ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 22(8): 5034-5041 (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 22(8)

Research Article

Received August 1, 2026; Revised August 31, 2026; Accepted August 31, 2026, Published August 31, 2026

DOI: 10.6026/973206300225034

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Edited by P Kangueane

Citation: Burubu *et al.* Bioinformation 22(8): 5034-5041 (2026)

Evaluation of quality of life among patients with chronic kidney disease on maintenance hemodialysis using the kidney disease quality of life–short form questionnaire

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ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(8): 5034-5041 (2026)

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Abstract:
Chronic kidney disease requiring maintenance hemodialysis is associated with substantial physical, psychological and social burden, leading to impaired quality of life. Therefore, it is of interest to assess the QoL among patients with CKD undergoing hemodialysis and evaluate its association with clinical, biochemical, oxidative stress, inflammatory and novel biomarkers. This hospital-based analytical case–control study included 450 participants. The demographic, clinical, laboratory, oxidative stress, inflammatory and molecular biomarkers were evaluated. Quality of life was assessed using the Kidney Disease Quality of Life–Short Form (KDQOL-SF™ 36). Hemodialysis patients showed significantly altered laboratory parameters, increased oxidative stress and elevated inflammatory and novel biomarkers compared with controls (all $p<0.001$). The overall KDQOL score was 60.5 ± 18.4, with the lowest scores observed in the physical component and burden of kidney disease domains. Quality of life is impaired in patients undergoing maintenance hemodialysis and is independently influenced by age, nutritional status, inflammation, oxidative stress and dialysis-related factors. Thus, early identification and targeted management of these modifiable factors may improve patient-centered outcomes.

Keywords: Chronic kidney disease (CKD), hemodialysis, quality of life (QoL), KDQOL-SF™-36, oxidative stress

Background:
Chronic kidney disease (CKD) is a major global public health problem characterized by the progressive and irreversible loss of kidney function, resulting in significant morbidity, mortality and healthcare expenditure **[1]**. The prevalence of CKD has increased steadily due to the rising burden of diabetes mellitus, hypertension, obesity and an aging population. Patients with advanced CKD often require renal replacement therapy; among which hemodialysis is the most commonly used treatment modality for end-stage renal disease (ESRD). Although hemodialysis prolongs survival, it is associated with numerous physical, psychological, social and economic challenges that substantially impair patients' quality of life **[2].** Patients undergoing maintenance hemodialysis frequently experience fatigue, sleep disturbances, chronic pain, pruritus, anemia, dietary restrictions, reduced physical functioning, depression, anxiety and financial stress **[3].** Regular dialysis sessions also interfere with employment, family responsibilities and social interactions, leading to reduced overall well-being. Consequently, assessment of quality of life has become an important outcome measure in the management of CKD, complementing traditional clinical and laboratory parameters **[4].** The Kidney Disease Quality of Life–Short Form (KDQOL-SF™ 36) questionnaire is a validated, disease-specific instrument designed to assess the multidimensional impact of kidney disease on patients receiving dialysis. It evaluates both generic health-related quality of life and kidney disease-specific domains, including physical and mental health, symptom burden, effects of kidney disease and the burden imposed by treatment. The KDQOL-SF™ 36 has been widely used in clinical practice and research to monitor patient-reported outcomes, identify areas requiring intervention and evaluate the effectiveness of therapeutic strategies **[5].** Understanding the quality of life of patients undergoing hemodialysis is essential for planning comprehensive patient-centered care and improving long-term outcomes. The present study was undertaken to assess the quality of life among patients with chronic kidney disease undergoing hemodialysis using the Kidney Disease Quality of Life–Short Form (KDQOL-SF™ 36) questionnaire and to evaluate the factors influencing their overall quality of life **[6].** Therefore, it is of interest to design the assessment of quality of life among patients with chronic kidney disease undergoing hemodialysis using the kidney disease quality of life–short form (KDQOL-SF™-36) questionnaire.

Methods:
This hospital-based analytical case–control study was conducted in the Department of Nephrology at a tertiary care teaching hospital over a period of 18 months after obtaining approval from the Institutional Ethics Committee. The study aimed to assess the quality of life among patients with chronic kidney disease (CKD) undergoing maintenance hemodialysis using the Kidney Disease Quality of Life–Short Form (KDQOL-SF™-36) questionnaire and to evaluate its association with clinical, biochemical, oxidative stress and inflammatory parameters. Written informed consent was obtained from all participants before enrolment and confidentiality of the collected data was maintained throughout the study. A total of 450 participants were included in the study, comprising 225 patients with CKD undergoing maintenance hemodialysis (cases) and 225 apparently healthy age- and sex-matched individuals (controls). The sample size was determined considering an expected moderate difference in quality-of-life scores between the groups, with a confidence level of 95%, study power of 80% and a case-to-control ratio of 1:1. Patients aged 18 years or older with established CKD receiving maintenance hemodialysis for at least three months and willing to provide written informed consent were included in the study. Patients with acute kidney injury,

active infection, malignancy, severe psychiatric illness, cognitive impairment preventing questionnaire completion, recent hospitalization within the preceding four weeks, or those unwilling to participate were excluded. Healthy volunteers without known renal disease, diabetes mellitus, hypertension, or other chronic systemic illnesses served as the control group. A detailed history was obtained from all participants using a predesigned and pretested case record form. Demographic characteristics including age and sex, duration of chronic kidney disease, duration and frequency of hemodialysis and associated comorbidities such as diabetes mellitus and hypertension were recorded. A through general physical examination and systemic examination were performed. Venous blood samples were collected under aseptic precautions for routine laboratory investigations, including haemoglobin, fasting blood glucose, postprandial blood glucose, glycated haemoglobin (HbA1c), blood urea, serum creatinine, uric acid, total protein, albumin, lipid profile, calcium, phosphorus, iron profile, ferritin, C-reactive protein (CRP) and complete blood count. Urine samples were analyzed for protein, creatinine and protein-to-creatinine ratio whenever applicable. Oxidative stress biomarkers including glutathione peroxidase (GPx), catalase, malondialdehyde (MDA), reduced glutathione (GSH) and 8-hydroxy-2'-deoxyguanosine (8-OHdG) were estimated using standardized laboratory methods. Novel biomarkers such as TMEM72 expression and circulating microRNA levels were also measured using validated molecular techniques. Quality of life among patients undergoing hemodialysis was assessed using the Kidney Disease Quality of Life–Short Form (KDQOL-SF™-36) questionnaire. The questionnaire evaluates both generic and kidney disease-specific domains, including the Physical Component Summary (PCS), Mental Component Summary (MCS), burden of kidney disease, symptoms/problems and effects of kidney disease. Domain scores and the overall KDQOL score were calculated according to the standard scoring manual, with higher scores showing better perceived quality of life. The primary outcome of the study was the overall KDQOL-SF™ 36 score among patients undergoing maintenance hemodialysis. Secondary outcomes included comparison of demographic, clinical, laboratory, oxidative stress, inflammatory and novel biomarker profiles between cases and controls; evaluation of the association of clinical and biochemical variables with quality-of-life scores; assessment of correlations between quality of life and selected laboratory parameters; and identification of independent predictors of poor quality of life using multivariable regression analysis. All data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Comparisons between hemodialysis patients and healthy controls were performed using the independent Student's *t*-test for normally distributed continuous variables and the Chi-square test for categorical variables. Associations between quality-of-life scores and categorical clinical variables were analyzed using the independent Student's *t*-test. Pearson's correlation coefficient was used to evaluate the relationship between overall quality-of-life scores and continuous clinical and laboratory variables. Variables showing statistical significance or clinical relevance on univariate analysis were entered into a multiple linear regression model to identify independent predictors of poor quality of life. Model fitness was assessed using the coefficient of determination (R^2), adjusted R^2 and F-statistic. A two-tailed *p*-value of less than 0.05 was considered statistically significant.

Results:

Table 1 shows that Hemodialysis patients were significantly older than controls (47.7 ± 12.7 vs. 40.0 ± 14.2 years, $p<0.001$). The hemodialysis group had a significantly higher prevalence of diabetes mellitus (49.8% vs. 24.0%) and hypertension (74.7% vs. 27.6%) compared with controls (both $p<0.001$). Patients underwent a mean of 10.8 ± 2.6 dialysis sessions per month. **Table 2** shows that Hemodialysis patients had significantly lower haemoglobin, albumin and total protein levels, while serum urea, creatinine, uric acid and C-reactive protein (CRP) levels were markedly higher than those of healthy controls (all $p<0.001$), indicating impaired renal function, inflammation and poor nutritional status. As shown in **Table 3**, Hemodialysis patients significantly reduced antioxidant enzyme levels, including glutathione peroxidase, catalase and reduced glutathione (GSH), whereas malondialdehyde (MDA), 8-hydroxy-2'-deoxyguanosine (8-OHdG), TMEM72 and miRNA expression were significantly elevated compared with controls (all $p<0.001$), reflecting increased oxidative stress and cellular injury. **Table 4** summarizes the Kidney Disease Quality of Life (KDQOL-SF™ 36) scores among patients on hemodialysis. The highest mean score was observed in the Symptoms/Problems domain (65.7 ± 12.6), whereas the Physical Component Summary (45.3 ± 10.4) and Burden of Kidney Disease (48.9 ± 13.5) showed comparatively lower scores. The overall mean KDQOL score was 60.5 ± 18.4. **Table 5** shows the association between clinical characteristics and quality of life. Male patients had significantly better quality-of-life scores than females ($p=0.041$). Patients without diabetes, those with hemoglobin ≥10 g/dL, albumin ≥3.5 g/dL and dialysis duration of less than two years had significantly higher quality-of-life scores than their respective counterparts (all $p<0.05$). **Table 6** presents the correlation between quality-of-life scores and clinical variables. Increasing age ($r = -0.474$, $p<0.001$) and higher serum urea levels ($r = -0.180$, $p=0.007$) showed significant negative correlations with quality of life, while no significant correlations were observed with dialysis frequency, hemoglobin, creatinine, albumin, CRP, ferritin, MDA, GSH, or protein-creatinine ratio. **Table 7** shows the multiple linear regression analysis identifying independent predictors of quality of life in hemodialysis patients. Older age, elevated CRP, increased MDA levels and higher dialysis frequency were independently associated with poorer quality of life, whereas higher hemoglobin and albumin levels were significant positive predictors of better quality of life. The regression model explained 46% of the variance in quality-of-life scores ($R^2 = 0.46$, adjusted $R^2 = 0.44$; $p<0.001$).

Table 1: Baseline demographic and clinical characteristics of study participants

Variable	Hemodialysis Patients (n=225)	Controls (n=225)	P value
Age (years), Mean ± SD	47.7 ± 12.7	40.0 ± 14.2	<0.001
Male, n (%)	137 (60.9)	158 (70.2)	0.037
Female, n (%)	88 (39.1)	67 (29.8)	--
Number of dialysis sessions/month	10.8 ± 2.6	NA	NA
Diabetes mellitus, n (%)	112 (49.8)	54 (24.0)	<0.001
Hypertension, n (%)	168 (74.7)	62 (27.6)	<0.001

Statistical tests: Independent Student's t-test and Chi-square test.

Table 2: Comparison of laboratory parameters between hemodialysis patients and controls

Variable	Cases Mean ± SD	Controls Mean ± SD	P value
Hemoglobin (g/dL)	9.08 ± 2.49	13.91 ± 1.20	<0.001
Urea (mg/dL)	94.16 ± 56.90	20.16 ± 5.29	<0.001
Creatinine (mg/dL)	6.52 ± 4.97	0.73 ± 0.16	<0.001
Uric acid (mg/dL)	8.18 ± 2.14	5.17 ± 1.13	<0.001
Albumin (g/dL)	3.40 ± 0.74	4.04 ± 0.67	<0.001
Total protein (g/dL)	6.45 ± 0.99	7.15 ± 0.59	<0.001
CRP (mg/L)	53.2 ± 66.6	2.4 ± 0.7	<0.001

Statistical test: **Independent Student's t-test.**

Table 3: Comparison of oxidative stress and novel biomarkers

Variable	Cases Mean ± SD	Controls Mean ± SD	P value
Glutathione Peroxidase (U/L)	41.1 ± 34.7	119.8 ± 37.6	<0.001
Catalase (U/mL)	7.39 ± 4.48	15.96 ± 3.37	<0.001
MDA (nmol/mL)	80.7 ± 15.5	24.5 ± 7.9	<0.001
GSH (µmol/L)	11.5 ± 11.8	76.1 ± 20.5	<0.001
8-OHdG (ng/mL)	278.8 ± 116.0	152.4 ± 58.6	<0.001
TMEM72	328.3 ± 125.4	120.0 ± 21.6	<0.001
miRNA (Relative expression)	2.82 ± 1.16	1.00 ± 0.34	<0.001

Table 4: Kidney disease quality of life (KDQOL-SF™-36) scores among hemodialysis patients

Domain	Mean ± SD
Physical Component Summary (PCS)	45.3 ± 10.4
Mental Component Summary (MCS)	53.2 ± 11.1
Burden of Kidney Disease	48.9 ± 13.5
Symptoms/Problems	65.7 ± 12.6
Effects of Kidney Disease	54.2 ± 11.8
Overall KDQOL Score	60.5 ± 18.4

Table 5: Association between clinical variables and quality of life of patients on hemodialysis

Variable	QoL Score Mean ± SD	P value
Male	62.8 ± 17.2	0.041
Female	57.1 ± 19.6	
Diabetes	54.6 ± 17.9	<0.001
No diabetes	66.2 ± 16.8	
Hb <10 g/dL	53.8 ± 17.5	<0.001
Hb ≥10 g/dL	68.7 ± 15.2	
Albumin <3.5 g/dL	52.6 ± 18.1	<0.001
Albumin ≥3.5 g/dL	67.4 ± 15.9	
Dialysis <2 years	64.9 ± 16.5	0.018
Dialysis ≥2 years	57.0 ± 19.1	

Table 6: Correlation of quality of life score of patients on hemodialysis with clinical and laboratory variables

Variable	Pearson's r Value	P value
Age	-0.474	<0.001
Number of dialysis	0.049	0.461
Hemoglobin	-0.092	0.170
Urea	-0.180	0.007
Creatinine	-0.102	0.126
Albumin	-0.031	0.648
CRP	-0.024	0.719
Ferritin	0.004	0.951
MDA	-0.005	0.939
GSH	0.098	0.144
Protein-Creatinine Ratio	-0.179	0.170

Table 7: Multiple linear regression analysis showing independent predictors of poor quality of life of patients on hemodialysis

Variable	β Coefficient	95% Confidence Interval	P value
Age	-0.312	-0.52 to -0.18	<0.001
Hemoglobin	0.184	0.09 to 0.46	0.011
Albumin	0.276	1.95 to 6.84	<0.001
CRP	-0.198	-0.15 to -0.03	0.008
MDA	-0.214	-0.11 to -0.04	0.004
Dialysis frequency	-0.148	-0.92 to -0.11	0.036

Model statistics: $R^2 = 0.46$, Adjusted $R^2 = 0.44$, $F = 26.8$, $p < 0.001$.

Discussion:

In the present study, patients undergoing hemodialysis (HD) for chronic kidney disease (CKD) showed significantly impaired health-related quality of life (HRQoL) compared to matched controls, as assessed by the Kidney Disease Quality of Life–Short Form (KDQOL-SF™ 36) questionnaire. Our cohort of 225 HD patients (mean age 47.7 ± 12.7 years, 60.9% male, with high comorbidity burden: 49.8% diabetes mellitus and 74.7% hypertension). These findings are similar to multiple international studies reporting reduced HRQoL scores among HD patients. In a large US dialysis population normative study by Greenwood *et al.*, (using KDQOL-36 data from over 58,000 patients), mean Physical Component Summary (PCS) scores were approximately 37.8 (T-score metric), with kidney disease-specific domains such as Burdens of Kidney Disease around 52.8 and Effects of Kidney Disease around 74.1 (0–100 scale). Our HD patients similarly showed compromised physical functioning relative to controls, showing the physical toll of frequent dialysis sessions (mean 10.8 ± 2.6 per month in our study) and comorbidities **[5]**. A Saudi study by Brown *et al.* (2021), Ajeebi *et al.* (2020) involving 254 HD patients (mean age 58.2 years, 61% male, 56.7% diabetic) reported mean PCS of 49.4 ± 16.5 and MCS of 38.7 ± 28.7, with the lowest scores in the "effects of kidney disease" subscale (37.2 ± 31.3). Notably, their MCS was significantly lower than PCS, a pattern often mirrored in HD populations where mental health burdens (*e.g.,* emotional adjustment to chronic illness) compound physical limitations. In our study, the higher prevalence of hypertension and diabetes compared to controls ($p<0.001$) likely contributed to analogous impairments, as these comorbidities are established negative predictors of QoL **[7, 8].** In a meta-analysis synthesizing data from 147 studies (over 623,000 dialysis patients), the pooled total HRQoL score using KDQOL was 64.25 (95% CI 55.67–72.82), with HD patients scoring around 60.52 overall; physical health domains were generally lower than mental health domains on SF-36 components. Our findings corroborate this, with HD patients showing statistically significant differences from controls in baseline characteristics that are known to exacerbate QoL decline (*e.g.,* older age and higher comorbidity load, $p<0.001$). Similarly, an Iranian study of 203 HD patients reported mean PCS and MCS of 42.3 each; with socio-economic factors (education, insurance) and dialysis duration influencing scores **[9, 10].** In an Albanian multicentre study, HD patients had mean

PCS of 34.17 ± 12.99 and MCS of 47.52 ± 13.95, with females, older individuals and those with multiple comorbidities reporting the lowest overall scores patterns similar to our demographic influences. Ugandan data from 124 HD patients showed even lower scores (PCS ~33.14, MCS ~38.01, kidney disease domain ~35.16), showing global disparities potentially linked to healthcare access **[11, 12].** Our study's younger mean age (47.7 years) compared to some reports (*e.g.,* 58.2 in Saudi Arabia) show relatively preserved scores in certain domains, yet the significant age difference versus controls ($p<0.001$) and high comorbidity rates still drove QoL reductions. Study shows older age, female sex (in some cohorts), diabetes, longer dialysis vintage and unemployment as negative predictors. The higher male proportion in our HD group (60.9%) and controls is similar to many studies, though gender effects on subscales vary **[7, 8 and 12].** In the present study, Hemoglobin levels were substantially lower in cases than in controls ($p< 0.001$), alongside significantly elevated urea, creatinine, uric acid and CRP with reduced albumin and total protein (all $p < 0.001$). Similar findings were reported by Zhang *et al.* and Boric-Skaro *et al.*, with hemodialysis cohorts showing hemoglobin around 10–11 g/dL versus normal controls. Elevated urea, creatinine and uric acid show inadequate clearance and residual renal dysfunction, similar to pre-dialysis values in Ethiopian and other cohorts where urea often exceeds 80–100 mg/dL and creatinine 6–8 mg/dL before sessions. Hypoalbuminemia and elevated CRP show malnutrition-inflammation complex, which correlates with poorer clinical outcomes **[13, 14].** Hemodialysis patients typically show impaired HRQoL, particularly in physical domains, relative to the general population and even other chronic illness groups. Our findings of compromised QoL are similar to normative US dialysis data from Greenwood *et al.*, where mean Physical Component Summary (PCS) was 37.8 and Mental Component Summary (MCS) 50.9 (T-score metric), with kidney-specific scales showing Burden of Kidney Disease (BKD) at 52.8, Symptoms and Problems of Kidney Disease (SPKD) 79.0 and Effects of Kidney Disease (EKD) 74.1 **[5].** In Saudi Arabia, Ajeebi *et al.* (2020) reported mean PCS of 49.4 ± 16.5 and MCS of 38.7 ± 28.7 among 254 hemodialysis patients using KDQOL-SF36, with the lowest scores in effects of kidney disease (notably lower MCS than PCS, $p=0.0001$), similar to the physical and emotional burdens observed in our cohort. Afternoon-shift patients and employed individuals scored higher, showing the role of scheduling and socio-economic factors **[8].** Similarly, a large US study of over 240,000 patients found mean PCS 36.6, MCS 49.0, BKD 51.3, SPKD 78.1 and EKD 73.0, showing persistently low physical functioning across dialysis populations **[15].** Yang *et al.* showed that dialysis patients (HD and PD) have lower SF-36/KDQOL scores than renal transplant recipients, with point differences of 2–32 across domains (attenuated but persistent after adjusting for age and diabetes) **[16].** The HD patients often score lower in physical domains compared to PD in some studies (*e.g.,* PCS differences favoring PD), though results vary by region and tool. A broad meta-analysis reported overall KDQOL, HRQoL around 64.25, with physical health scores generally lower than mental health **[10, 17 and 18].** Anemia, hypoalbuminemia and inflammation (high CRP) correlate with lower PCS, vitality and physical functioning scores, as seen in Indonesian and Iranian cohorts where lower hemoglobin and albumin predicted poorer HRQoL. Burden of kidney disease and effects subscales are particularly sensitive to these parameters and treatment-related restrictions **[9, 19].** The present study shows profound oxidative stress and dysregulation of novel biomarkers in hemodialysis patients with CKD compared to healthy controls. Conversely, markers of oxidative damage were elevated. Multiple studies report similar imbalances. In Saudi hemodialysis patients, GPx and superoxide dismutase (SOD) activities were significantly lower, while MDA levels were higher both pre- and post-dialysis compared to controls, with negative correlations between antioxidant enzymes and MDA. Marques *et al.,* Vida *et al.* and Qian *et al.* observed decreased catalase and GSH alongside increased oxidative markers (*e.g.,* TBARS) in post-hemodialysis patients versus controls. Elevated 8-OHdG, showing DNA oxidative damage and lipid peroxidation (MDA) are similar to broader ESRD study, where these markers correlate with cardiovascular risk and disease severity **[20-22].** Novel biomarkers further show uremic toxicity. Up regulated miRNA expression is similar to studies showing hemodialysis alters circulating miRNA profiles, potentially disrupting pathways related to inflammation, fibrosis and cell cycle regulation. TMEM72 elevation is less commonly reported but fits emerging evidence of novel proteins linked to renal injury and oxidative stress in CKD **[23, 24].** These biochemical disturbances have direct implications for health-related quality of life (HRQoL) as assessed by the KDQOL-SF™ 36 in our study. Oxidative stress and inflammation contribute to fatigue, muscle wasting, cognitive impairment and cardiovascular morbidity key drivers of impaired physical and mental domains. Our laboratory findings (low antioxidants, high MDA/8-OHdG) parallel reports linking oxidative burden to worse PCS and kidney-specific subscales (*e.g.,* symptoms, effects of kidney disease). A study associating oxidative stress markers (TBARS, GSSG/GSH ratio) with KDQOL-SF-12 scores in hemodialysis patients found significant correlations with physical functioning, general health and emotional problems **[25].** This is similar to normative dialysis data (Raoofi *et al.*, 2019: PCS ~37.8, MCS ~50.9) and regional studies (*e.g.,* Bhandari *et al.*, 2023: PCS 49.4, MCS 38.7), where physical domains are particularly compromised. Systemic reviews confirm overall KDQOL scores around 60–64 in dialysis populations, with physical health consistently lower than mental health. Elevated CRP and oxidative markers (as seen in our prior laboratory data) independently predict poorer QoL across domains **[10, 26].** Similarly, Our PCS score (45.3) was higher than normative values reported for the US dialysis population (37.8) by Greenwood (2021) *et al.* and many other international cohorts, such as 36.6 in a large US study of over 240,000 patients and approximately 37–40 in various HD cohorts **[5].** It was also higher than scores in southern Iran (42.3) and other resource-limited settings. However, it aligns more closely with some regional studies, such as 49.4 reported in a Saudi Arabian HD cohort **[8, 9 and 15]**. The MCS score in our study ***(53.2)*** was

slightly higher than US normative dialysis values (50.9) and many other reports (*e.g.,* around 49 in large US data and 47.8–48 in Iranian and Indonesian studies), showing relatively better mental well-being perception in our population. This pattern of higher MCS relative to PCS is similar to broader study on dialysis patients, where mental adaptation may occur despite physical limitations **[5, 10, 15 and 16].** For kidney disease–specific domains, our Burden of Kidney Disease score (48.9) was similar to the US normative value of 52.8 Greenwood *et al.*, Ajeebi *et al.* and scores around 49–52 in other studies. Our Symptoms/Problems score (65.7) was lower than the US normative 79.0 and many reported values (often 75–80+), showing greater symptom burden in our patients. The Effects of Kidney Disease score (54.2) was substantially lower than US norms (74.1) and other reports (often 70+), showing a stronger perceived impact on daily life **[5, 8].** Our overall KDQOL score (60.5) is close to meta-analysis findings for HD patients (*e.g.,* 60.52 in one large synthesis) and shows the typical moderate impairment seen in dialysis populations **[10]**. Comparisons with other study show variability influenced by geographic, socioeconomic and clinical factors. A Saudi study reported higher PCS (49.4) but markedly lower MCS (38.7), contrasting our balanced profile. Systematic reviews and meta-analyses consistently show dialysis patients have lower HRQoL than transplant recipients, with physical domains more affected and modest differences between HD and PD that are partly explained by demographics like age and diabetes **[8, 16]**. In the present study, several clinical and demographic variables showed significant associations with overall KDQOL-SF™ 36 scores among hemodialysis patients. Similar to our results, male gender was associated with better HRQoL in multiple studies. For example, in a Saudi Arabian cohort using KDQOL-36, males had significantly higher PCS and Effects of Kidney Disease scores ($p<0.001$ and $p=0.02$, respectively). A multi-center study in Southern Albania similarly reported females had significantly lower PCS, MCS, KDCS and overall scores ($p<0.05$ to <0.0001) **[5]**. Diabetes was a strong negative predictor in our study, corroborating reports by Ajeebi *et al.* (in the DOPPS study) and others, where diabetes and associated comorbidities were independently linked to lower PCS, MCS and kidney disease–targeted scales. A Saudi study also found non-diabetic patients had higher PCS ($p=0.006$) **[8]**. Our data show the critical role of anemia and nutritional status. Lower hemoglobin (<10 g/dL) was associated with substantially reduced QoL, similar to evidence linking higher hemoglobin levels to improved physical functioning, energy/fatigue and overall HRQoL. Studies have shown positive correlations between hemoglobin and KDQOL domains, with anemia identified as a key modifiable factor. Similarly, hypoalbuminemia (<3.5 g/dL) correlated with poorer QoL in our cohort, mirroring findings across study where higher albumin levels were positively associated with better physical functioning and overall scores, showing nutritional status and inflammation **[27-29]**. Regarding dialysis vintage, our observation of better QoL in patients with <2 years on dialysis contrasts with some reports of adaptation over time but is similar to others noting initial burdens or cumulative effects of prolonged dialysis. One Iranian study linked dialysis duration ≥5 years to lower scores, while meta-regression has shown mixed or positive trends with longer vintage in certain contexts **[9, 10]**. The present study examined correlations between overall KDQOL-SF™ 36 scores and various clinical and laboratory variables in hemodialysis patients. A strong negative correlation was observed with age, showing substantially lower. These results are similar to multiple studies, including those by the DOPPS group and regional cohorts, report significant negative correlations between age and physical domains or overall scores, with older patients showing lower PCS and functional scores due to increased comorbidity burden and frailty. Meta-regression analyses have quantified this effect, showing that each additional year of age is associated with a decline in QoL scores **[7, 10 and 30]**. The negative correlation with urea in our study shows that higher azotaemia may contribute to symptom burden and poorer perceived QoL, aligning with reports linking uremic toxins and metabolic parameters to reduced HRQoL domains (*e.g.,* symptoms and physical functioning). However, the lack of strong correlations with hemoglobin and albumin contrasts with some prior findings where higher levels of these markers were positively associated with better physical and overall scores, potentially due to differences in patient characteristics, anemia management, or nutritional status in our cohort **[26, 31]**. Non-significant correlations with CRP and oxidative stress markers (MDA, GSH) in our data may show that inflammation and oxidative stress exert more indirect or domain-specific effects rather than broad impacts on overall KDQOL scores, or that other unmeasured factors predominate. This partially diverges from studies where elevated CRP was linked to worse QoL, particularly physical and mental components **[5]**. Multiple linear regression analysis identified older age, lower hemoglobin, lower serum albumin, higher C-reactive protein (CRP), higher malondialdehyde (MDA) and lower dialysis frequency as significant independent predictors of poor quality of life among patients undergoing hemodialysis ($p < 0.05$). Similar to multiple prior studies, older age emerged as a strong negative predictor of QoL in our cohort. In a Saudi Arabian study of 100 HD patients using KDQoL-SF and SF-36, multiple linear regressions showed age as the most influential negative predictor of total QoL score, alongside dialysis duration and male sex, with the model explaining 45% of variance remarkably similar to our R^2 value. Another cross-sectional analysis in Spain (n=155) using KDQOL-36 found that age, together with resilience, explained up to 26.8% of variance in total KDQOL-36 scores. Similarly, studies in China and elsewhere have reported negative correlations between age and KDQOL-36 subscales, with older patients experiencing greater burden of kidney disease and poorer physical/mental component summaries. These likely shows accumulated comorbidities reduced physiological reserve and psychosocial challenges in older individuals **[7, 28 and 32].** Nutritional and anemia-related markers also showed significant associations in our study. Higher serum albumin was positively associated with better QoL, similar to evidence linking hypoalbuminemia to malnutrition-inflammation complex and poorer outcomes. A

study of HD patients reported positive associations between hemoglobin, albumin and HRQoL scores, with systemic inflammation (*e.g.,* CRP) exerting negative effects (CRP β = -0.361, p < 0.001 in one analysis). Our findings on hemoglobin (positive predictor) are similar to research showing higher hemoglobin levels associated with reduced kidney disease burden (*e.g.,* β=3.45, p=0.006), though some large trials like PIVOTAL noted hemoglobin was not always an independent predictor after multivariable adjustment **[26, 31 and 33]**. Inflammation (higher CRP) and oxidative stress (higher MDA) were negative predictors in our regression, reinforcing the role of the malnutrition-inflammation-atherosclerosis syndrome in CKD. This is similar to the PIVOTAL trial post-hoc analysis, where higher CRP levels were associated with worse QoL across EQ5D and KDQOL domains, independent of hemoglobin in some models. MDA, as a marker of lipid peroxidation, adds a novel oxidative stress dimension less commonly quantified in QoL regressions but mechanistically linked to endothelial dysfunction and fatigue in dialysis patients **[26]**. Dialysis frequency as a predictor (negative β for lower frequency) shows that more frequent sessions may mitigate uremic burden and improve QoL, aligning with studies showing positive correlations between dialysis frequency and QoL scores and negative associations with longer dialysis duration or inadequate sessions **[34]**.

Conclusion:

We show that patients with chronic kidney disease undergoing maintenance hemodialysis had significantly poor quality of life than healthy individuals. Quality of life was adversely affected by older age, diabetes mellitus, anemia, hypoalbuminemia and longer duration of dialysis. Hemodialysis patients also exhibited significantly higher inflammatory and oxidative stress markers compared with controls. Older age, lower hemoglobin and albumin levels, elevated CRP, increased MDA levels and higher dialysis frequency were identified as significant independent predictors of poor quality of life.

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ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(8): 5034-5041 (2026)

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