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The Role of Biochemical Parameters, Body Fat, and Comorbidities in Health-Related Quality of Life among Haemodialysis Patients.

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Abstract

Introduction: Health-related quality of life (HRQOL) is often compromised in patients with end-stage renal disease (ESRD), despite the life-saving benefits of haemodialysis (HD). Although poor nutritional status is prevalent among HD patients, the association between HRQOL and specific factors, such as biochemical parameters, body fat, and comorbidities, remains insufficiently explored. This study aimed to examine the correlations between these factors and HRQOL in HD patients. **Methods:** A cross-sectional study involving 97 ESRD patients from two HD centres in an urban area of Selangor was conducted to ascertain the correlation between HRQOL and nutritional status. Data on socio-demographic characteristics, anthropometric measurements, biochemical parameters, and medical history were collected. HRQOL was evaluated using the Kidney Disease Quality of Life Short Form (KDQOL-SF™ version 1.3). **Results:** The mean KDQOL-SF™ scores ranged from 30.41 ± 29.37 to 85.91 ± 16.38. The mean scores for physical composite summary (PCS) and mental composite summary (MCS) were 40.89 ± 9.77 and 47.17 ± 9.84, respectively. Significant differences in HRQOL were observed across socio-demographic characteristics with the exception of gender and money allowance. Positive correlations with HRQOL were found for serum phosphorus, sodium, creatinine, albumin, HDL-cholesterol, and duration of ESRD diagnosis. Meanwhile, serum chloride, total iron-binding capacity (TIBC), transferrin, body fat, and the number of comorbidities were inversely correlated with HRQOL. **Conclusion:** This study highlights the role of biochemical parameters, body fat, and comorbidities on HRQOL in haemodialysis patients, emphasizing the need for regular monitoring and targeted interventions to enhance HRQOL and overall patient outcomes.

Keywords: *Biochemical parameters, body fat, haemodialysis, HRQOL.*

Introduction

End-stage renal disease (ESRD) is on the rise throughout the world. Over the past two decades, the global prevalence of ESRD has increased from 165 per million population (pmp) in 1990 to 284 pmp in 2010 [1]. The increment of 1.7% was due to the increasing ageing population, the prevalence of diabetes, and hypertension [2-4]. In 2010, 2.6 million people received renal replacement therapy (RRT) worldwide, and expected to increase by 5.4 million people in 2030, with the most growth in Asia [5].

In Malaysia, the prevalence of ESRD has also been on an upward trend for the past 10 years. According to the 26th Report of the Malaysian Dialysis and Transplant Registry, 44,136 patients underwent dialysis therapy in 2018, with 39,593 on haemodialysis (HD) (86.2%) and 4,543 on peritoneal dialysis (PD) (9.9%), with only 1,801 on renal transplantation (3.9%) [6]. In 2008, 4,606 new ESRD patients were treated with dialysis, but by 2018, the number had risen dramatically to 8,431. The prevalence of patients with ESRD on dialysis also increased by 1,363 pmp in 2018 compared to 706 pmp in 2008, whereas the new cases and the prevalence of renal transplantation remained stable for the past 10 years [6].

RRT is lifesaving for ESRD patients, yet, compared to renal transplantation, dialysis therapy itself is time-consuming, costly, and requires a restriction of fluid and dietary intake [7]. Besides that, dialysis is a lifelong therapy that causes physiological discomfort as well as limitation of physical activities [8]. Apart from that, adverse effects of the medication and therapy such as pain, sleep disorder, the weakening of fluctuations in blood pressure, and stomach ache exacerbate the difficulties faced by dialysis patients, leading to poor health-related quality of life (HRQOL) [9]. HRQOL usually declines as chronic kidney disease progresses, and HD patients reported the lowest HRQOL when compared to PD patients [10].

Other than HRQOL, dialysis patients also face nutritional issues, with HD patients having a poorer nutritional status than PD patients [11]. Multiple factors contribute to malnutrition in dialysis patients, including loss of nutrients due to dialysis, inflammation, inadequate dialysis, as well as insufficient protein and calorie intake due to loss of appetite, taste alteration, insulin resistance and low diet quality [12]. Nutritional status in ESRD patients was found to be correlated with HRQOL and poor HRQOL was closely related to mortality [13].

Malnutrition and diminished HRQOL are significant risk factors for mortality among patients with ESRD, underscoring the necessity for systematic monitoring of nutritional status and HRQOL[14]. Early intervention has demonstrated efficacy in improving HRQOL and reducing mortality rates in malnourished individuals. However, research examining these factors in the Malaysian population remains limited. This study aims to investigate the influence of biochemical parameters, body composition, and comorbidities on HRQOL in HD patients. The nutritional parameters selected for analysis—serum phosphorus, sodium, creatinine, albumin, and body fat—are recognized for their robust associations with nutritional status and health outcomes in HD patients, thereby enabling a thorough evaluation of overall health in ESRD.

Materials and methods

Study design and subjects

A cross-sectional study was conducted among 101 ESRD patients from two HD centres located in an urban area of Selangor, Malaysia. Inclusion criteria included Malaysian nationality, age above 18 years, a confirmed diagnosis of ESRD, and undergoing HD therapy at least three times a week for more than three months. Exclusion criteria encompassed individuals with acute kidney injury, Hepatitis A or B, recent kidney transplants, non-adherence to dialysis treatment

and communication barriers such as hearing deficits or mental health conditions that could impair participation.

Sample size and recruitment

The sample size was determined using G*Power version 3.1. The statistical test employed was the "Correlation: Bivariate normal model" within the "exact" test family. A two-tailed test was selected, with an alpha error probability of 0.1 and a desired power of 0.9. A medium effect size resulted in a calculated sample size of 92. A 10% increase was added to the calculated sample size to account for potential non-responses or recording errors during data collection. Thus, the total sample size was determined to be 101 patients. A face-to-face interview was conducted for each recruited patient. Patients were approached for participation, and a self-administered questionnaire was used to assess patients' HRQOL, while anthropometric and biochemical parameters were retrieved from the medical records.

Socio-demographic characteristics

Socio-demographic characteristics such as age, ethnicity, gender, marital status, and education level were collected using a self-administered questionnaire. Information on employment and financial status was also collected.

Body fat

Total body fat mass and body fat percentage were measured using OMRON body fat analyser HBF-356 (Omron Matsusaka Co. Ltd, Matsusaka, Japan).

Biochemical parameters and medical history

Biochemical parameters included serum creatinine, calcium, phosphorus, albumin, sodium, chloride, potassium, total protein, alkaline phosphatase, triglyceride, total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), haemoglobin, total iron-binding capacity (TIBC) and transferrin were obtained from the medical report of the patients. Medical history, such as duration of diagnosis with kidney failure, having HD, number of co-morbidities, primary cause of ESRD, and previous treatment options were obtained via face-to-face interview.

HRQOL

Kidney Disease Quality of Life-Short Form (KDQOL-SF^{TM}) version 1.3 is a validated, self-administered questionnaire designed to measure HRQOL in patients with kidney disease undergoing dialysis [15]. This questionnaire is available in English and was translated into Mandarin Chinese and Malay (Singapore version) by the KDQOL-SF^{TM} group and RAND [16]. This instrument comprises two scales: generic and kidney-specific, with 80 items and 19 subscales. Kidney-specific scale focuses on health-related concerns of individuals with kidney disease (43 kidney disease-targeted items and 11 subscales): symptoms/problems, effects of kidney disease, burden of kidney disease, work status, cognitive function, quality of social interaction, sexual function, sleep, social support, dialysis staff encouragement and patient satisfaction. The generic scale is the SF-36 health survey, which has 36 items and eight subscales: physical functioning, role-physical, pain, general health, emotional well-being, role emotional, social function, and energy. The final item, the overall health rate item, asks the patients to rate their health on a scale of 0 to 10. The generic scale results are further summarised in the physical composite summary (PCS) and mental composite summary (MCS), with PCS aggregating subscales from physical functioning, role physical, pain, and general health, and MCS aggregating subscales from emotional well-being, role emotional, social function, and general health. Scores of the different subscales were calculated according to the KDQOL-SF™ scoring program, with a range of 0 to 100, higher scores reflecting better HRQOL [15].

Ethical approval and permission

This study was approved by the Institutional Review Board of [JKEUPM Ethics Committee for Research Involving Human Subjects], approval number [MJKEtikaPer/F01(UPM)(U)Nov(11)]. All participants provided informed consent before participation.

Statistical analysis

The data collected were analysed using the IBM SPSS Statistics for Windows, version 22.0. Armonk, NY. Descriptive data were presented as frequency, percentage, mean, and standard deviation. The difference in mean KDQOL-SF™ across group was analysed by independent-samples t-test and one-way analysis of variance (ANOVA) test. Pearson correlation test was used to measure the associations between continuous variables with KDQOL-SF™ score. The level of significance of the *P*-value was set at 0.05 or below for all statistical tests.

Results

A total of 101 patients agreed to take part in this study, but four patients did not complete the questionnaires. Hence, they were excluded from the analysis, resulting in a final sample size of 97 patients. Table 1 shows the socio-demographic characteristics, anthropometric measurements, biochemical parameters, and medical history of the patients in this study. The mean age of the patients was 59.38 ± 11.28 years. The majority were Chinese (n = 76, 78.4%), female (n = 50, 51.5%), married (n = 67, 69.1%), and had secondary level education (n = 44, 45.3%). Although most patients were unemployed (n = 84, 86.6%) and had a household income of less than or MYR3000 per month (n = 67, 72.0%), only 25.8% (n = 25) of them received a monthly allowance for their HD treatment. The mean body mass index (BMI) of the patients was 24.17 ± 4.52 kg/$m^{2,}$ with almost half of them (n= 40, 41.3%) classified as obese. The mean values for inter-dialytic weight gain (IDWG), mid-upper arm circumference (MUAC), total body fat, and percentage of body fat were 1.59 ± 0.09 kg, 27.01 ± 3.43 cm, 16.77 ± 8.08 kg, 26.18 ± 9.69%, respectively. For biochemical parameters, majority of the patients had a higher level of creatinine (n = 60, 61.9%) and haemoglobin (n= 73, 75.3%), whereas 85.6% (n = 83) of them had undesirable level of HDL-cholesterol. Furthermore, 68.0% (n = 66) of the patients had low albumin levels, while the others had desirable or optimal levels of total cholesterol (n = 81, 83.5%) and LDL-cholesterol (n = 45, 46.4%). The mean duration since kidney failure diagnosis and HD therapy initiation was 8.82 ± 6.00 and 6.42 ± 3.99 years, respectively. The majority of the patients presented with co-morbidities (n = 77, 79.4%), with a mean of 1.33 ± 0.89 per patient. The primary cause of ESRD in this study was diabetes mellitus (n = 32, 33.0%), followed by hypertension (n = 30, 30.9%), others (n = 22, 22.7%), and unknown causes (n = 13, 3.4%).

The mean score of KDQOL-SF™ is presented in Table 2. The mean score for each subscale ranged from 30.41 ± 29.37 to 85.91 ± 16.38. For kidney-specific scale, patient satisfaction (85.91 ± 16.30) had the highest score, while work status (30.41±29.37) had the lowest score. The mean score for PCS and MCS were 40.89 ± 9.77 and 47.17 ± 9.84, respectively. The highest score for PCS and MCS were pain (78.17 ± 28.32) and social function (72.94 ± 24.78), while the lowest score were role-physical (42.27 ± 40.08) and energy/fatigue (52.58 ± 23.90), respectively.

Table 3-1 and Table 3-2 show the mean score of KDQOL-SF™ by socio-demographic characteristics. Significantly lower KDQOL-SF™ scores were observed in older patients, especially in the domains of cognitive function, PCS, physical functioning, social function, energy/fatigue, and overall health. As for working status, unemployed patients had a significantly lower scores in work status, physical functioning, and energy/fatigue compared to employed patients. For ethnicity, significant differences were observed between groups in terms of

symptom/problem list, burden of kidney disease and pain. Marital status showed significant differences in social support scores. Additionally, patients with no formal education scored significantly lower in physical functioning than those with primary or secondary education.

The correlations between anthropometric measurements, biochemical parameters, and medical history and KDQOL-SF™ are presented in Table 4-1 and Table 4-2. Among anthropometric measurements, only body fat percentage showed a significant correlation with KDQOL-SF™, specifically demonstrating a negative correlation with physical functioning. Regarding biochemical parameters, serum phosphorus, sodium, creatinine, albumin, and HDL-cholesterol levels showed positive correlations with several subscales of KDQOL-SF™. Conversely, serum chloride, TIBC, and transferrin exhibited negative correlations with KDQOL-SF™ scores. Furthermore, duration since kidney failure diagnosis was positively correlated with PCS, role-physical and social function scores. In contrast, in the number of comorbidities showed inverse correlations with several subscales of KDQOL-SF™, including effects of kidney disease, PCS, physical functioning, and social function.

Discussion

This study was conducted to determine the HRQOL and its correlation with nutritional status among HD patients in Malaysia. The findings revealed significant relationships between HRQOL and age, ethnicity, education level, marital and working status. Among anthropometric measurements, only body fat percentage significantly influenced HRQOL. In biochemical parameters, serum phosphorus, sodium, creatinine, albumin, HDL-cholesterol, chloride, TIBC, and transferrin were significantly correlated with HRQOL. Additionally, duration kidney failure diagnosis and number of co-morbidities significantly affected HRQOL outcomes.

The present study demonstrated that older patients exhibited lower HRQOL across all domains compared to their younger counterparts. This contrasts with previous studies reporting better scores among older patients on kidney-specific scales and the MCS, but did not show comparable improvements in the PCS scores [17-19]. This discrepancy may imply thatolder patients developed better adaptation to chronic illness, particularly regarding mental health aspects.

Consistent with prior research, married and Malay patients were less affected by kidney disease and its treatemnt [17, 20, 21]. This might be because married and Malay patients received more support from their surroundings, as illustrated by the results of the social support subscales in this study. Furthermore, it has been emphasized in previous studies that affectionate social support did impact HRQOL, which demonstrated the importance of family support in HD patients [22].

The findings of better HRQOL in a group with higher education level were consistent with previous studies [17-19]. As in the previous study, employed patients had higher HRQOL than unemployed patients [17]. These findings collectively suggest that better socioeconomic status and education level significantly influenced HRQOL in HD patients. This is probably due to a better understanding of the disease and available financial resources that facilitate adaptation to renal disease and reduce their life stress [23].

Analysis indicated that BMI was unrelated to HRQOL in HD patients. This outcome was consistent with earlier research conducted in Singapore [19]. However, a new finding was discovered in this study, where body fat percentage had an impact on HRQOL. This may be related to reduced physical functioning in this population of patients.

In terms of biochemical parameters, this study showed that serum phosphate, chloride, TIBC and transferrin were related to HRQOL, which had not been demonstrated in other studies [24, 25]. Meanwhile, similar to previous studies, lower serum creatinine, sodium, and albumin were found to be related to poor HRQOL [17-19, 24-26]. Low serum creatinine is a predictor of skeletal muscle mass loss, whereas low levels of sodium and albumin have always been associated with malnutrition, mortality, and morbidity [27-29]. Thus, it is plausible to expect an association between low creatinine, sodium, or albumin levels and poor HRQOL. Another interesting finding is that HDL-cholesterol level was also correlated with HRQOL, and this might be explained by physical activity level in HD patients [30].

A previous study highlighted that the duration of therapy was related to HRQOL in HD patients, however, the result was in contrast to this study. Similarly, a significant correlation between duration of kidney failure diagnosis and HRQOL was observed in this study [19]. The most likely explanation is better disease adaptation among long-term patients [19]. In this study, as the number of co-morbidities increased, HRQOL worsened. This finding was in line with a previous study that emphasized that presence of multiple co-morbidities impacts HRQOL [19]. It has been well established that ESRD patients typically have lower HRQOL, thus, presenting with other co-morbidities will worsen their current condition, and as the number of co-morbidities increases, the condition becomes more severe [31]. Notably, malnutrition has also been identified as the most significant predictor of impaired KDQOL-SF scores, reinforcing the importance of nutritional status in influencing quality of life in this population[14].

Limitations

Several limitations in this study need to be addressed. First, this is a cross-sectional design, which restricts the establishment of causal relationships among the variables. The cultural and dietary practices of the population may not represent other ethnic groups, limiting the generalizability of the findings. Furthermore, factors such as co-morbidities, socio-economic status, and access to healthcare may not have been sufficiently controlled, potentially confounding the observed relationships.

Conclusion

In conclusion, this study highlights the role of biochemical parameters, body fat, and comorbidities in determining HRQOL among haemodialysis patients. We identified positive correlations between HRQOL and serum phosphorus, sodium, creatinine, albumin, and HDL-cholesterol levels, while inverse association were observed with serum chloride, TIBC, transferrin, body fat, and comorbidities. These findings underscore the critical need for regular nutritional status assessment and biochemical markers monitoring in clinical practice, which could facilitate personalized interventions to improve HRQOL and optimize treatment outcomes for haemodialysis patients.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' Contributions

LPJ conceptualized and designed the study, led data collection, and analysis, and interpreted findings. As Principal Investigator, ZI supervised all aspects of the research including data analysis and interpretation, prepared the initial manuscript draft, and critically reviewed the final manuscript.

Table 1. Socio-demographic characteristics, anthropometric measurements, biochemical parameters, and medical history of the patients (n = 97)

Variables	*n (%) / Mean±SD*
Socio-demographic characteristics	
Age	59.38±11.28
18-60	50 (51.5)
≥ 60	47 (48.5)
Ethnicity	
Chinese	76 (78.4)
Malay	14 (14.4)
Indian	6 (6.2)
Others	1 (1.0)
Gender	
Male	47 (48.5)
Female	50 (51.5)
Marital status	
Single	19 (19.6)
Divorced	1 (1.0)
Married	67 (69.1)
Widowed	10 (10.3)
Level of education	
Primary	36 (37.1)
Secondary	44 (45.3)
Tertiary	4 (4.2)
No formal education	13 (13.4)
Working status	
Yes	13 (13.4)
No	84 (86.6)
Household income*	
No income	5 (5.4)
≤ MYR3000	67 (72.0)
> MYR3001	21 (22.6)
Money allowances	
Yes	25 (25.8)
No	72 (74.2)
Anthropometric measurements	
BMI (kg/m^2)	24.17±4.52
Underweight	7 (7.2)
Normal	33 (34.0)
Overweight	17 (17.5)
Obesity	40 (41.3)
IDWG (kg)	1.59±0.09
MUAC (cm)	27.01±3.43
Total body fat (kg)	16.77±8.08
Percentage of body fat (%)	26.18±9.69
Biochemical parameters	
Serum creatinine (mg/dL)	10.57±2.26
Normal (< 10)	37 (38.1)
Higher (≥ 10)	60 (61.9)
Serum calcium (mmol/L)	2.34±0.22
Serum phosphorus (mmol/L)	1.86±0.56
Serum albumin (g/L)	38.19±3.68
Low (< 40)	66 (68.0)
Normal (≥ 40)	31 (32.0)
Total protein (g/dL)	68.35±3.91
Alkaline phosphatase (g/dL)	129.71±99.67
Serum sodium (mmol/L)	135.71±13.17
Serum chloride (mmol/L)	96.04±6.29
Serum potassium (mmol/L)	4.87±0.73
Triglyceride (mmol/L)	2.19±1.40

Total cholesterol (mmol/L)	4.85±4.20
Desirable (< 5.2)	81 (83.5)
Borderline high (5.2 – 6.2)	12 (12.4)
High (> 6.2)	4 (4.1)
HDL-cholesterol (mmol/L)	0.84±0.37
Undesirable (<1.0)	83 (85.6)
Acceptable (1.0 – 1.6)	11 (11.3)
High desirable(> 1.56)	3 (3.1)
LDL-cholesterol (mmol/L)	2.60±0.84
Optimal (< 2.6)	45 (46.4)
Near optimal (2.6 – 3.3)	38 (39.2)
Borderline high (3.3 – 4.1)	7 (7.2)
High (4.1 – 4.9)	6 (6.2)
Very high (> 4.9)	1 (1.0)
Haemoglobin (g/dL)	11.19±1.60
Normal (< 10)	24 (24.7)
Higher (≥ 10)	73 (75.3)
TIBC	35.55±7.70
Transferrin	1.59±0.35
Medical history	
Years of diagnosed kidney failure	8.82±6.00
Primary cause of ESRD	
Diabetes mellitus	32 (33.0)
Hypertension	30 (30.9)
Unknown causes	13 (13.4)
Others	22 (22.7)
Years having HD	6.42±3.99
Previous treatment options	
Peritoneal dialysis	11 (11.0)
Acupuncture	1 (1.0)
Chinese herbal remedies	4 (4.0)
No other treatment	81 (84.0)
Co-morbidities	1.33±0.89
Not present with co-morbidities	20 (20.6)
Present with co-morbidities	77 (79.4)

*n=93, missing data, as patients refuse to answer

Values are n (%), mean ± standard deviation (SD)

MYR: Malaysian Ringgit, BMI: Body mass index, CVD: Cardiovascular disease, ESRD: End stage renal disease, HD: haemodialysis, IDWG: Inter-dialytic weight gain, MUAC: Mid upper arm circumference, TIBC: Total iron-binding capability

Table 2. Mean score of KDQOL-SF™ for the patients (n = 97)

Scale	*Mean±SD*
Kidney-specific scale	
Symptoms/problem list	83.23±12.86
Effects of kidney disease	72.31±17.50
Burden of kidney disease	46.01±28.90
Work status	30.41±29.37
Cognitive function	81.44±20.17
Quality of social interaction	81.37±18.18
Sexual function	67.05±27.43
Sleep	67.35±20.97
Social support	79.90±22.94
Dialysis staff encouragement	67.14±29.61
Patient satisfaction	85.91±16.38
Overall health	66.80±16.62
Generic scale	
PCS	40.89±9.77
Physical functioning	52.89±31.34
Role-physical	42.27±40.08
Pain	78.17±28.32
General health	56.96±22.20
MCS	47.17±9.84
Emotional well-being	70.06±19.61
Role-emotional	68.39±41.49
Social function	72.94±24.78
Energy/fatigue	52.58±23.90

Values are mean ± standard deviation (SD)
MCS: Mental component summary, PCS: Physical component summary

Table 3-1. Mean score of KDQOL-SF™ by socio-demographic characteristics among patients (n = 97)

Variables	*Kidney-specific scale*												*t test / ANOVA F value*	*P value*
	Symptom /Problem	*Effects of kidney disease*	*Burden of kidney disease*	*Work status*	*Cognitive function*	*Quality of social interact-tion*	*Sexual function*	*Sleep*	*Social support*	*Dialysis staff encourage-ment*	*Patient satisfac-tion*	*Overall health*		
Age:														
18-60	85.02± 12.35	73.82± 16.14	50.40± 30.93	30.85± 28.65	**86.67± 14.11**†	79.58± 18.46	72.50± 26.81	71.33± 21.88	77.31± 26.10	68.35± 29.36	84.04± 17.01	**70.85± 15.30**†	-2.518	0.012
≥ 60	81.54± 13.23	70.88± 18.74	41.88± 26.49	30.00± 30.30	**76.53± 23.65**	83.07± 17.93	55.36± 26.86	63.60± 19.56	82.33± 19.46	66.00± 30.10	87.67± 15.72	**60.00± 17.06**	-2.381	0.019
Ethnicity:														
Chinese	**83.94± 12.18**‡	72.26± 17.78	**44.41± 27.11**‡	30.26± 30.64	80.35± 21.19	81.84± 17.47	66.18± 26.80	68.09± 19.64	78.29± 23.57	66.61± 31.12	85.75± 15.80	66.45± 16.71	F=3.847	0.012
Malay	**93.40± 7.39**	82.30± 18.92	**77.08± 25.21**	16.67± 25.82	90.00± 18.74	87.78± 12.94	-	74.17± 31.57	86.11± 26.70	89.58± 20.03	-	76.67± 22.51	F=2.767	0.046
Indian	**74.55± 14.51**	68.53± 15.43	**42.86± 34.31**	35.71± 23.44	82.38± 14.47	75.24± 23.30	62.50± 32.27	62.32± 22.99	84.52± 17.86	58.93± 19.87	79.76± 19.80	65.00± 13.45	-	-
Gender:														
Male	84.57± 11.62	70.15± 16.98	46.94± 26.99	32.98± 33.42	83.69± 20.04	81.28± 20.36	61.61± 31.19	67.82± 23.70	80.50± 23.91	67.29± 28.62	85.46± 14.99	65.22± 17.18	-1.002	0.319
Female	81.96± 13.93	74.33± 17.91	45.13± 30.83	28.00± 25.07	79.33± 20.26	81.47± 16.07	76.56± 16.95	66.90± 18.26	79.33± 22.22	67.00± 30.80	86.33± 17.72	60.40± 16.00	1.179	0.241
Marital status:														
Single	84.43± 12.72	73.08± 18.89	49.34± 31.45	34.21± 23.88	81.05± 19.91	76.14± 17.68	-	67.50± 18.10	**62.28± 33.26**‡	63.16± 31.59	85.96± 17.80	66.32± 17.39	F=5.530	0.002
Married	83.46± 12.66	71.04± 17.23	46.08± 27.93	29.10± 31.56	81.89± 20.92	83.08± 18.65	65.48± 27.07	67.28± 22.77	**84.33± 17.38**	71.27± 27.27	84.33± 16.64	66.87± 17.16	-	-
Widowed	79.17± 15.60	80.63± 16.32	38.13± 33.26	30.00± 25.82	79.33± 18.18	82.67± 13.41	-	67.25± 15.25	**81.67± 18.34**	51.25± 35.58	95.00± 8.05	68.00± 13.17	-	-
Level of education:														
Primary	81.02± 13.33	69.88± 20.14	41.32± 28.48	29.17± 27.71	78.89± 21.29	84.26± 14.27	60.00± 37.91	66.39± 18.81	80.56± 22.36	70.14± 31.52	86.57± 15.85	65.28± 17.15	F=0.419	0.74
Secondary	84.87± 12.14	72.71± 16.01	46.20± 29.45	29.35± 32.62	81.01± 20.94	80.73± 21.19	67.19± 24.10	69.84± 20.87	78.99± 25.20	68.75± 26.05	84.78± 16.79	68.48± 14.90	-	-
Tertiary	75.00± 26.52	65.63± 13.26	56.25± 8.84	50.00± 0.00	96.67± 4.72	73.34± 9.43	-	52.50± 56.57	-	87.50± 17.68	75.00± 11.78	55.00± 7.07	-	-
No formal education	84.77± 12.42	78.61± 14.92	56.73± 29.14	34.62± 24.02	87.69± 13.57	76.92± 17.35	-	63.46± 22.51	-	50.00± 33.46	89.74± 17.40	66.92± 21.75	-	-
Working status:														

*Values are mean ± standard deviation (SD;†P<0.05, independent t-test; ‡P<0.05, oneway ANOVA; CVD: Cardiovascular disease

Table 3-2. Mean score of KDQOL-SF™ by socio-demographic characteristics among patients (n = 97) (cont.)

Variables	*Generic scale*										*t test / ANOVA F value*	*P value*
	PCS	*Physical functioning*	*Role-physical*	*Pain*	*General health*	*MCS*	*Emotional well-being*	*Role-emotional*	*Social function*	*Energy/ fatigue*		
Age												
18-60	**44.29± 8.39**†	**67.87± 25.66**†	46.28± 39.69	81.06± 26.73	48.73± 8.56	48.73± 8.56	73.96± 20.03	74.47± 37.57	**78.46± 23.56**†	**57.66± 24.38**†	-5.134	0.001
≥ 60	**37.69± 9.97**	**38.80± 29.80**	38.50± 40.47	75.45± 29.75	45.70± 10.78	45.70± 10.78	66.40± 18.66	62.67± 44.49	**67.75± 25.01**	**47.80± 22.66**	-2.167	0.033
Ethnicity												
Chinese	41.26± 10.27	52.43± 32.03	41.45± 40.94	**83.45± 25.85**‡	47.52± 9.95	47.52± 9.95	70.58± 18.94	70.18± 39.84	72.53± 24.83	53.68± 23.33	F=6.359	0.001
Malay	43.03± 8.43	69.17± 39.04	69.17± 39.04	**70.42± 26.48**	50.66± 13.86	50.66± 13.86	74.00± 34.57	66.67± 51.64	85.42± 20.03	70.00± 28.11	-	-
Indian	37.90± 7.47	46.43± 22.91	46.43± 22.91	**51.25± 28.11**	44.15± 7.09	44.15± 7.09	67.14± 15.94	57.14± 47.91	70.54± 27.12	39.29± 20.93	-	-
Gender												
Male	41.53± 8.94	56.91± 30.06	43.09± 39.60	82.77± 27.33	47.40± 9.62	47.40± 9.62	69.28± 19.97	73.76± 39.28	75.00± 24.73	55.53± 22.89	-1.561	0.122
Female	40.29± 10.54	49.10± 32.34	41.50± 40.91	73.85± 28.83	46.95± 10.13	46.95± 10.13	70.80± 19.43	63.33± 43.25	71.00± 24.93	49.80± 24.72	-1.24	0.218
Marital status												
Single	41.22± 9.79	56.58± 29.49	39.47± 35.66	76.32± 33.09	46.29± 9.12	46.29± 9.12	69.47± 22.60	71.94± 37.29	67.76± 32.09	51.05± 24.36	F=2.235	0.089
Married	41.38± 9.71	55.07± 31.53	44.40± 40.78	79.96± 27.55	47.46± 10.21	47.46± 10.21	70.63± 19.98	70.15± 41.09	74.81± 23.49	52.99± 23.57	-	-
Widowed	37.02± 10.76	29.50± 27.23	37.50± 46.02	72.00± 25.81	47.93± 9.22	47.93± 9.22	68.40± 11.54	56.67± 49.81	71.25± 18.68	55.50± 27.13	-	-
Level of education												
Primary	39.64± 11.26	**44.58± 32.04**§	45.83± 44.92	76.32± 30.92	46.63± 10.89	46.63± 10.89	69.56± 20.93	67.59± 43.27	69.79± 25.24	50.69± 23.91	F=7.777	0.001
Secondary	43.17± 8.60	**65.98± 27.38**§	38.59± 36.40	80.05± 26.96	47.26± 9.68	47.26± 9.68	70.43± 20.85	68.84± 39.38	76.63± 25.77	55.65± 23.44	-	-
Tertiary	44.58± 3.90	**65.00± 35.36**§	62.50± 53.03	72.50± 38.89	50.04± 1.82	50.04± 1.82	78.00± 19.80	-	81.25± 26.52	50.00± 28.28	-	-
No formal education	35.71± 7.65	**27.69± 19.32**§	42.31± 40.03	77.50± 27.31	47.89± 8.58	47.89± 8.58	68.92± 10.97	64.10± 48.04	67.31± 19.46	47.31± 26.43	-	-
Working status												
Yes	44.77± 7.16	**80.77± 14.56**†	40.38± 34.67	84.42± 29.65	48.96± 6.43	48.96± 6.43	74.77± 16.92	76.92± 34.39	82.69± 18.78	**65.77± 16.31**†	-6.109	0.001
No	40.29± 10.01	**48.57± 31.06**	42.56± 41.03	77.20± 28.17	46.89± 10.26	46.89± 10.26	69.33± 19.98	67.06± 42.51	71.43± 25.34	**50.54± 24.31**	2.180	0.032
Money allowances												
Yes	42.88± 7.91	59.60± 30.34	48.00± 40.77	80.70± 27.45	46.57± 9.05	46.57± 9.05	71.04± 20.27	61.33± 41.59	77.50± 23.94	55.80± 21.92	1.187	0.238
No	40.20± 10.29	50.56± 31.55	40.28± 39.93	77.29± 28.75	47.37± 10.15	47.37± 10.15	69.72± 19.50	70.83± 41.47	71.35± 25.04	51.46± 24.60	1.247	0.216

*Values are mean ± standard deviation (SD); †$p<0.05$, independent t-test; ‡$p<0.05$, oneway ANOVA; §$p<0.05$, oneway ANOVA, significant difference within the group using post hoc test; CVD: Cardiovascular disease; MCS: Mental component summary; PCS: Physical component summary

Table 4-1. Correlation between anthropometric measurements, biochemical parameters, and medical history with KDQOL-SF™

Variables	*Kidney-specific scale*												*P value*
	Symptom /Problem	*Effects of kidney disease*	*Burden of kidney disease*	*Work status*	*Cognitive function*	*Quality of social interact-tion*	*Sexual function*	*Sleep*	*Social support*	*Dialysis staff encourage-ment*	*Patient satisfac-tion*	*Overall health*	
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	
Anthropometric measurements													
BMI (kg/m^2)	-0.950	-0.135	0.510	0.048	0.072	0.084	0.024	-0.036	0.019	0.060	0.094	0.073	0.187
IDWG (kg)	-0.168	-1.530	-0.088	-0.180	-0.030	-0.187	-0.188	-0.145	-0.094	0.106	-0.011	-0.008	0.067
MUAC (cm)	0.006	-0.062	0.156	-0.004	0.162	0.111	0.121	0.002	0.116	0.018	0.050	0.033	0.114
Total body fat (kg)	-0.130	-0.009	0.091	0.034	0.047	0.016	0.113	0.036	0.009	0.071	0.148	0.025	0.151
Body fat (%)	-0.127	0.069	0.099	-0.030	0.050	-0.075	0.179	0.001	-0.044	0.064	0.112	0.052	0.219
Biochemical parameters													
Serum creatinine (mg/dL)	0.155	-0.039	0.092	-0.057	0.103	0.022	0.241	0.020	0.190	0.032	0.003	0.163	0.063
Serum calcium (mmol/L)	-0.018	0.082	0.030	0.125	-0.164	0.008	-0.110	0.061	0.039	-0.034	0.060	-0.031	0.111
Serum phosphorus (mmol/L)	0.131	0.147	**0.203***	0.070	**0.205***	0.008	0.414	-0.054	0.069	0.094	0.097	0.106	0.048
Serum albumin (g/L)	0.105	-0.052	-0.019	-0.033	-0.06	0.077	0.223	0.032	0.117	-0.094	0.087	0.126	0.221
Total protein (g/dL)	0.001	0.068	-0.073	0.119	0.06	-0.009	0.276	-0.018	-0.035	0.099	0.067	0.017	0.214
Alkaline phosphatase (g/dL)	0.003	0.085	-0.116	-0.143	0.031	-0.100	-0.286	-0.006	-0.005	-0.069	0.058	-0.051	0.161
Serum sodium (mmol/L)	**0.281***	0.080	0.108	0.145	**0.307***	0.008	-0.406	0.172	**0.235***	-0.061	0.087	0.128	0.005
Serum chloride (mmol/L)	-0.060	-0.023	-0.175	-0.007	-0.139	-0.073	**-0.511***	0.199	0.097	-0.009	-0.138	0.002	0.015
Serum potassium (mmol/L)	0.035	-0.030	0.034	-0.157	0.055	0.022	0.136	0.081	-0.069	0.019	0.162	0.173	0.089
Triglyceride (mmol/L)	-0.009	-0.111	-0.003	-0.076	0.065	0.194	0.202	-0.016	0.097	0.172	0.180	0.167	0.056
Total cholesterol (mmol/L)	0.092	0.073	-0.044	0.192	-0.049	0.121	-0.231	-0.069	0.006	0.080	0.087	0.046	0.059
HDL-cholesterol (mmol/L)	0.104	0.017	-0.167	0.018	-0.133	-0.034	-0.043	-0.093	-0.153	-0.015	0.057	0.115	0.102
LDL-cholesterol (mmol/L)	-0.063	0.151	0.057	-0.156	-0.026	-0.023	-0.188	0.081	-0.026	-0.034	-0.133	-0.057	0.141
Haemoglobin (g/dL)	-0.003	-0.066	0.008	0.008	-0.129	0.028	-0.374	0.028	0.081	0.003	0.190	0.096	0.062
TIBC	-0.189	**-0.257***	-0.186	0.141	-0.186	**-0.248***	-0.041	-0.189	-0.045	-0.040	0.079	-0.016	0.011
Transferrin	-0.200	**-0.250***	-0.174	0.156	-0.167	**-0.243***	-0.035	-0.186	-0.046	-0.047	0.074	0.025	0.014
Medical history													
Years of diagnosed kidney failure	0.006	0.101	0.011	0.104	0.028	0.023	-0.060	0.118	0.184	-0.057	0.074	0.034	0.072
Years having HD	-0.027	0.063	-0.007	-0.040	-0.087	-0.095	0.115	0.052	0.166	-0.129	0.172	0.072	0.093
Number of co-morbidities	-0.149	**-0.243***	-0.113	-0.109	-0.093	0.006	-0.316	-0.181	-0.072	-0.009	0.001	-0.090	0.017

Values are *r:* Pearson correlation coefficient; BMI: Body mass index; HD: Haemodialysis; IDWG: Inter-dialytic weight gain; MUAC: Mid upper arm circumference; TIBC: Total iron-binding capability; *Bold number indicate significant for correlation (*P<0.05), Pearson correlation

Table 4-2. Correlation between anthropometric measurements, biochemical parameters, and medical history with KDQOL-SF^{TM} (cont.)

Variables	*Generic scale*										*P value*
	PCS	*Physical functioning*	*Role-physical*	*Pain*	*General health*	*MCS*	*Emotional well-being*	*Role-emotional*	*Social function*	*Energy/ fatigue*	
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	*r*	
Anthropometric measurements											
BMI (kg/m^2)	-0.105	-0.090	-0.046	-0.007	-0.055	0.019	0.008	0.038	-0.017	0.018	0.307
IDWG (kg)	0.001	0.106	-0.103	0.004	-0.109	-0.043	-0.066	-0.005	-0.061	-0.048	0.289
MUAC (cm)	-0.019	0.042	0.012	-0.002	0.011	0.054	0.014	0.033	0.060	0.064	0.534
Total body fat (kg)	-0.082	-0.132	0.006	0.027	0.043	0.009	0.088	-0.108	-0.031	-0.074	0.201
Body fat (%)	-0.146	**-0.235***	-0.065	-0.006	0.081	0.015	0.052	-0.121	-0.075	-0.084	0.021
Biochemical parameters											
Serum creatinine (mg/dL)	**0.240***	**0.440****	0.078	-0.019	0.168	0.083	0.032	0.121	0.154	0.168	0.001
Serum calcium (mmol/L)	0.142	0.057	0.149	-0.015	0.126	-0.082	-0.030	-0.034	0.020	-0.079	0.147
Serum phosphorus (mmol/L)	0.062	**0.247***	0.077	-0.044	0.106	**0.255***	0.180	**0.249***	-0.017	0.129	0.013
Serum albumin (g/L)	**0.306***	**0.272***	**0.274***	0.101	**0.253***	0.027	0.086	0.134	0.058	**0.281***	0.007
Total protein (g/dL)	0.167	0.125	0.198	0.003	0.056	-0.091	-0.019	-0.014	0.009	0.011	0.051
Alkaline phosphatase (g/dL)	-0.183	-0.110	-0.089	-0.131	-0.163	-0.045	-0.034	-0.116	0.030	-0.136	0.073
Serum sodium (mmol/L)	0.195	**0.217***	0.114	**0.206***	**0.236***	0.114	**0.216***	0.001	**0.235***	**0.207***	0.021
Serum chloride (mmol/L)	0.064	0.141	-0.088	0.021	0.027	0.012	0.021	-0.056	0.191	0.057	0.061
Serum potassium (mmol/L)	0.136	0.097	0.148	-0.040	0.139	0.029	0.068	0.100	0.009	0.193	0.058
Triglyceride (mmol/L)	0.056	-0.031	-0.103	0.123	0.009	-0.127	-0.114	-0.075	0.121	0.101	0.217
Total cholesterol (mmol/L)	0.085	0.067	0.156	0.067	0.073	0.114	0.137	0.088	0.132	-0.003	0.126
HDL-cholesterol (mmol/L)	0.174	0.117	**0.217***	0.099	0.145	0.148	0.142	0.165	0.074	0.077	0.032
LDL-cholesterol (mmol/L)	-0.140	-0.041	0.022	-0.121	0.008	0.121	0.039	0.095	0.022	-0.037	0.173
Haemoglobin (g/dL)	0.070	-0.020	0.128	-0.055	0.195	-0.038	-0.036	-0.052	0.032	0.138	0.055
TIBC	0.114	0.076	0.123	-0.059	-0.044	-0.151	-0.169	-0.023	-0.006	-0.023	0.100
Transferrin	0.101	0.067	0.128	0.089	-0.051	-0.145	-0.169	-0.027	-0.014	-0.020	0.099
Medical history											
Years of diagnosed kidney failure	**0.251***	0.164	**0.204***	0.103	0.161	-0.082	0.050	-0.094	**0.236***	-0.059	0.045
Years having HD	0.060	0.036	0.112	-0.083	0.120	0.034	0.113	-0.141	0.160	-0.070	0.117
Number of co-morbidities	**-0.223***	**-0.308***	-0.118	-0.164	0.004	-0.088	-0.066	-0.072	**-0.253***	-0.063	0.002

Values are *r:* Pearson correlation coefficient; BMI: Body mass index; HD: Haemodialysis; IDWG: Inter-dialytic weight gain; MUAC: Mid upper arm circumference; TIBC: Total iron-binding capability; *Bold number indicate significant for correlation (*P<0.05), Pearson correlation

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