression in patients with CKD. Compared with CKD 1–2 patients, we observed an increase of 0.541 and 4.171 in the odds for developing depression in patients CKD 4 (odds ratio [OR] =1.541;  $P=0.031$ ) and CKD 5 (odds ratio [OR] =5.171;  $P<0.001$ ), respectively. We observed negative and significant correlations with the GDS score for the following components: PCS ( $r=-0.370$ ,  $P<0.001$ ), MCS ( $r=-0.412$ ,  $P<0.001$ ), burden of kidney disease ( $r=-0.403$ ,  $P<0.001$ ), symptoms and problems of kidney disease ( $r=-0.360$ ,  $P<0.001$ ) and effects of kidney disease ( $r=-0.355$ ,  $P<0.001$ ). Depression was an independent and significant predictor of all the subcomponents of the HRQOL.

**Conclusions:** The prevalence of depression in elderly patients with CKD was high and was negatively correlated with kidney function. Depression had a major negative impact on HRQOL.

**Keywords:** chronic kidney disease, health-related quality of life, depression, aging, kidney function

## Introduction

Chronic kidney disease (CKD) is a worldwide public health problem. The prevalence of CKD in the general population is approximately 10–13%.<sup>1–3</sup> With increased age, the prevalence of CKD increases significantly. Data from the 2011–2012 National Health

and Nutrition Examination Survey (NHANES) showed that the prevalence of CKD was 31.5% for those 65–79 years old, and it was as high as 65.0% in those over 80 years old.<sup>4</sup> The prevalence of CKD in people aged 60–69 years and older than 70 years was 18% and 24.2%, respectively, which was much higher than 10.8% in the general population in China.<sup>5</sup> Elderly patients with CKD were more likely to suffer mortality than to progress to end-stage renal disease (ESRD) due to complications and comorbidities.<sup>6,7</sup> They also had a high prevalence of geriatric syndromes, including depression, cognitive impairment and malnutrition.<sup>8–10</sup>

Depression is a common and significant psychiatric disorder in ESRD patients. The reported prevalence of depression varies from 23% to 46% in patients with ESRD or in dialysis populations.<sup>11–13</sup> Studies have shown the effect of depression on dialysis, mortality, hospitalization and quality of life in these patients.<sup>14–16</sup> However, there are relatively few studies about the prevalence of depression in elderly patients with early-stage CKD.<sup>17,18</sup> The association between the level of renal function measured by estimated glomerular filtration rate (eGFR) and depression is ambiguous, and the association between depression and its risk factors, especially biological factors such as systemic inflammation, is not known.

Health-related quality of life (HRQOL) is an important outcome and prognostic predictor in patients with CKD. The Kidney Disease Quality of Life-36 (KDQOL-36) instrument, a globally accepted tool, is a simple and important mechanism to evaluate the HRQOL of patients with CKD. The relationship between HRQOL and depression in patients with ESRD is well established.<sup>19,20</sup> However, little is known about the association between depression and HRQOL in the early stages of CKD in China.

We conducted a multicenter prospective cohort study of Chinese elderly patients with CKD. The baseline data, including the Geriatric Depression Scale (GDS) score and KDQOL-36, were obtained. In this population study, we aimed to examine the prevalence of depression and its association with kidney function and HRQOL in elderly Chinese CKD patients.

## Materials and methods

### Study design and participants

This study was a multicenter, cross-sectional, noninterventional study of elderly Chinese patients (above 60 years of age) with CKD and included 32 clinical centers located within 26 cities throughout 24 provinces in China. All of these

clinical centers were renal departments from different hospitals. Altogether, 1163 Chinese elderly patients with predialysis CKD were enrolled in the study. Eighty-four patients were excluded because they refused to participate in the survey. Finally, a total of 1079 patients were included between March 2017 and November 2018. CKD was diagnosed as follows: a history of CKD for more than three months; eGFR less than 60 mL/min/1.73 m<sup>2</sup> or albumin-to-creatinine ratio (ACR) more than 30 mg/g or proteinuria more than 150 mg/24 h. GFR was estimated with the CKD Epidemiology Collaboration (CKD-EPI) creatinine equation.<sup>21</sup> We defined eGFR categories as follows: Stage 1,  $\geq 90$  mL/min/1.73 m<sup>2</sup>; Stage 2, 60–89 mL/min/1.73 m<sup>2</sup>; Stage 3, 30–59 mL/min/1.73 m<sup>2</sup>; Stage 4, 15–29 mL/min/1.73 m<sup>2</sup>; Stage 5,  $< 15$  mL/min/1.73 m<sup>2</sup>, respectively.<sup>22</sup>

We excluded participants if they (1) were participating in other interventional clinical trials; (2) were receiving dialysis; (3) were diagnosed as having acute kidney injury; (4) had a history of renal or other transplantation; (5) had an active malignancy or metastatic cancer within 24 months prior to screening; (6) had severe heart failure (New York Heart Association function class III or IV); (7) had HIV infection; (8) had isolated hematuria; and (9) were unable to communicate with researchers or unable to complete the study procedure even if assisted and otherwise unable to comply with the study protocol.<sup>23</sup>

Cardiovascular disease (CVD) history, hypertension and diabetes mellitus were recorded in detail. A history of CVD was defined as myocardial infarction, angina pectoris, cerebrovascular accident, transient ischemic attack, peripheral artery disease or revascularization, diagnosed in the medical history.<sup>24</sup> Hypertension was defined as systolic blood pressure (SBP)  $\geq 140$  mmHg or diastolic blood pressure (DBP)  $\geq 90$  mmHg on repeated measurements, or both, or as the use of antihypertensive drugs, or both.<sup>25</sup> Diabetes was defined as a fasting glucose level  $\geq 7.0$  mmol/L, glycated hemoglobin  $\geq 6.5\%$ , or use of anti-diabetic drugs.<sup>26</sup> This study was conducted in accordance with the Declaration of Helsinki. It was approved by the Ethics Committee of the Chinese PLA General Hospital (No. S2016-100-02), and all patients gave their written informed consent before their inclusion in the study.

### Demographic information and laboratory analysis

Information regarding age, sex, marital status, education, annual household income, and history of smoking and

alcohol use was collected from patients. Marital status included married and others (single, divorced, widowed). Body mass index (BMI) was obtained within 1 week of blood sample collection from the patients. Blood samples were collected in the morning after an overnight fast. White blood cells, neutrophils, lymphocytes, platelets, hemoglobin, serum albumin, total cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein, serum calcium and phosphate, serum creatinine, and serum uric acid were collected for each participant. We also collected urinary protein excretion. The neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were calculated as the ratio of the neutrophils and platelets to lymphocytes, and both were obtained from the same automated blood sample during admission to the study.

## Depressive symptoms

Symptoms of depression were assessed using the GDS-15, a reliable and well-validated measure of depressive symptoms in elderly patients in Chinese subjects.<sup>27</sup> This self-administered questionnaire contains 15 yes/no questions. Scores range from 0 to 15, with higher scores indicating greater severity. A GDS score of 5 or more was defined as the presence of depressive symptoms,<sup>18</sup> which have been shown to have high sensitivity (97%) and specificity (95%) in cases of major depressive disorders from structured diagnostic interviews.<sup>27</sup>

## Health-related quality of life

HRQOL was assessed using the KDQOL-36 instrument, which was introduced in 1994 and is specific to kidney disease.<sup>28</sup> The Chinese version of the KDQOL-36 has been validated.<sup>29</sup> The KDQOL-36 has 36 items: the 12-item Short-Form Health Survey (SF-12) and another 24 kidney disease-specific targeted domains. The kidney disease-specific targeted domains comprise three scales: burden of kidney disease (4 items), symptoms and problems of kidney disease (12 items), and effects of kidney disease (8 items). Since our study participants were not on dialysis, one question related to dialysis was omitted from the KDQOL-36. The SF-12 measured eight dimensions of health-related functioning [physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE) and mental health (MH)]. Responses were scored (0–100), and a higher score reflected a better HRQOL.<sup>30</sup> The SF-12 scores were aggregated into a physical component summary (PCS) and a mental component summary (MCS).<sup>31</sup>

## Statistical analysis

The variables were expressed as the mean  $\pm$  SD, median (interquartile range, IQR) or percentage, as appropriate. Groups were compared by independent *t*-test, the Mann-Whitney U test or  $\chi^2$  analysis, as appropriate. As many values were not normally distributed, Spearman's rank correlation (Rho) was used to determine correlations. The individual impact of several confounding factors on the variance of a continuous variable was assessed by building multivariate regression models, and if the dependent variable was dichotomous, the assessment was conducted by building multivariate logistic regressions. The predictors were accepted according to a forward stepwise algorithm (inclusion criteria:  $P < 0.05$ , exclusion criteria:  $P > 0.10$ ). Analyses were performed with IBM SPSS 25.0 software (SPSS Institute, IBM, USA). All *P*-values were two-sided. Statistical significance was set at the level of  $P < 0.05$ .

## Results

### Patient characteristics

A total of 1163 participants were recruited. There was an overall response rate of 93% (1079/1163), with 84 non-responders removed from the analyses (Table 1). The mean age of the patients who responded to the questionnaire was  $68.8 \pm 6.6$  years and included more men (62.7%). Nonresponders were significantly older ( $74.6 \pm 8.5$  years,  $P < 0.001$ ) and had a lower eGFR ( $45.13 \pm 23.70$  mL/min/1.73 m<sup>2</sup>) than responders ( $54.90 \pm 32.22$  mL/min/1.73 m<sup>2</sup>). Nonresponders were more likely to suffer from diabetes than were responders. There were no significant differences in hypertension and CVD between the two groups.

Characteristics of the 1079 participants are shown in Table 2. The prevalence of CKD complications and comorbidities was as follows: 77.1% had hypertension, 37.3% had diabetes, and 23.7% had cardiovascular diseases. The prevalence of depressive symptoms was 23.0% ( $N = 248$ ). Compared with nondepressed patients, depressed patients were more likely to be single, divorced or widowed and to have lower education levels, higher rates of CVD, higher phosphate levels and proteinuria, and lower GFR and hemoglobin. However, patients who had diabetes seemed to have a lower rate of depression than nondiabetic patients. There were no significant differences between depressed and nondepressed patients in the other characteristics.

**Table 1** Characteristics of responders and nonresponders

Variables	Responders (N=1079)	Nonresponders (N=84)	P-value
Age	68.8±6.6	74.6±8.5	<b>&lt;0.001</b>
Sex: male	676(62.7)	47(56.0)	0.223
Hypertension (N=1129)	830(77.1)	44(84.6)	0.204
Diabetes (N=1132)	402(37.3)	30 (54.5)	<b>0.010</b>
CVD (N=1128)	256(23.8)	13(25)	0.842
eGFR(mL/ min/1.73m <sup>2</sup> )	54.90±32.22	45.13±23.70	<b>0.001</b>

**Notes:** The bold values were statistically significant with  $P<0.05$ . Values for continuous variables were expressed as mean  $\pm$  SD, categorical variables were number (% of group).

**Abbreviations:** CVD, Cardiovascular diseases; eGFR, estimated glomerular filtration rate.

## Association between depressive symptoms and kidney function

The association between depressive symptoms and kidney function is presented in Figure 1. The eGFR was negatively correlated with the GDS score whether it was treated as a categorical variable ( $r=-0.097$ ,  $P=0.001$ ) or as a continuous variable ( $r=-0.100$ ,  $P=0.001$ ).

## Correlates of depressive symptoms in patients with CKD

We created a multivariate logistic regression model with the presence of depression as an outcome and with the following as predictors: age, sex, marital status, education, diabetes, CVD, CKD stage, and proteinuria, hemoglobin and phosphate levels. The final regression equation was validated according to a forward stepwise algorithm, having an inclusion threshold criterion for predictors of a  $P$ -value for goodness of fit lower than or equal to 0.05 and an exclusion threshold of a  $P$ -value higher than 0.10. In the final regression equation, the following predictors were accepted: marital status, education, diabetes, CVD, CKD stage and proteinuria.

According to our model, the incidence of depression was significantly associated with single, divorced or widowed status; lower education level; presence of CVD; absence of diabetes; CKD Stages 4 and 5; and increased proteinuria. The impact of significant predictors on the development of depression is presented in Table 3. Compared with CKD 1–2 patients, we observed an increase of 0.541 and 4.171 in the odds of developing

depression in patients with CKD 4 (odds ratio [OR] =1.541;  $P=0.031$ ) and CKD 5 (odds ratio [OR] =5.171;  $P<0.001$ ), respectively.

## Depressive symptoms influence the HRQOL

Results of the eight generic domains and summary scores and the scores for kidney disease-specific health concerns are displayed in Table 4. Patients in the depressed group were significantly more likely to have low scores for GH, PF, BP, RE, MH, VT, SF, PCS, MCS, burden of kidney disease, symptoms and problems of kidney disease and effects of kidney disease and high scores for RP. Since PCS and MCS were summary scores, individual components were not further analyzed separately.

Regarding the subcomponents of the HRQOL, we observed that PCS ( $r=-0.370$ ,  $P<0.001$ ), MCS ( $r=-0.412$ ,  $P<0.001$ ), burden of kidney disease ( $r=-0.403$ ,  $P<0.001$ ), symptoms and problems of kidney disease ( $r=-0.360$ ,  $P<0.001$ ) and effects of kidney disease ( $r=-0.355$ ,  $P<0.001$ ) had negative and significant correlations with the GDS score. After adjusting for factors such as age, sex, BMI, diabetes, CVD, proteinuria and eGFR, which may possibly impact HRQOL, the relationship between depression and the subcomponents of the HRQOL also existed (Table 5).

## Discussion

Depression is a very common but complex problem among individuals with CKD. In this multicenter cross-sectional elderly CKD data set, the prevalence of depression was 23.0%. By comparison, the prevalence of depression was reported to be approximately 1.1–3.3% in the general population, 12–18% in patients with diabetes and 15–23% in patients with coronary heart disease.<sup>32,33</sup> The prevalence of depression in our study was similar to that reported by a meta-analysis. In that study, the prevalence rate was 26.5% in patients with Stages 1–5 CKD.<sup>11</sup> However, the rate was relatively higher than that reported in a previous study (12.8%), which may be because the patients were all community-dwelling adults.<sup>18</sup> Another study also reported that the prevalence of depression among elderly medical inpatients (18.1%) was significantly higher than that among community-dwelling elderly people (11.6%).<sup>34</sup> The prevalence of depression was high in CKD patients. The presence of depression may have a serious negative impact on the global health and well-being of the patients. They may

**Table 2** Characteristics of CKD patients by depressive symptoms

Variables	Total	Depressed	Nondepressed	P-value
No. of patients	1079 (100)	248 (23.0)	831 (77.0)	–
Age	68.8±6.6	69.0±6.5	68.8±6.6	0.610
Sex: male	676 (62.7)	144(58.1)	532(64.0)	0.089
Marital status (N=1067)				<b>0.017</b>
Married	1005(94.2)	224(91.1)	781(95.1)	
Others	62(5.8)	22(8.9)	40(4.9)	
Education (N=976)				<b>0.002</b>
0–6 years	307(31.5)	92(41.3)	215 (28.6)	
7–12 years	513(52.6)	102(45.7)	411(54.6)	
>12 years	156(16.0)	29(3.0)	127(16.9)	
Annual household income (N=948)				0.055
<50,000 RMB	460(48.5)	123(54.9)	337(46.5)	
50,000–100,000 RMB	274(28.9)	52(23.2)	222(30.7)	
≥100,000 RMB	214(22.6)	49(21.9)	165(22.8)	
Hypertension(N=1077)	830 (77.1)	190(76.6)	640(77.2)	0.847
Diabetes(N=1077)	402 (37.3)	77(31.0)	325 (39.2)	<b>0.020</b>
CVD(N=1076)	256 (23.7)	77(31.0)	179(21.6)	<b>0.002</b>
Current smoking(N=1077)	145 (13.5)	29(11.7)	116(14.0)	0.366
Current drinking(N=1075)	315(29.2)	64(26.0)	251(30.3)	0.197
BMI(N=1066), kg/m <sup>2</sup>	25.08±3.49	24.86±3.52	25.14±3.48	0.272
eGFR, mL/min/1.73 m <sup>2</sup>	54.90±32.22	49.17±32.00	56.60±32.10	<b>0.001</b>
CKD stage				<b>&lt;0.001</b>
CKD1-2	390(36.1)	77(31.0)	313(37.7)	
CKD3	403(37.3)	80(32.3)	323(38.9)	
CKD4	236(21.9)	65(26.2)	175(20.6)	
CKD5	50(4.6)	26(10.5)	24(2.9)	
Proteinuria (N=969) g/day	2.63±2.77	3.01±2.80	2.52±2.76	<b>0.024</b>
Hemoglobin(N=1066), g/L	121.31±20.59	116.09±21.04	121.57±20.30	<b>&lt;0.001</b>
Serum albumin(N=1067), g/L	34.45±8.65	34.69±8.49	34.37±8.71	0.615
Uric acid(N=1071), μmol/L	397.83±107.51	394.48±114.10	398.84±105.51	0.576
Calcium(N=1044), mmol/L	2.16±0.25	2.17±0.23	2.16±0.25	0.581
Phosphate(N=1026), mmol/L	1.19±0.23	1.23±0.29	1.18±0.21	<b>0.013</b>
NLR (N=1057)	2.95±2.62	3.22±2.31	2.87±2.70	0.076
PLR(N=1055)	133.79±79.30	138.49±66.28	132.42±82.69	0.299
Total cholesterol (N=1022), mmol/L	5.22±1.86	5.16±1.79	5.23±1.88	0.614
Triglycerides (N=1019), mmol/L	1.99±1.28	1.97±1.08	2.00±1.34	0.803
HDL(N=977), mmol/L	1.24±0.42	1.22±0.42	1.24±0.42	0.529
LDL(N=977), mmol/L	3.19±1.50	3.07±1.43	3.22±1.51	0.194

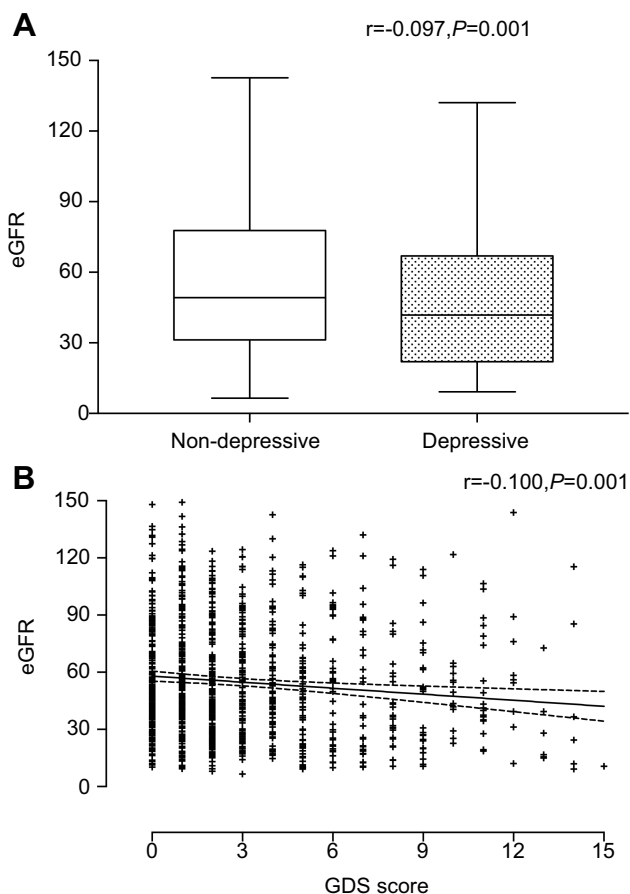
**Notes:** The bold values were statistically significant with  $P<0.05$ . Values for continuous variables were expressed as the mean ± SD, or median with interquartile ranges. Categorical variables were number (% of group).

**Abbreviations:** CVD, Cardiovascular diseases; BMI, body-mass index; eGFR, estimated glomerular filtration rate; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; HDL, high-density lipoprotein; LDL, low-density lipoprotein; CKD, chronic kidney disease.

exhibit poor adherence behaviors, have a poor response to treatment and require much social support.

There was a significant difference in kidney function between patients with depressive symptoms and nondepressive symptoms in our study. Patients with CKD Stages 4 and 5 had a high risk of depression. In 2018, Liu et al demonstrated that the estimated glomerular filtration rate was associated with depressive symptoms. In

their study, patients with CKD Stages 1–3 were included. Depressive symptoms were defined as GDS score  $\geq 6$ , and eGFR was calculated by the Cockcroft-Gault (CG) equation.<sup>35</sup> However, in 2009, Hedayati et al concluded that depression did not vary significantly among patients with different CKD stages.<sup>36</sup> The evidence for an association between the level of renal function measured by eGFR and depression was indefinite. Since cross-sectional



**Figure 1** Association between depressive symptoms and eGFR. **Abbreviations:** eGFR, estimated glomerular filtration rate; GDS, Geriatric Depression Scale.

studies cannot explain the causal relationship, longitudinal studies are needed to verify the relationship between depression and eGFR.

Low eGFR and proteinuria are signs of severe renal impairment that could require dialysis or kidney transplantation. These patients were more susceptible to experiencing psychological diseases. In 2012, Liborio et al reported that proteinuria was associated with depression in primary glomerulopathy patients with preserved renal function.<sup>37</sup> In our study, we also concluded that proteinuria was associated with depression in elderly CKD patients.

The association between being unmarried, having a low educational level and having CVD and the occurrence of depressive symptoms in CKD patients has been shown in our study. However, the association with age and sex was not revealed. Variations in participants' demographic characteristics and the type of study design might be the reasons for the discrepancy. In our study, we found that patients with diabetes seemed to have a low rate of depression, which was not consistent with a previous study.<sup>38</sup> This might be because some patients with diabetes were excluded due to a lack of response to the survey or to a refusal to participate in our study.

HRQOL is an important outcome in CKD. We observed that PCS, MCS, burden of kidney disease, symptoms and problems of kidney disease and effects of kidney disease had negative and significant correlations with the GDS score. Longitudinal data from hemodialysis patients demonstrated that depression was related to a reduction of 1.09 and 4.52 points in HRQOL, as evaluated by PCS and MCS, respectively.<sup>39</sup> Previous studies have not reported a relationship between depression and the kidney disease-specific targeted domains. In our study, depression was

**Table 3** Multiple logistic regression analysis parameters (dependent variable - depression)

Predictor	B	Wald	Exp (β)	95% CI (Exp [β])	P-value
Marital status	-0.601	4.343	0.548	(0.312 to 0.965)	0.037
Education					
≤6	Referent	Referent	Referent	Referent	Referent
7-12	-0.575	11.701	0.563	(0.405 to 0.782)	0.001
≥12	-0.570	5.197	0.565	(0.346 to 0.923)	0.023
Diabetes	-0.511	9.591	0.600	(0.434 to 0.829)	0.002
CVD	0.643	14.083	1.902	(1.360 to 2.661)	<0.001
CKD stage					
CKD1-2	Referent	Referent	Referent	Referent	Referent
CKD3	-0.011	0.003	0.989	(0.689 to 1.420)	0.954
CKD4	0.433	4.652	1.541	(1.040 to 2.283)	0.031
CKD5	1.643	26.138	5.171	(2.754 to 9.709)	<0.001
Proteinuria	0.056	4.105	1.057	(1.002 to 1.116)	0.043

**Notes:** The predictors were accepted according to a stepwise algorithm (inclusion criteria:  $P < 0.05$ , exclusion criteria:  $P > 0.10$ ).

**Abbreviations:** CVD, Cardiovascular diseases; CKD, chronic kidney disease.

**Table 4** HRQOL components of CKD patients by depressive symptoms

Variables	Total (N=1079)	Depressed (N=248)	Nondepressed (N=831)	P-value
GH	44.74±20.29	36.19±18.78	47.29±20.03	<0.001
PF	65.47±33.02	46.37±35.38	71.17±30.02	<0.001
RP	64.01±43.40	69.35±42.41	64.17±43.23	<0.001
BP	77.39±24.98	39.11±44.11	71.45±40.44	<0.001
RE	80.75±36.67	59.48±45.00	87.11±31.10	<0.001
MH	82.89±17.83	71.22±21.20	86.21±15.20	<0.001
VT	71.53±26.93	53.12±28.90	77.01±23.71	<0.001
SF	78.67±28.27	62.70±31.97	83.45±25.19	<0.001
PCS	49.97±9.13	44.72±9.79	51.54±8.31	<0.001
MCS	50.03±9.14	43.22±11.03	52.07±7.37	<0.001
Burden of kidney disease	55.38±25.32	39.32±24.18	60.18±23.64	<0.001
Symptoms and problems of kidney disease	88.69±10.36	81.24±13.40	90.92±8.02	<0.001
Effects of kidney disease	89.67±12.02	81.47±15.93	92.13±9.26	<0.001

**Notes:** The bold values were statistically significant with  $P < 0.05$ . Values were expressed as the mean  $\pm$  SD.

**Abbreviations:** GH, general health; PF, physical functioning; RP, role-physical; BP, bodily pain; RE, role-emotional; MH, mental health; VT, vitality; SF, social functioning; PCS, physical component summary; MCS, mental component summary.

**Table 5** Correlation and linear regression between GDS score and HRQOL subscales

	Correlation		Linear regression	
	r	P-value	B	P-value
PCS	-0.370	<0.001	-1.014	<0.001
MCS	-0.412	<0.001	-1.397	<0.001
Burden of kidney disease	-0.403	<0.001	-3.332	<0.001
Symptoms and problems of kidney disease	-0.360	<0.001	-1.264	<0.001
Effects of kidney disease	-0.355	<0.001	-1.667	<0.001

**Notes:** Predictors in the model: sex, age, BMI, diabetes, cardiovascular disease, proteinuria, eGFR and GDS score.

**Abbreviations:** PCS, physical component summary; MCS, mental component summary; GDS, Geriatric Depression Scale; HRQOL, health-related quality of life.

independently related to HRQOL following multiple regression analyses. The presence of depression may influence the patient's attention and interest in the management of the disease, leading to a deterioration of kidney function and HRQOL. Thus, early identification of depression and active interventions should be considered to reduce the burden of kidney disease and to relieve the symptoms and problems related to kidney disease.

There were also several limitations to this study. First, the analysis used a cross-sectional design, and therefore, longitudinal relationships between the factors and depression could not be established. Second, the patients who did not agree to participate or were excluded were actually older, had lower GFRs and had diabetes, which would

induce possible biases that might affect the results. Third, there was no drug information in the study: we did not account for the effects of medication on the prevalence of depression and on the relationships between depression and HRQOL.

While the study primarily explained the correlation between depression and HRQOL in a multicenter study in elderly Chinese CKD patients, more information will be reported after acquiring the follow-up data. Some treatments, including psychosocial interventions and aerobic exercise, were found to be effective in relieving depression.<sup>40,41</sup> The early identification of depression and active interventions should be considered to improve overall well-being and the HRQOL of these patients. Clinical trials evaluating whether treatment interventions benefit HRQOL in CKD patients with depression are warranted.

## Conclusion

The prevalence of depression in elderly CKD patients is high and correlates with kidney function and all aspects of HRQOL. The integration of depression and HRQOL assessment into routine clinical practice may be important and clinically beneficial for elderly Chinese CKD patients.

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## Disclosure

The authors report no conflicts of interest in this work.

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