Cognitive Dysfunction and Health-Related Quality of Life in Patients with End-Stage Renal Disease Undergoing Hemodialysis in Comparison with Patients Undergoing Peritoneal Dialysis: A Cross-Sectional Study

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Background: This study compared the effects of peritoneal dialysis and hemodialysis on cognitive dysfunction and health-related quality of life (HRQOL) in end-stage renal disease (ESRD) patients and analyzed other potential influencing factors.

Material/Methods: A total of 265 patients who received dialysis at our hospital were included and divided into the hemodialysis group (n=115) and the peritoneal dialysis group (n=150). The cognitive performance was assessed by the Beijing version of the Montreal Cognitive Assessment. The Kidney Disease Quality of 36-Item Short Form Survey and a kidney disease-related quality of life assessment were used for evaluating HRQOL. Univariate and multivariate linear regression analyses were used to explore the effects of dialysis on cognitive dysfunction and HRQOL.

Results: As compared with the hemodialysis group, the peritoneal dialysis group had lower scores on the Montreal Cognitive Assessment ($b=-8.35, 95\% \text{CI:} -9.85$ to $-6.86$), 36-Item Short Form Survey ($b=-10.20, 95\% \text{CI:} -11.94$ to $-8.45$), and kidney disease-related quality of life assessment ($b=-8.67, 95\% \text{CI:} -10.10$ to $-7.23$). After adjustment for sex, age, BMI, marital status, educational level, income level, presence of diabetes, duration of kidney disease, duration of dialysis, and dialysis frequency, the results were consistent with that of the crude model.

Conclusions: In the present study, patients receiving peritoneal dialysis had worse cognitive dysfunction and worse HRQOL compared to patients receiving hemodialysis, which might lead to poorer outcomes of ESRD patients. The related factors affecting cognitive dysfunction and HRQOL were also explored, which could help clinicians to determine the optimal treatment for ESRD patients.

Keywords: Cognitive Dysfunction • Peritoneal Dialysis • Renal Dialysis

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Background

End-stage renal disease (ESRD), occurring at the final stage of chronic kidney disease, is a progressive chronic disease that requires nursing and medical interventions, including dialysis, lifestyle changes, and dietary restriction [1]. Over the past few decades, ESRD has imposed great health and economic burdens worldwide, especially in developing countries [2]. Currently, there are 3 main medical treatment modalities for ESRD: kidney transplantation, hemodialysis, and peritoneal dialysis. Although kidney transplantation is the ideal renal replacement therapy to restore the physical function of ESRD patients, most patients still need to rely on dialysis therapy to sustain their lives due to the shortage of organ donors [1].

Studies have shown that ESRD patients have a higher prevalence of cognitive dysfunction, with a higher risk for hospitalization and mortality [3,4]. It is estimated that about 60-90% of ESRD patients receiving dialysis have cognitive dysfunction [5,6]. In addition, dialysis was also reported to have an impact on the health-related quality of life (HRQOL) of ESRD patients, with worse symptoms of fatigue, muscle weakness, decreased physical function, and increased risk of depression compared to the general population [7]. Recently, the effects of these 2 dialysis modalities on cognitive dysfunction and HRQOL in ESRD patients have been investigated but produced no uniform conclusions. Neumann et al demonstrated that patients receiving peritoneal dialysis showed better cognitive function compared with those receiving hemodialysis [8]. Two meta-analyses also suggested that patients undergoing hemodialysis had relatively worse cognitive dysfunction and may have a higher risk of dementia [4,9]. Regarding the HRQOL of patients, some studies suggested that patients receiving peritoneal dialysis had better HRQOL than those receiving hemodiagnosis [10-12], while some other studies found no notable differences between the 2 dialysis modalities [13,14]. The present study compared the effects of peritoneal dialysis and hemodialysis on cognitive dysfunction and HRQOL in ESRD patients and analyzed potential factors influencing affecting ESRD in patients receiving dialysis, thereby helping clinicians to explore the optimal treatment for ESRD and improve the outcomes.

Material and Methods

Study Selection and Data Collection

This cross-sectional study included a total of 265 patients who received hemodialysis or peritoneal dialysis in the Second People’s Hospital of Shantou from January 2017 to December 2019. The eligible patients were divided into the hemodialysis group and the peritoneal dialysis group. The inclusion criteria were as follows: (1) age ≥18 years old; (2) ESRD patients who have undergone regular hemodialysis or peritoneal dialysis for more than 3 months; (3) reading comprehension ability sufficient to read and complete questionnaires; (4) complete clinical data. The exclusion criteria were: (1) degenerative brain diseases, cerebrovascular disease, brain inflammation, and traumatic brain injury that could cause organic encephalopathy; (2) mental disorders such as depression and dementia; (3) coronary artery disease, autoimmune diseases, malignant tumors, liver disease, or other metabolic diseases; (4) severe infections including pulmonary, gastrointestinal and abdominal infections, and bacteremia; (5) alcohol abuse or uncontrolled hypertension (systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg); (6) received antibiotics, cytotoxic drugs, anti-histamines, blood transfusions, corticosteroids or other drugs that could affect the neuropsychological function within 3 months before enrollment; (7) poor peritoneal or vascular access for dialysis; (8) patients who were considered not suitable for this study by their physician in charge. The inclusion and exclusion criteria were consistent with methods used in the published literature [15,16]. Verbal informed consent was obtained from the eligible patient or their next of kin. This study was approved by the Ethics Committee of the Second People’s Hospital of Shantou (registration number 2020002).

After enrollment were collected demographic data (eg, age, sex, nationality, body mass index (BMI), marital status, education level, and income level) and clinical data (eg, comorbid hypertension and diabetes mellitus, duration of renal disease, and duration and frequency of dialysis). We recorded the results of laboratory tests, including blood routine examination, liver function, renal function, blood pressure, blood lipid, electrolyte, parathyroid function, and inflammatory markers. In addition, the results of the Montreal Cognitive Assessment (MoCA) test and the Kidney Disease Quality of Life-Short Form (KDQOL-SF™ 1.2) scale were recorded.

Cognitive Dysfunction and HRQOL Assessment

In the present study, cognitive performance of patients was assessed by the Beijing version of the MoCA scale, which examined 7 domains: visuospatial/executive function, naming, attention, abstraction, language, delayed memory, and orientation. The MoCA scale has a total of 30 points, and a score of ≤25 points is defined as cognitive dysfunction [17].

For evaluating the HRQOL of patients, we used the KDQOL-SF™ 1.2 scale, which consists of 2 parts: a 36-item Short Form Survey (SF-36) and a kidney disease-related quality of life (KD Ta) assessment. SF-36 included analyses of physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, mental health, and reported

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| Table 1. Baseline characteristics of all eligible patients. |
|-------------------------------|-----------------|-----------------|-----------------|
| Variable, n (%)               | Total            | Hemodialysis (n=115) | Peritoneal dialysis (n=150) |
| Gender                        |                  |                  |                  |
| Male                          | 126 (47.55)      | 71 (61.74)       | 55 (36.67)       |
| Female                        | 139 (52.45)      | 44 (38.26)       | 95 (63.33)       |
| Age, mean±SD                  | 56.45±12.12      | 53.96±12.99      | 58.35±11.07      |
| BMI, mean±SD                  | 21.41±2.85       | 20.82±2.71       | 21.86±2.88       |
| Marital status                |                  |                  |                  |
| Married                       | 245 (92.45)      | 101 (87.83)      | 144 (96.00)      |
| Unmarried                     | 20 (7.55)        | 14 (12.17)       | 6 (4.00)         |
| Educational level             |                  |                  |                  |
| Primary education             | 106 (40.00)      | 31 (26.96)       | 75 (50.00)       |
| Secondary education           | 131 (49.43)      | 74 (64.35)       | 57 (38.00)       |
| Higher education              | 28 (10.57)       | 10 (8.70)        | 18 (12.00)       |
| Income level                  |                  |                  |                  |
| Low                           | 41 (15.47)       | 30 (26.09)       | 11 (7.33)        |
| Middle                        | 192 (72.45)      | 60 (52.17)       | 132 (88.00)      |
| High                          | 32 (12.08)       | 25 (21.74)       | 7 (4.67)         |
| Hypertension                  |                  |                  |                  |
| No                            | 195 (73.58)      | 86 (74.78)       | 109 (72.67)      |
| Yes                           | 70 (26.42)       | 29 (25.22)       | 41 (27.33)       |
| Diabetes                      |                  |                  |                  |
| No                            | 177 (66.79)      | 83 (72.17)       | 94 (62.67)       |
| Yes                           | 88 (33.21)       | 32 (27.83)       | 56 (37.33)       |
| Duration of kidney disease, M(Q1,Q3), years | 13.00 (10.00, 17.00) | 11.00 (10.00, 15.00) | 14.00 (11.00, 18.00) |
| Duration of dialysis, M(Q1,Q3), months | 15.00 (9.00, 36.00) | 15.00 (8.00, 27.00) | 15.00 (11.00, 40.00) |
| Dialysis frequency, weeks    |                  |                  |                  |
| ≤2                            | 56 (21.13)       | 56 (48.70)       | 0 (0.00)         |
| ≥3                            | 209 (78.87)      | 59 (51.30)       | 150 (100.00)     |
| MoCA, M (Q1, Q3)              | 19.00 (14.00, 27.00) | 27.00 (22.00, 28.00) | 15.00 (12.00, 20.00) |
| SF-36, M (Q1, Q3)             | 20.30 (14.12, 30.85) | 31.63 (23.55, 32.96) | 17.41 (12.64, 20.93) |
| KDTA, Mean ± SD               | 24.61±7.27       | 29.52±7.05       | 20.85±4.79       |

BMI – body mass index; MoCA – Montreal Cognitive Assessment; SF-36 – Short Form-36; KDTA – kidney disease-related quality of life assessment.
health transition. The KDTA included a symptoms/discomfort list, effects of kidney disease, burden of kidney disease, work status, cognitive function, quality of social interaction, sexual function, sleep, and social support. For the assessment of HRQOL, the scores were summed, with a total score of 100 points, and compared between groups, with a higher score indicating a better HRQOL [18].

### Power Analysis and Sample Size Determination

The G*Power software and the existing sample size were used for power analysis to test the efficiency of multiple regression model. The results showed that the statistical power value was >0.999 among the main variables in this study, including MoCA, SF-36, and KDTA, indicating that the sample size was able to support the results of the multiple regression model.

### Statistical Analysis

The two-sided test was used in all statistical tests, and \( P<0.05 \) was considered statistically significant. All statistical analyses were performed using SAS9.4 software (SAS Institute, Inc., Cary, NC, USA). Normally distributed measurement data were described as mean±standard deviation (Mean±SD), and the independent samples t test was used for comparison between groups; data with non-normal distribution were described as the median and interquartile range [M (Q1, Q3)], and the Mann-Whitney U test was used for comparisons between groups. Enumeration data were described as the number of cases and the constituent ratio [N (%)], and the \( \chi^2 \) test or the Fisher’s exact test was used for comparison. Baseline variables with statistical significance were identified by univariate analysis and then included in the multivariate linear

| Variable                              | \( \beta \) | S.E  | \( t \)  | \( P \)  | 95% CI Lower | 95% CI Upper |
|---------------------------------------|-------------|------|---------|---------|--------------|--------------|
| Gender                                |             |      |         |         |              |              |
| Male                                  | Ref         |      |         |         |              |              |
| Female                                | -3.95       | 0.88 | -4.51   | <.001   | -5.68        | -2.23        |
| Age, years                            | -0.24       | 0.04 | -6.82   | <.001   | -0.30        | -0.17        |
| BMI                                   | -0.09       | 0.16 | -0.57   | 0.572   | -0.41        | 0.22         |
| Marital status                        |             |      |         |         |              |              |
| Married                               | Ref         |      |         |         |              |              |
| Unmarried                             | 4.51        | 1.70 | 2.66    | 0.009   | 1.17         | 7.85         |
| Educational level                    | 4.04        | 0.66 | 6.16    | <.001   | 2.75         | 5.33         |
| Income level                          | -0.04       | 0.87 | -0.05   | 0.962   | -1.75        | 1.67         |
| Hypertension                          |             |      |         |         |              |              |
| No                                    | Ref         |      |         |         |              |              |
| Yes                                   | -1.64       | 1.03 | -1.60   | 0.112   | -3.65        | 0.38         |
| Diabetes                              |             |      |         |         |              |              |
| No                                    | Ref         |      |         |         |              |              |
| Yes                                   | -2.49       | 0.95 | -2.61   | 0.009   | -4.36        | -0.61        |
| Duration of kidney disease, years    | -0.56       | 0.09 | -6.30   | <.001   | -0.73        | -0.38        |
| Duration of dialysis, months          | -0.02       | 0.02 | -0.70   | 0.486   | -0.06        | 0.03         |
| Dialysis frequency, weeks             | -5.92       | 1.05 | -5.63   | <.001   | -7.99        | -3.85        |
| Dialysis modality                     |             |      |         |         |              |              |
| Hemodialysis                          | Ref         |      |         |         |              |              |
| Peritoneal dialysis                   | -8.35       | 0.76 | -11.02  | <.001   | -9.85        | -6.86        |

CI – confidence interval; BMI – body mass index; MoCA – Montreal Cognitive Assessment; Ref – reference.
regression to explore the effects of dialysis modalities on patients’ cognitive dysfunction and HRQOL.

**Results**

**Baseline Characteristics**

In the study, we included 265 eligible patients and divided them into the hemodialysis group (n=115) and the peritoneal dialysis group (n=150). A total of 126 patients (47.55%) were male and 139 were female (52.45%) with a mean age of 56.45±12.12 years old. The mean BMI was 21.41±2.85 kg/m². For educational level, 106 patients (40.00%) had primary education, 131 (49.43%) had secondary education, and 28 (10.57%) had higher education. For income level, 41 patients (15.47%) had low income, 192 had middle income, and 32 had high income (12.08%). Seventy patients had hypertension (26.42%) and 88 had diabetes (33.21%). The median duration of kidney diseases was 13.0 (10.0, 17.0) years, and the median duration of dialysis was 19.0 (9.0, 36.0) months, with 209 patients having a dialysis frequency of ≥3 times a week. The median MoCA was 19.0 (14.0, 27.0) points, the median SF-36 was 20.30 (14.12, 30.85) points, and the mean KDTA was 24.61±7.27 points (Table 1).

**Differences Between Hemodialysis and Peritoneal Dialysis**

According to our results, the constituent ratio of female sex ($\chi^2=16.41, P<0.001$), age ($t=-2.97, P=0.003$), BMI ($t=-2.99, P=0.003$), duration of kidney disease ($Z=-4.12, P<0.001$), duration of dialysis ($Z=-2.93, P=0.003$), and the constituent ratio of dialysis frequency ≥3 ($\chi^2=92.62, P<0.001$) in the peritoneal dialysis group were significantly higher than those in the hemodialysis group. The constituent ratio of unmarried patients ($\chi^2=6.23, P=0.013$), MoCA score ($Z=8.94, P<0.001$), SF-36 score ($Z=9.09, P<0.001$), and KDTA score ($t=11.33, P<0.001$) were all significantly lower than those in the hemodialysis group. Significant differences were observed in the distributions of income level ($\chi^2=42.04, P<0.001$) and educational level ($\chi^2=18.46, P<0.001$) between the 2 groups (Table 1).

![Figure 1. Univariate analysis of MoCA (SAS v. 9.4, SAS Institute).](image-url)
As shown in Table 1, the MoCA score (Z=8.94, P<0.001), the SF-36 score (Z=9.09, P<0.001), and the KDTA score (t=11.33, P<0.001) were all significantly lower in the peritoneal dialysis group compared to the hemodialysis group. We performed univariate analyses for MoCA, SF-36, and KDTA to explore their corresponding potential influencing factors.

According to the results, sex (P<0.001), age (P<0.001), marital status (P=0.009), duration of kidney disease (P<0.001), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were significantly associated with the MoCA score (Table 2, Figure 1). Sex (P<0.001), age (P<0.001), marital status (P=0.003), educational level (P<0.001), presence of diabetes (P<0.001), duration of kidney disease (P<0.001), duration of dialysis (P=0.008), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were also found to be influencing factors of the SF-36 score (Table 3, Figure 2). In addition, sex (P<0.001), age (P<0.001), marital status (P=0.003), educational level (P<0.001), presence of diabetes (P<0.001), duration of kidney disease (P<0.001), duration of dialysis (P=0.003), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were significantly associated with the KDTA score (Table 4, Figure 3).

### Univariate Analysis of Cognition Dysfunction and HRQOL

As shown in Table 1, the MoCA score (Z=8.94, P<0.001), the SF-36 score (Z=9.09, P<0.001), and the KDTA score (t=11.33, P<0.001) were all significantly lower in the peritoneal dialysis group compared to the hemodialysis group. We performed univariate analyses for MoCA, SF-36, and KDTA to explore their corresponding potential influencing factors.

According to the results, sex (P<0.001), age (P<0.001), marital status (P=0.009), duration of kidney disease (P<0.001), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were significantly associated with the MoCA score (Table 2, Figure 1). Sex (P<0.001), age (P<0.001), marital status (P=0.003), educational level (P<0.001), presence of diabetes (P<0.001), duration of kidney disease (P<0.001), duration of dialysis (P=0.008), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were also found to be influencing factors of the SF-36 score (Table 3, Figure 2). In addition, sex (P<0.001), age (P<0.001), marital status (P=0.003), educational level (P<0.001), presence of diabetes (P<0.001), duration of kidney disease (P<0.001), duration of dialysis (P=0.003), frequency of dialysis (P<0.001), and dialysis modalities (P<0.001) were significantly associated with the KDTA score (Table 4, Figure 3).

#### Effects of different dialysis modalities on cognition dysfunction and HRQOL

After univariate analysis, a crude model was developed and significant variables were adjusted to further investigate the effect of different dialysis modalities on cognition dysfunction and HRQOL in ESRD patients.

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**Table 3. Univariate analysis of SF-36.**

| Variable                      | β    | S.E  | t     | P     | 95% CI          |
|-------------------------------|------|------|-------|-------|-----------------|
|                               |      |      |       |       | Lower           | Upper           |
| Gender                        |      |      |       |       |                 |                 |
| Male                          | Ref  |      |       |       |                 |                 |
| Female                        | -4.15| 1.05 | -3.96 | <.001 | -6.21           | -2.08           |
| Age, years                    | -0.26| 0.04 | -6.37 | <.001 | -0.35           | -0.18           |
| BMI                           | -0.11| 0.19 | -0.58 | 0.566 | -0.48           | 0.26            |
| Marital status                |      |      |       |       |                 |                 |
| Married                       | Ref  |      |       |       |                 |                 |
| Unmarried                     | 5.92 | 2.01 | 2.95  | 0.003 | 1.97            | 9.87            |
| Educational level             | 3.57 | 0.80 | 4.45  | <.001 | 1.99            | 5.15            |
| Income level                  | -0.78| 1.03 | -0.76 | 0.446 | 2.31            | 1.21            |
| Hypertension                  |      |      |       |       |                 |                 |
| No                            | Ref  |      |       |       |                 |                 |
| Yes                           | -1.17| 1.22 | -0.96 | 0.338 | -3.57           | 1.23            |
| Diabetes                      |      |      |       |       |                 |                 |
| No                            | Ref  |      |       |       |                 |                 |
| Yes                           | -3.88| 1.12 | -3.47 | <.001 | -6.08           | -1.68           |
| Duration of kidney disease, years | -0.72| 0.10 | -6.98 | <.001 | -0.93           | -0.52           |
| Duration of dialysis, months  | -0.07| 0.03 | -2.65 | 0.008 | -0.12           | -0.02           |
| Dialysis frequency, weeks     | -7.36| 1.24 | -5.94 | <.001 | -9.80           | -4.92           |
| Dialysis modality             |      |      |       |       |                 |                 |
| Hemodialysis                  | Ref  |      |       |       |                 |                 |
| Peritoneal dialysis           | -10.20| 0.89 | -11.50| <.001 | -11.94          | -8.45           |

CI – confidence interval; BMI – body mass index; SF-36 – Short Form-36; Ref – reference.
The crude model suggested that, as compared with hemodialysis group, the peritoneal dialysis group had lower scores of MoCA (β = -8.35, 95% CI: -9.85 to -6.86), SF-36 (β = -10.20, 95% CI: -11.94 to -8.45), and KDTA (β = -8.67, 95% CI: -10.10 to -7.23). After adjustment for sex and age, peritoneal dialysis was still associated with the decreases in MoCA (β = -7.16, 95% CI: -8.61 to -5.70), SF-36 (β = -9.00, 95% CI: -10.73 to -7.28), and KDTA (β = -7.64, 95% CI: -9.05 to -6.24) compared to hemodialysis. After adjustment for sex, age, BMI, marital status, educational level, income level, presence of diabetes, duration of kidney disease, duration of dialysis, and dialysis frequency, the peritoneal dialysis group still had lower MoCA scores (β = -7.02, 95% CI: -8.87 to -5.26), SF-36 score (β = -8.67, 95% CI: -10.76 to -6.58), and KDTA score (β = -7.55, 95% CI: -9.25 to -5.85) (Table 5, Supplementary Table 1).

**Discussion**

The current study made attempts to cast light on the cognitive dysfunction and HRQOL in hemodialysis and peritoneal dialysis patients when adjusting for their corresponding related factors. The MoCA score, the SF-36 score, and the KDTA score were all significantly lower in the peritoneal dialysis group than those in the hemodialysis group. The results suggested that patients receiving peritoneal dialysis had worse cognitive dysfunction and HRQOL as compared with hemodialysis patients.

Previous studies have reported a high prevalence of cognitive dysfunction in ESRD patients receiving dialysis [19-22]. During hemodialysis, massive and uncontrollable hemodynamic and metabolic changes in the brain can contribute to cognitive decline, and the fluid overloading and secondary metabolic disorders from glucose-based dialysate used in peritoneal dialysis can contribute to cognitive dysfunction [19]. Previous studies have suggested that hemodialysis was associated with better cognitive function than peritoneal dialysis, which was in line with our findings [20,21]. George et al also demonstrated that patients with hemodialysis had better performance, especially in attention, memory, visuospatial, and orientation [21]. However, results of studies on the effects of peritoneal dialysis and hemodialysis on cognitive dysfunction are inconsistent. Some studies have reported that peritoneal dialysis was superior to hemodialysis in the management of
cognitive dysfunction [22-24], and some other studies have observed no significant difference in the prevalence of cognitive dysfunction [19,25]. A Taiwanese retrospective study revealed that hemodialysis did not increase the risk of dementia compared to those receiving peritoneal dialysis, which may also indicate that there was no remarkable difference in the effect of peritoneal dialysis and hemodialysis on cognitive dysfunction [19]. A possible explanation for the difference here is the different study methods or tools used for assessing cognitive dysfunction. In the present study, we mainly used the Beijing version of the MoCA score, an ideal screening tool for cognitive dysfunction, with higher sensitivity and specificity, to assess the cognitive performance of our patients [26,27]. Another explanation may be the different sample sizes, study populations, study designs, and unadjusted demographic and clinical characteristics.

Long-term dialysis also has a great impact on patients’ HRQOL. It was reported that HRQOL was much worse in patients receiving dialysis as compared with the general population [28]. HRQOL was considered as an outcome measure in the evaluation of dialysis due to an increase in survival rates of ESRD patients [29]. The results of the present study suggest that hemodialysis was associated with higher HRQOL in ESRD patients compared to peritoneal dialysis. Similarly, some previous studies have reported that hemodialysis patients had better performance in HRQOL, especially in physical health and functioning [30,31]. However, some studies have reported better mental outcomes and satisfaction with care in patients receiving peritoneal dialysis as compared to those receiving hemodialysis, which indicated that peritoneal dialysis was associated with higher HRQOL [10,32]. In addition, some other studies suggested no significant differences in HRQOL between peritoneal dialysis and hemodialysis [14,33]. The difference here

Table 4. Univariate analysis of KDTA.

| Variable                      | β     | S.E  | t     | P      | 95% CI Lower | 95% CI Upper |
|-------------------------------|-------|------|-------|--------|--------------|--------------|
| Gender                        |       |      |       |        |              |              |
| Male                          | Ref   |      |       |        |              |              |
| Female                        | -3.54 | 0.87 | -4.07 | <.001  | -5.25        | -1.83        |
| Age, years                    | -0.23 | 0.03 | -6.60 | <.001  | -0.29        | -0.16        |
| BMI                           | -0.11 | 0.16 | -0.68 | 0.5    | -0.42        | 0.20         |
| Marital status                |       |      |       |        |              |              |
| Married                       | Ref   |      |       |        |              |              |
| Unmarried                     | -5.40 | 1.66 | -3.25 | 0.001  | 2.13         | 8.68         |
| Educational level             | 3.33  | 0.66 | 5.05  | <.001  | 2.03         | 4.63         |
| Income level                  | -0.31 | 0.86 | -0.37 | 0.713  | -2.02        | 1.37         |
| Hypertension                  |       |      |       |        |              |              |
| No                            | Ref   |      |       |        |              |              |
| Yes                           | -1.94 | 1.01 | -1.92 | 0.056  | -3.92        | 0.05         |
| Diabetes                      |       |      |       |        |              |              |
| No                            | Ref   |      |       |        |              |              |
| Yes                           | -2.76 | 0.94 | -2.95 | 0.003  | -4.60        | -0.92        |
| Duration of kidney disease, years | -0.62 | 0.09 | -7.17 | <.001  | -0.78        | -0.45        |
| Duration of dialysis, months  | -0.07 | 0.02 | -2.99 | 0.003  | -0.11        | -0.02        |
| Dialysis frequency, weeks     | -5.89 | 1.04 | -5.69 | <.001  | -7.93        | -3.85        |
| Dialysis modality             |       |      |       |        |              |              |
| Hemodialysis                  | Ref   |      |       |        |              |              |
| Peritoneal dialysis           | -8.67 | 0.73 | -11.90| <.001  | -10.10       | -7.23        |

CI – confidence interval; BMI – body mass index; KDTA – kidney disease-related quality of life assessment; Ref – reference.
may be that in most studies, hemodialysis was performed in hospitals by medical staff, and peritoneal dialysis could be performed independently or with the help of a caregiver, at home or in any other clean place; while in our study, peritoneal dialysis was performed in our hospital by professionals, which may increase the psychological burden of patients. In addition, most studies did not adjust for other related demographic or clinical characteristics, which may also affect the results. Our study adjusted for potential confounders, indicating that our results may be reliable for use in Chinese-speaking populations, limiting the generalizability of our results. Further multicenter studies are needed in various populations.

In the present study, we performed univariate analyses for MoCA, SF-36, and KDTA to find the related potential influencing factors. By adjusting for the variables with statistical significance, the results remained consistent with that of the crude model, which further confirmed our findings. However,

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**Table 5. Effects of hemodialysis and peritoneal dialysis on cognition dysfunction and HRQOL**

| Variable               | Model 1 | Model 2 | Model 3 |
|------------------------|---------|---------|---------|
|                        | $\beta$ (95% CI) | $\beta$ (95% CI) | $\beta$ (95% CI) |
| MOCA                   | -8.35 (-9.85 to -6.86)** | -7.16 (-8.61, -5.70)** | -7.02 (-8.87, -5.26)** |
| SF-36                  | -10.12 (-11.94 to -8.45)** | -9.00 (-10.73, -7.28)** | -8.67 (-10.76, -6.58)** |
| KDTA                   | -8.67 (-10.10 to -7.23)** | -7.64 (-9.05, -6.24)** | -7.55 (-9.25, -5.85)** |

*** $P<0.001$; CI – confidential interval; Model 1 – the univariate linear regression; Model 2 – gender and age were adjusted; Model 3 – gender, age, BMI, marital status, education level, income level, presence of diabetes, duration of kidney disease, duration of dialysis, and dialysis frequency were adjusted.
the present study still had some limitations. First, the limitation lies in the nature of the cross-sectional study, which could only explore associations and correlations, but could not infer causal relationships. Second, our sample size was limited and the study population was non-representative, which requires a larger sample size and studies enrolling different populations for confirmation. Third, although we adjusted for several potential confounders, the potential pathogenesis behind cognitive dysfunction, HRQOL, and peritoneal dialysis was not fully investigated. Clinical parameters (e.g., sodium, total cholesterol, residual kidney function) may act as residual confounders [15]. Therefore, further studies are needed to compare the effects of peritoneal dialysis and hemodialysis on cognitive dysfunction and HRQOL in ESRD patients by adjusting more comprehensive covariates.

Conclusions

In the present study, the cognitive dysfunction and HRQOL of patients receiving peritoneal dialysis were worse than those of hemodialysis patients. The related factors affecting cognitive dysfunction and HRQOL were also explored, which could help clinicians to find the optimal treatment for ESRD patients. The results suggested that clinicians should conduct regular assessments and provide comprehensive support for peritoneal dialysis patients’ possible physiological reactions, physical symptoms, and psychological stress that can seriously affect the quality of life during the peritoneal dialysis process.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

Supplementary Material

Supplementary Table 1. Effects of hemodialysis and peritoneal dialysis on cognition dysfunction and HRQOL.

| Measure               | Variable                                      | β     | S.E  | t     | P     | 95% CI Lower | 95% CI Upper |
|----------------------|-----------------------------------------------|-------|------|-------|-------|--------------|--------------|
| MoCA                 | MODEL1                                        |       |      |       |       |              |              |
| Intercept            |                                               | 32.42 | 1.25 | 26.04 | <.001 | 29.96        | 34.87        |
| Dialysis modality    | (Peritoneal dialysis vs Hemodialysis)         | -8.35 | 0.76 | -11.02| <.001 | -9.85        | -6.86        |
| MODEL2               |                                               |       |      |       |       |              |              |
| Intercept            |                                               | 43.04 | 1.99 | 21.61 | <.001 | 39.12        | 46.97        |
| Gender (female vs male) |                                             | -1.71 | 0.72 | -2.36 | 0.019 | -3.13        | -0.28        |
| Age                  |                                               | -0.18 | 0.03 | -5.96 | <.001 | -0.23        | -0.12        |
| Dialysis modality    | (peritoneal dialysis vs hemodialysis)         | -7.16 | 0.74 | -9.71 | <.001 | -8.61        | -5.70        |
| MODEL3               |                                               |       |      |       |       |              |              |
| Intercept            |                                               | 33.73 | 4.30 | 7.85  | <.001 | 25.26        | 42.19        |
| Gender (female vs male) |                                             | -1.25 | 0.71 | -1.76 | 0.080 | -2.65        | -0.15        |
| Age, years           |                                               | -0.13 | 0.04 | -3.21 | 0.002 | -0.20        | -0.05        |
| BMI                  |                                               | 0.24  | 0.12 | 1.92  | 0.055 | -0.01        | 0.48         |
| Marital status       | (unmarried vs married)                        | -1.49 | 1.50 | -0.99 | 0.321 | -4.44        | 1.46         |
| Educational level    |                                               | 2.48  | 0.53 | 4.47  | <.001 | 1.39         | 3.57         |
| Income level         |                                               | -0.02 | 0.65 | -0.03 | 0.974 | -1.30        | 1.26         |
| Diabetes (yes)       |                                               | -1.11 | 0.78 | -1.43 | 0.155 | -2.64        | 0.42         |
| Duration of kidney disease, years |                         | 0.15  | 0.09 | -1.75 | 0.081 | -0.33        | 0.22         |
| Duration of dialysis, months |                            | 0.01  | 0.02 | 0.64  | 0.520 | -0.02        | 0.05         |
| Dialysis frequency, weeks |                                      | 0.16  | 0.10 | -0.11 | 0.916 | -1.96        | 2.18         |
| Dialysis modality    | (peritoneal dialysis vs hemodialysis)         | -7.02 | 0.89 | -7.85 | <.001 | -8.78        | -5.26        |
| Measure | Variable                                                      | β     | S.E  | t     | P      | 95% CI Lower | 95% CI Upper |
|---------|--------------------------------------------------------------|-------|------|-------|--------|--------------|--------------|
| SF-36   | MODEL1                                                       |       |      |       |        |              |              |
|         | Intercept                                                    | 37.40 | 1.46 | 25.69 | <.001  | 34.53        | 40.27        |
|         | Dialysis modality (peritoneal dialysis vs hemodialysis)      | -10.20| 0.89 | -11.50| <.001  | -11.94       | -8.45        |
| MODEL2  | Intercept                                                    | 48.45 | 2.37 | 20.48 | <.001  | 43.80        | 53.11        |
|         | Gender (female vs male)                                      | -1.40 | 0.86 | -1.63 | 0.104  | -3.09        | 0.29         |
|         | Age, years                                                   | -0.19 | 0.04 | -5.47 | <.001  | -0.26        | -0.12        |
|         | Dialysis modality (peritoneal dialysis vs hemodialysis)      | -9.00 | 0.88 | -10.29| <.001  | -10.73       | -7.28        |
| MODEL3  | Intercept                                                    | 41.57 | 5.10 | 8.15  | <.001  | 31.53        | 51.61        |
|         | Gender (female vs male)                                      | -0.97 | 0.84 | -1.15 | 0.251  | -2.63        | 0.69         |
|         | Age, years                                                   | -0.12 | 0.05 | -2.46 | 0.015  | -0.21        | -0.02        |
|         | BMI                                                          | 0.31  | 0.15 | 2.13  | 0.034  | 0.02         | 0.60         |
|         | Marital status (unmarried vs married)                        | -1.74 | 1.78 | -0.98 | 0.330  | -5.24        | 1.77         |
|         | Educational level                                            | 1.80  | 0.66 | 2.74  | 0.007  | 0.51         | 3.09         |
|         | Income level                                                 | 0.91  | 0.77 | -1.17 | 0.242  | -0.07        | 1.04         |
|         | Diabetes (yes)                                               | -2.76 | 0.92 | -2.99 | 0.003  | -4.57        | -0.94        |
|         | Duration of kidney disease, years                            | -0.27 | 0.11 | -2.62 | 0.009  | -0.49        | -0.07        |
|         | Duration of dialysis, months                                 | -0.05 | 0.02 | -2.13 | 0.034  | -0.09        | -0.00        |
|         | Dialysis frequency, weeks                                    | 0.66  | 1.25 | 0.53  | 0.597  | -1.79        | 2.11         |
|         | Dialysis modality (peritoneal dialysis vs hemodialysis)      | -8.67 | 1.06 | -8.17 | <.001  | -10.76       | -6.58        |
| KDTA    | MODEL1                                                       |       |      |       |        |              |              |
|         | Intercept                                                    | 38.19 | 1.20 | 31.92 | <.001  | 35.83        | 40.54        |
|         | Dialysis modality (peritoneal dialysis vs hemodialysis)      | -8.67 | 0.73 | -11.90| <.001  | -10.10       | -7.23        |
| MODEL2  | Intercept                                                    | 47.68 | 1.93 | 24.68 | <.001  | 43.88        | 51.49        |
|         | Gender (female vs male)                                      | -1.21 | 0.70 | -1.72 | 0.087  | -2.59        | 0.18         |
|         | Age, years                                                   | -0.16 | 0.03 | -5.75 | <.001  | -0.22        | -0.11        |
|         | Dialysis modality (peritoneal dialysis vs hemodialysis)      | -7.64 | 0.72 | -10.70| <.001  | -9.05        | -6.24        |
| MODEL3  | Intercept                                                    | 40.62 | 4.15 | 9.80  | <.001  | 32.45        | 48.78        |
|         | Gender (female vs male)                                      | -0.88 | 0.68 | -1.29 | 0.199  | -2.23        | 0.47         |
|         | Age, years                                                   | 0.10  | 0.04 | -2.68 | 0.008  | -0.18        | -0.03        |
|         | BMI                                                          | 0.23  | 0.12 | 1.89  | 0.060  | -0.01        | 0.46         |
|         | Marital status (unmarried vs married)                        | 1.15  | 1.45 | -0.79 | 0.428  | -4.00        | 1.70         |
| Measure                                   | Variable          | β    | S.E  | t     | P     | 95% CI Lower | 95% CI Upper |
|------------------------------------------|-------------------|------|------|-------|-------|--------------|--------------|
| Educational level                        |                   | 1.73 | 0.54 | 3.24  | 0.001 | 0.68         | 2.79         |
| Income level                             |                   | -0.42| 0.63 | -0.66 | 0.509 | -1.65        | 0.82         |
| Diabetes (yes)                           |                   | -1.79| 0.75 | -2.39 | 0.017 | -3.27        | -0.32        |
| Duration of kidney disease, years       |                   | -0.23| 0.09 | -2.67 | 0.008 | -0.39        | -0.06        |
| Duration of dialysis, months             |                   | -0.04| 0.02 | -2.45 | 0.015 | -0.08        | -0.01        |
| Dialysis frequency, weeks                |                   | 1.11 | 1.01 | 1.09  | 0.276 | -0.89        | 3.10         |
| Dialysis modality (peritoneal dialysis vs hemodialysis) |       | -7.55| 0.86 | -8.75 | <0.001 | -9.25       | -5.85        |

CI = confidential interval; BMI = body mass index; MoCA = Montreal Cognitive Assessment; SF-36 = Short Form-36; KDTA = kidney disease-related quality of life assessment. Model 1 – the univariate linear regression; Model 2 – gender and age were adjusted; Model 3 – gender, age, BMI, marital status, education level, income level, presence of diabetes, duration of kidney disease, duration of dialysis, and dialysis frequency were adjusted.

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