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Association of Treatment Satisfaction with Quality of Life and All-Cause Mortality in Hemodialysis Patients

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Abstract

Background

Treatment burden in chronic hemodialysis (HD) requires the use of patient-centered outcomes like Quality of Life (QOL). This study investigated the association of treatment satisfaction with QOL and all-cause mortality in maintenance HD patients.

Methods

This was a prospective observational cohort study of 346 chronic HD patients. Patients were classified into Satisfied (score ≥ 66.7, n = 241) and Not Satisfied (score < 66.7, n = 105) groups based on the Kidney Disease Quality of Life-Short Form (KDQOL-SF™). The association of satisfaction with QOL was analyzed by linear regression, and with all-cause mortality by Kaplan-Meier and multivariable Cox proportional hazards models.

Results

The Not Satisfied Group showed a significantly higher prevalence of diabetes mellitus (DM) (49.5% vs. 38.6%, $p = 0.044$) and cardiovascular disease (CVD) (43.8% vs. 32.8%, $p = 0.038$), along with higher serum C-reactive protein (CRP) and LDL-cholesterol levels. Patients in the Satisfied Group exhibited significantly higher scores across all domains of both SF-36 and KDQOL (all $p < 0.05$). However, Kaplan-Meier analysis showed no significant difference in cumulative survival (Log-rank test: $p = 0.838$). In multivariable Cox analysis, treatment satisfaction was not an independent predictor of all-cause mortality.

Conclusions

Treatment satisfaction is significantly and positively associated with comprehensive QOL domains in HD patients, but it is not a direct, independent predictor of all-cause mortality. These findings suggest that satisfaction reflects psychosocial well-being distinct from the objective physiological factors driving long-term survival.

Background

Chronic kidney disease (CKD) and its progression to end-stage renal disease (ESRD) constitute a serious and escalating global health concern [1]. Hemodialysis (HD) is widely established as the primary modality of renal replacement therapy for patients with ESRD. However, while HD is indispensable for sustaining patients' lives, it has long been recognized that the treatment itself imposes a substantial physical, psychological, and social burden [2]. Patients face extensive constraints, including chronic

fatigue, polypharmacy, strict dietary and fluid restrictions, and the necessity of prolonged, multiple-weekly treatment sessions. Consequently, the evaluation of dialysis treatment has shifted beyond mere extension of survival to prioritizing the patient's Quality of Life (QOL) and Health-Related Quality of Life (HRQOL) as key metrics [3, 4]. The World Health Organization (WHO) defines QOL as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns," emphasizing its multidimensional nature influenced by physical health, psychological state, independence, social relationships, and environment. HRQOL, specifically, is a concept focused on how disease and its treatment affect an individual's health status, physical functioning, life satisfaction, and overall well-being [4]. Indeed, some studies have demonstrated that low HRQOL is associated with adverse clinical outcomes, including increased risk of hospitalization and mortality, underscoring its critical role in treatment evaluation [3, 4]. Patient satisfaction is an indispensable component in assessing the quality of healthcare services [5, 6]. As it reflects both patient expectations and preferences alongside the reality of care delivery, it provides vital information for evaluating the efficacy of the services provided. Particularly in chronic diseases requiring long-term treatment, such as dialysis, satisfaction with the treatment is presumed to be deeply linked to the patient's overall QOL. Although dialysis patients generally report lower satisfaction with their physical and psychological health, evidence suggests they often attempt to compensate by seeking satisfaction in other areas of daily life, particularly through support from family, healthcare professionals, and the provided medical and social infrastructure. This highlights that a patient's subjective perception of their situation is paramount in determining their overall life satisfaction, often outweighing objective facts [2].

While previous studies have demonstrated that HRQOL metrics are robust predictors of clinical outcomes, particularly mortality [7], research focusing on the broader concept of "treatment satisfaction" is comparatively scarce, and its association with long-term survival remains insufficiently elucidated. Consequently, many ambiguities persist regarding the specific relationship between satisfaction with dialysis treatment and its impact on the patient's multidimensional QOL and, ultimately, their prognosis. The present study aims to comprehensively investigate the relationships among treatment satisfaction, QOL, and long-term prognosis in patients receiving maintenance hemodialysis. The findings of this research are intended to contribute to the development of effective interventions aimed at enhancing QOL and improving outcomes for dialysis patients.

Methods

Study design and participants

This study was a prospective observational cohort study designed to investigate the association among treatment satisfaction, QOL, and prognosis in patients receiving maintenance HD. The study was conducted between 2019 and 2022 at Toho University Sakura Medical Center and four affiliated facilities of the Seijinkai Mihama Group (Mihama Hospital, Mihama Sakura Clinic, Mihama Narita Clinic, and Mihama Katori Clinic).

Eligible participants were maintenance HD patients aged 18 years or older who had been undergoing HD for at least three months and who provided consent to participate in an arteriosclerosis study. Patients were excluded based on the following criteria: myocardial infarction or heart failure within the previous six months, presence of a pacemaker, active malignancy, diagnosis of dementia, presence of ascites, severe limb amputation, or pregnancy. A total of 387 patients initially consented to the study. After excluding those who did not complete the questionnaire or for whom data were unavailable, 346 participants provided both clinical laboratory data and questionnaire results for analysis. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Toho University Sakura Medical Center (Approval Numbers: S24012_S21073(S18086)). Written informed consent was obtained from all participants.

Data collection and outcome measures

Baseline data collected included age, sex, presence of diabetes mellitus (DM), dialysis vintage (duration), and pre-dialysis systolic blood pressure. Various clinical laboratory data, including serum albumin, C-reactive protein (CRP), and LDL-cholesterol, were extracted from electronic medical records. Dialysis efficacy was assessed using Kt/Vurea. Furthermore, biochemical data, including N-terminal pro-B-type natriuretic peptide (NT-proBNP), were also collected. The study tracked outcomes for four years until April 30, 2024, to assess prognosis.

Body composition was assessed using a segmental multi-frequency bioelectrical impedance analysis device (InBody S10®; InBody Co., Ltd., Seoul, Republic of Korea). Segmental resistance and reactance were measured at four frequencies (5, 50, 250, and 500 kHz). Total body water, intracellular water (ICW), extracellular water (ECW), fat-free mass (FFM), and the skeletal muscle mass index (SMI) were calculated by the device's built-in software based on segmental bioelectrical impedance analysis. The phase angle (PhA) was calculated from resistance (R) and reactance (Xc) at 50 kHz using the formula: PhA (°) = arctangent(Xc/R) × (180/π). Because body composition parameters, including muscle mass and body fat percentage, are known to differ substantially by sex, comparisons of these parameters between satisfaction groups were performed separately for male and female patients.

Assessment of treatment satisfaction and QOL

Treatment satisfaction and QOL were assessed using the self-administered KDQOL-SF™ version 1.3 (Kidney Disease Quality of Life-Short Form) Japanese version [8, 9], based on the SF-36v2® Japanese manual [10]. Questionnaires were distributed during dialysis sessions, and patients were asked to complete and return them by the next session. For analysis, treatment satisfaction was categorized into two groups: the Satisfied Group ("most satisfied" or "satisfied") and the Not Satisfied Group ("not satisfied" or "neither satisfied nor dissatisfied"). This classification was not based on statistical thresholds (such as the median or ROC-derived cutoffs) but was intended to reflect a clinically meaningful, subjective sense of satisfaction. Specifically, a score of 66.7 corresponds to the response

category of 'generally satisfied' on the KDQOL-SF™ scoring system. This threshold is consistent with those applied in prior studies evaluating patient satisfaction in dialysis populations [5, 11]. The robustness of this cutoff was further supported by complementary analyses in which treatment satisfaction was treated as a continuous variable, yielding results consistent with the group-based findings.

Statistical analysis

Statistical analyses were performed using JMP Pro version 17 (SAS Institute Inc.). Continuous variables were summarized as the median with interquartile range (IQR) or as the mean ± standard deviation (SD), as appropriate, while categorical variables were expressed as frequencies and percentages. Comparisons of baseline characteristics between treatment satisfaction groups were conducted using the Kruskal–Wallis test for continuous variables and the Pearson chi-square test for categorical variables. Fisher's exact test was applied when the expected frequency in any cell was less than five. Comparisons of body composition parameters (SMI, FFM, the ICW-to-total body water ratio, the ECW-to-total body water ratio, and PhA) between the Satisfied and Not Satisfied groups were performed separately for male and female patients using the Kruskal–Wallis test, given known sex-based differences in body composition. The primary analyses evaluated the association between dichotomized treatment satisfaction and quality of life (QOL) outcomes. Linear regression analyses were performed to examine the relationships between treatment satisfaction and individual subscales of health-related QOL, kidney disease–specific QOL, and non–health-related QOL. Model 1 was unadjusted; Model 2 was adjusted for age, diabetes mellitus (DM), and N-terminal pro–B-type natriuretic peptide (NT-proBNP); and Model 3 was further adjusted for sex, cardiovascular disease (CVD), serum creatinine, and serum albumin levels. To examine the consistency of the observed associations and to complement the group-based analyses, additional analyses were performed treating treatment satisfaction scores and QOL subscale scores as continuous variables. In these complementary analyses, bivariate correlation analyses and simple linear regression models were applied to evaluate linear relationships between satisfaction and QOL measures. For prognosis, cumulative all-cause mortality was first assessed using the Kaplan–Meier method, and survival curves were compared between satisfaction groups using the log-rank test. Subsequently, Cox proportional hazards regression analyses were conducted to evaluate the association between treatment satisfaction and all-cause mortality. The adjustment strategy for the Cox models followed the same stepwise approach as described above: Model 1 was unadjusted; Model 2 was adjusted for age, DM, and NT-proBNP; and Model 3 additionally included sex, CVD, serum albumin, and serum creatinine. Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated, and *p*-values were calculated using the Wald test. A two-sided $p < 0.05$ was considered statistically significant for all analyses.

A generative artificial intelligence tool (Claude, Anthropic) was used to assist with language translation and formatting of the manuscript.

Results

Patient characteristics and association with treatment satisfaction

A total of 346 patients participated in this study, of whom 241 (69.8%) were classified into the Satisfied Group and 105 (30.2%) were classified into the Not Satisfied Group. The comparison of baseline characteristics and clinical laboratory values between the two groups is shown in Table 1. Regarding laboratory parameters, serum CRP levels and LDL-cholesterol levels were higher in the Not Satisfied Group, while no significant differences were observed in other laboratory parameters.

Table 1. Laboratory data according to treatment satisfaction groups

Variable	Satisfied (n = 241) median [IQR]	Not Satisfied (n = 105) median [IQR]	*p*-value
Age (years)	67 [56–73]	67 [54.5–76]	0.751
HD vintage (months)	68 [38–126]	69 [29.5–143.5]	0.983
Systolic BP at start (mmHg)	146 [130–160]	146 [128.5–164]	0.667
Total protein (g/dL)	6.6 [6.2–6.8]	6.5 [6.3–6.8]	0.725
Albumin (g/dL)	3.6 [3.4–3.8]	3.6 [3.4–3.7]	0.404
Sodium (mEq/L)	139 [138–140]	139 [138–141.5]	0.091
Potassium (mEq/L)	4.8 [4.4–5.3]	4.7 [4.3–5.1]	0.131
Chloride (mEq/L)	103 [102–105]	103 [101.5–106]	0.773
Triglycerides (mg/dL)	105 [71–153.5]	100 [64–146.5]	0.533
LDL-C (mg/dL)	88 [71–109.5]	81 [66–97.5]	**0.027**
Uric acid (mg/dL)	7.7 [6.8–8.5]	7.6 [6.9–8.75]	0.545
BUN (mg/dL)	58 [48–68.95]	56 [47.6–66.9]	0.397
Creatinine (mg/dL)	10.26 [8.865–11.82]	10.1 [8.715–11.59]	0.412
Calcium (mg/dL)	8.6 [8.3–8.9]	8.7 [8.3–9.0]	0.266
Phosphorus (mg/dL)	5.6 [5.0–6.25]	5.5 [4.8–6.3]	0.525
CRP (mg/dL)	0.09 [0.04–0.248]	0.135 [0.0585–0.39]	**0.035**
β2-microglobulin (mg/L)*	27.0 [23.9–29.575]	25.7 [22.7–28.5]	0.098
Hemoglobin (g/dL)	11.3 [10.7–11.9]	11.2 [10.7–11.85]	0.952
NT-proBNP (pg/mL)	3470 [1865–7410]	3600 [1550–7760]	0.786
Kt/Vurea (dialysis)	1.806 [1.658–2.058]	1.825 [1.606–2.001]	0.612
iPTH (pg/mL)	157 [107–221]	154 [94–203]	0.406

Note: Values are presented as median [IQR] using the 25th and 75th percentiles from the Quantiles output. *p*-values are from the Kruskal–Wallis test. Values with a $p < 0.05$ are shown in bold. β_2-microglobulin data were missing for 11 patients and were excluded from the analysis.

Body composition parameters did not differ significantly between the Satisfied and Not Satisfied groups when analyzed separately by sex. Among female patients, no significant differences were observed in SMI, FFM, the ICW-to-total body water ratio, the ECW-to-total body water ratio, or PhA (all $p > 0.05$,

Kruskal–Wallis test). Similarly, among male patients, none of these parameters differed significantly between the two groups (all $p > 0.05$).

Comparison of categorical baseline characteristics between satisfaction groups

Categorical variables including sex, diabetes mellitus (DM), cardiovascular disease (CVD), and smoking history were compared between the Satisfied Group (score ≥ 66.7) and the Not Satisfied Group (score < 66.7) (Table 2). No statistically significant differences were observed between the two groups for sex (male ratio: 71.0% in Satisfied vs. 72.4% in Not Satisfied, $p = 0.773$) or smoking history (history of smoking: 29.9% in Satisfied vs. 36.2% in Not Satisfied, $p = 0.209$). Conversely, a significant difference was observed in comorbidities between the two satisfaction groups. The prevalence of DM was significantly higher in the Not Satisfied Group (49.5%) compared to the Satisfied Group (38.6%) ($p = 0.044$). Similarly, the prevalence of CVD was also significantly higher in the Not Satisfied Group (43.8%) than in the Satisfied Group (32.8%) ($p = 0.038$).

Table 2. Categorical baseline characteristics according to treatment satisfaction groups

Characteristic	Satisfied Group (n = 241), %	Not Satisfied Group (n = 105), %	Total	*p*-value
Sex — Male	70.95	72.38	247	0.773
Sex — Female	29.05	27.62	99	
DM — Yes	38.59	49.52	145	**0.044**
DM — No	61.41	50.48	201	
CVD — Yes	32.78	43.81	125	**0.038**
CVD — No	67.22	56.19	221	
Smoking — Yes	29.88	36.19	110	0.209
Smoking — No	70.12	63.81	236	

Note: Values are presented as percentage (%). Percentages are calculated based on the total number of patients in each satisfaction group. Values with a $p < 0.05$ are shown in bold.

Association between treatment satisfaction and QOL

The comparisons of SF-36 and KDQOL domain scores between the Satisfied and Not Satisfied groups are illustrated in Figure 1 and Figure 2, respectively. Patients in the Satisfied Group exhibited significantly higher QOL scores across all domains in both the SF-36 (comprising HRQOL subscales) and the Kidney

Disease Quality of Life (KDQOL) (comprising effects of kidney disease subscales and non-health-related QOL subscales) (all $p < 0.05$, Kruskal–Wallis test).

Table 3 and the corresponding heatmap illustrate the associations between treatment satisfaction and each subscale of the SF-36 and KDQOL. In unadjusted models, treatment satisfaction was positively associated with nearly all QOL domains. These associations remained robust after adjustment for age, diabetes mellitus, and NT-proBNP (Model 2), and further persisted in the fully adjusted multivariable model (Model 3), which included additional covariates such as sex, cardiovascular disease, serum creatinine, and serum albumin levels. Among the SF-36 domains, General Health (β = 0.28), Bodily Pain (β = 0.25), and Mental Health (β = 0.36) demonstrated particularly strong associations with treatment satisfaction (all $p < 0.001$). Similarly, within the kidney disease–specific KDQOL domains, Dialysis Staff Encouragement (β = 0.41), Social Interaction (β = 0.26), and Effects of Kidney Disease (β = 0.32) showed significant positive relationships (all $p < 0.001$). In contrast, Work Status and Effects of Kidney Disease on Daily Life exhibited relatively weaker associations (β = 0.10–0.31, $p = 0.043$). In complementary analyses treating treatment satisfaction as a continuous variable, positive correlations were observed between satisfaction scores and nearly all SF-36 and KDQOL subscales. These linear associations were consistent with the findings of the group-based and multivariable regression analyses, supporting the robustness of the observed relationships. Detailed correlation coefficients are presented in Supplementary Table S1 (see Additional file 1).

Table 3. Associations between treatment satisfaction and QOL subscales (β coefficients)

Domain	Unadjusted β	Adjusted (Age, DM, NT-proBNP) β	Multivariable adjusted β	*p*-value
Physical Functioning	0.25	0.24	0.23	<0.001
Role-Physical	0.23	0.22	0.21	<0.001
Bodily Pain	0.30	0.26	0.25	<0.001
General Health	0.42	0.29	0.28	<0.001
Vitality	0.30	0.30	0.29	<0.001
Role-Emotional	0.24	0.23	0.23	<0.001
Social Functioning	0.29	0.29	0.29	<0.001
Mental Health	0.36	0.36	0.36	<0.001
Effects of Kidney Disease	0.32	0.32	0.32	<0.001
Work Status	0.12	0.11	0.10	0.043
Cognitive Function	0.30	0.30	0.29	<0.001
Symptoms/Problems	0.30	0.29	0.29	<0.001
Social Interaction	0.46	0.26	0.26	<0.001
Dialysis Staff Encouragement	0.42	0.42	0.41	<0.001
Effects of Kidney Disease on Daily Life	0.32	0.32	0.31	0.043
Sleep	0.30	0.30	0.29	<0.001
Social Support	0.29	0.29	0.29	<0.001
Burden due to Kidney Disease	0.30	0.29	0.30	<0.001
Interpersonal Relationships	0.29	0.29	0.29	<0.001

Note: The heatmap shows standardized β coefficients for the association between treatment satisfaction and each QOL subscale. Warmer colors (orange to red) indicate stronger positive associations, whereas cooler colors (green to yellow) indicate weaker associations. All analyses were performed using the Kruskal–Wallis test for group comparisons, and multiple regression models were adjusted for age, sex, diabetes mellitus, cardiovascular disease, serum creatinine, serum albumin, and NT-proBNP. $p < 0.05$ was considered statistically significant.

Association between treatment satisfaction and all-cause mortality

During the four-year observation period, 40 deaths occurred among the 346 patients, including 12 in the Not Satisfied Group and 28 in the Satisfied Group. The mean survival time was 1369.5 days (approximately 3.75 years); the median survival time could not be estimated because cumulative survival did not fall below 50% during the observation period. The association between treatment satisfaction and all-cause mortality was investigated using the Kaplan-Meier method. No statistically significant difference was observed in the cumulative survival curves between the Satisfied Group and the Not Satisfied Group (Log-rank test; $p = 0.838$). This result is presented in Figure 3.

Cox proportional hazards regression analyses were subsequently performed to evaluate the independent association between treatment satisfaction and all-cause mortality, and the results are summarized in Table 4. In the unadjusted Cox model (Model 1), the Satisfied Group showed a lower risk of all-cause mortality compared with the Not Satisfied Group (HR 0.85, 95% CI 0.67–1.09, $p = 0.192$). After adjusting for age, diabetes mellitus, and NT-proBNP (Model 2), and further adjusting for sex, cardiovascular disease, serum albumin, and serum creatinine (Model 3), the association remained non-significant (HR 0.90, 95% CI 0.70–1.16, $p = 0.411$). These findings indicate that treatment satisfaction was not independently associated with survival among maintenance hemodialysis patients.

Table 4. Cox proportional hazards model for all-cause mortality according to treatment satisfaction

Model	Hazard Ratio (HR)	95% Confidence Interval (CI)	*p*-value
Model 1	0.85	0.67–1.09	0.192
Model 2	0.90	0.70–1.15	0.385
Model 3	0.90	0.70–1.16	0.411

Note: Model 1 was unadjusted. Model 2 was adjusted for age, diabetes mellitus (DM), and NT-proBNP. Model 3 was further adjusted for sex, cardiovascular disease (CVD), serum albumin, and serum creatinine. *p*-values were calculated using the Wald test.

Discussion

This prospective observational cohort study was conducted to examine how treatment satisfaction in chronic maintenance HD patients is associated with their QOL and all-cause mortality. To our knowledge, this is one of the few studies to examine this association in a Japanese hemodialysis cohort, where cultural attitudes toward healthcare may differ from Western populations. Our findings revealed that treatment satisfaction was positively associated with many aspects of HRQOL, kidney disease-specific QOL, and non-health-related QOL [1, 6, 12]. This suggests that the patient's subjective sense of satisfaction widely contributes to their overall well-being, even under the challenging circumstances of dialysis therapy [1]. QOL in dialysis patients is a multidimensional concept composed of physical, psychological, social, and economic aspects. Treatment satisfaction is closely linked to psychosocial factors, particularly the patient-staff relationship and the trust in the medical care provided. We

hypothesize that patients who are satisfied with their treatment can maintain a more positive psychological state and experience a reduced burden of therapy, consequently leading to higher scores across various QOL domains. These associations were consistently observed not only in the primary group-based analyses but also when treatment satisfaction was analyzed as a continuous variable. The concordance of results across different analytical approaches indicates that the observed relationships between treatment satisfaction and QOL are robust and are unlikely to be driven by the choice of a specific cutoff value for satisfaction. This analytical consistency strengthens the validity of our findings and supports the interpretation that treatment satisfaction represents a continuous, patient-centered construct closely linked to multidimensional QOL in HD patients.

Interestingly, the associations between treatment satisfaction and two specific QOL domains—Work Status and Effects of Kidney Disease on Daily Life—were relatively weaker compared to other QOL domains. These areas may be influenced by objective limitations in physical function and socio-environmental factors, such as the flexibility of dialysis session times and facilities, rather than subjective satisfaction with the treatment itself. Specifically, the ability of HD patients to work is largely dependent on the dual challenges of residual physical capacity and the compatibility of the work environment, more so than factors attributable to the quality of medical care (treatment satisfaction). This result suggests that while the improvement of treatment satisfaction is useful for many QOL aspects, domains dependent on socio-physical background require multi-faceted interventions, including social and vocational support, beyond purely medical care.

Furthermore, the analysis of baseline characteristics revealed that the Not Satisfied Group had a significantly higher prevalence of both diabetes mellitus (DM) and cardiovascular disease (CVD) (Table 2). This association suggests that the lower level of treatment satisfaction may, in part, be attributed to the objective burden of comorbidities experienced by the patients. DM exacerbates physical distress, such as foot numbness from diabetic neuropathy or hemodynamic instability during dialysis due to autonomic neuropathy. Additionally, stringent glycemic control and vision loss from retinopathy increase the burden of self-management and daily living difficulties, leading to overall dissatisfaction with treatment [13, 14]. Similarly, CVD impairs QOL by reducing physical activity capacity due to heart failure and increases the risk of complications like intradialytic hypotension and arrhythmias. Frequent hospitalizations due to CVD further interrupt treatment and increase physical and psychological burden, directly undermining confidence and satisfaction with the quality of care and healthcare system [15]. Therefore, the substantial physical distress and treatment burden imposed by these comorbidities are presumed to be direct factors reducing patient satisfaction. Despite these comorbidity-related differences in satisfaction, treatment satisfaction itself was not an independent predictor of all-cause mortality, even though it was associated with numerous QOL components. This result appears to deviate from previous studies that consistently reported an association between low HRQOL and increased mortality in dialysis patients [4, 16]. This discrepancy suggests that treatment satisfaction and QOL are distinct concepts with differing impacts on vital prognosis. As pointed out by Ferrans et al. [5], treatment satisfaction is a subjective evaluative index heavily influenced by individual expectations, cultural background, and values regarding healthcare. Consequently, it may not directly reflect disease severity or

clinical outcomes; rather, it primarily measures the psychosocial dimension of how a patient experiences and understands their care. In contrast, all-cause mortality in HD patients is known to be more strongly governed by objective physiological factors such as chronic inflammation, malnutrition, and cardiovascular disease [7, 17]. Consistent with this view, the Not Satisfied Group in our study showed a trend toward higher serum C-reactive protein (CRP) levels and LDL-cholesterol levels. Given that cardiovascular disease is the leading cause of death in patients with chronic kidney disease and HD [18], chronic inflammation (high CRP) and dyslipidemia (high LDL-cholesterol) are implicated. CRP, as a marker of chronic inflammation, is known to promote endothelial dysfunction and the progression of atherosclerosis [19, 20]. Furthermore, chronic inflammation contributes to conditions like malnutrition, sarcopenia, and frailty, which worsen prognosis in dialysis patients [21]. Notably, in the present cohort, objective indices of nutritional and body composition status, including the skeletal muscle mass index, fat-free mass, and phase angle, did not differ significantly between the Satisfied and Not Satisfied groups in either sex, further supporting the interpretation that subjective treatment satisfaction is decoupled from the objective physiological status that principally governs survival in this population. This suggests that the patient's subjective satisfaction does not necessarily align with these underlying complex pathophysiological changes. Thus, even if a patient feels subjectively satisfied with their treatment, disease progression may occur independently, and subjective satisfaction alone is presumed insufficient to counteract these strong prognostic determinants.

This study provides the insight that treatment satisfaction is correlated with QOL yet was not independently associated with all-cause mortality. To further elucidate this complex relationship, the following research avenues are critical. First, long-term longitudinal studies are indispensable to evaluate the impact of changes in treatment satisfaction over time on both QOL and prognosis. Second, to test the hypothesis that treatment satisfaction is indirectly associated with prognosis through QOL, prospective interventional studies are warranted. Third, given the cultural specificity of this Japanese cohort, international comparative studies are needed to examine whether the relationship between treatment satisfaction and QOL generalizes across different healthcare systems and cultural contexts. Specific interventions could include patient education programs, psychological counseling, and individualized dietary/exercise guidance provided by multidisciplinary teams, all aimed at enhancing patient satisfaction.

Limitations

This study has several limitations that should be acknowledged. First, the evaluation of treatment satisfaction and QOL was conducted at a single time point, reflecting a cross-sectional nature. This inherent limitation prevents us from definitively identifying the causal relationship between these two factors. Second, the categorization of treatment satisfaction into the Satisfied (≥ 66.7) and Not Satisfied (< 66.7) groups was based on an exploratory grouping using patients' subjective responses from the KDQOL-SF™, and not on a statistically determined optimal threshold. Although we adopted a clinically meaningful cutoff value (66.7 points, corresponding to generally satisfied) with reference to previous studies, the generalizability of these results must account for the potential influence of psychological

and cultural backgrounds, as well as individual expectations. Therefore, future research is required to validate the statistically optimal cutoff value, potentially through methods such as ROC analysis. Third, the study population was limited to patients in specific regions and facilities in Japan, which restricts the generalizability of the findings to the broader hemodialysis population. Furthermore, cultural attitudes toward healthcare and subjective satisfaction may differ across countries, and caution is warranted when extrapolating these findings to non-Japanese populations. Fourth, we cannot rule out the limitations of statistical detection power due to the observation period and the number of events, as well as the potential influence of unmeasured confounding factors (e.g., detailed family support status, economic status).

Conclusions

In this prospective cohort of maintenance hemodialysis patients, treatment satisfaction was significantly associated with a wide range of QOL domains but was not independently associated with all-cause mortality. Lower satisfaction coincided with a greater burden of diabetes mellitus, cardiovascular disease, and dyslipidemia, yet body composition parameters remained unchanged between groups, suggesting that treatment satisfaction reflects perceived disease burden rather than objective physical status. Taken together, these findings support treatment satisfaction as a patient-centered indicator of psychosocial well-being, complementary to—but not a substitute for—established physiological prognostic markers in this population.

Abbreviations

BIA: Bioelectrical impedance analysis

CKD: Chronic kidney disease

CI: Confidence interval

CRP: C-reactive protein

CVD: Cardiovascular disease

DM: Diabetes mellitus

ECW: Extracellular water

ESRD: End-stage renal disease

FFM: Fat-free mass

HD: Hemodialysis

HR: Hazard ratio

HRQOL: Health-related quality of life

ICW: Intracellular water

IQR: Interquartile range

iPTH: Intact parathyroid hormone

KDQOL-SF: Kidney Disease Quality of Life-Short Form

LDL: Low-density lipoprotein

NT-proBNP: N-terminal pro-B-type natriuretic peptide

PhA: Phase angle

QOL: Quality of life

ROC: Receiver operating characteristic

SD: Standard deviation

SF-36: 36-Item Short Form Health Survey

SMI: Skeletal muscle mass index

WHO: World Health Organization

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Toho University Sakura Medical Center, Chiba, Japan (Approval Numbers: S24012_S21073(S18086)). Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

NY and YO designed the study. YO, SI, MH, and KY contributed to sample acquisition. NY, TT, YS, ST, and YO analysed and interpreted the data. Each author contributed important intellectual content during manuscript drafting and/or revision and accepted accountability for the overall work. All authors read and approved the final manuscript.

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Figures

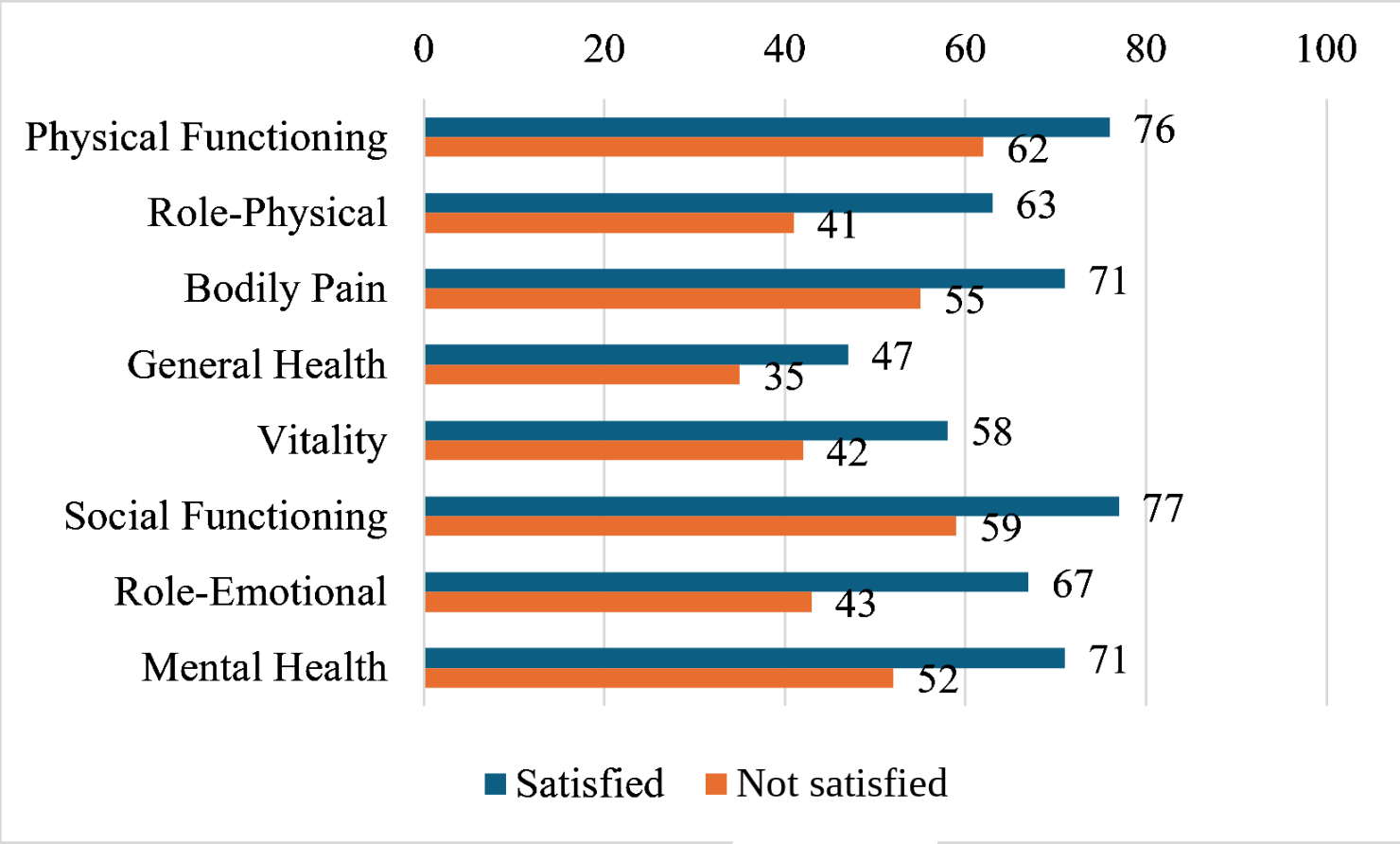

Figure 1

Associations between treatment satisfaction and SF-36 scores

Note: Mean domain scores of SF-36 according to treatment satisfaction. The Satisfied Group showed significantly higher scores than the Not Satisfied Group in all domains ($p < 0.001$, Kruskal–Wallis test).

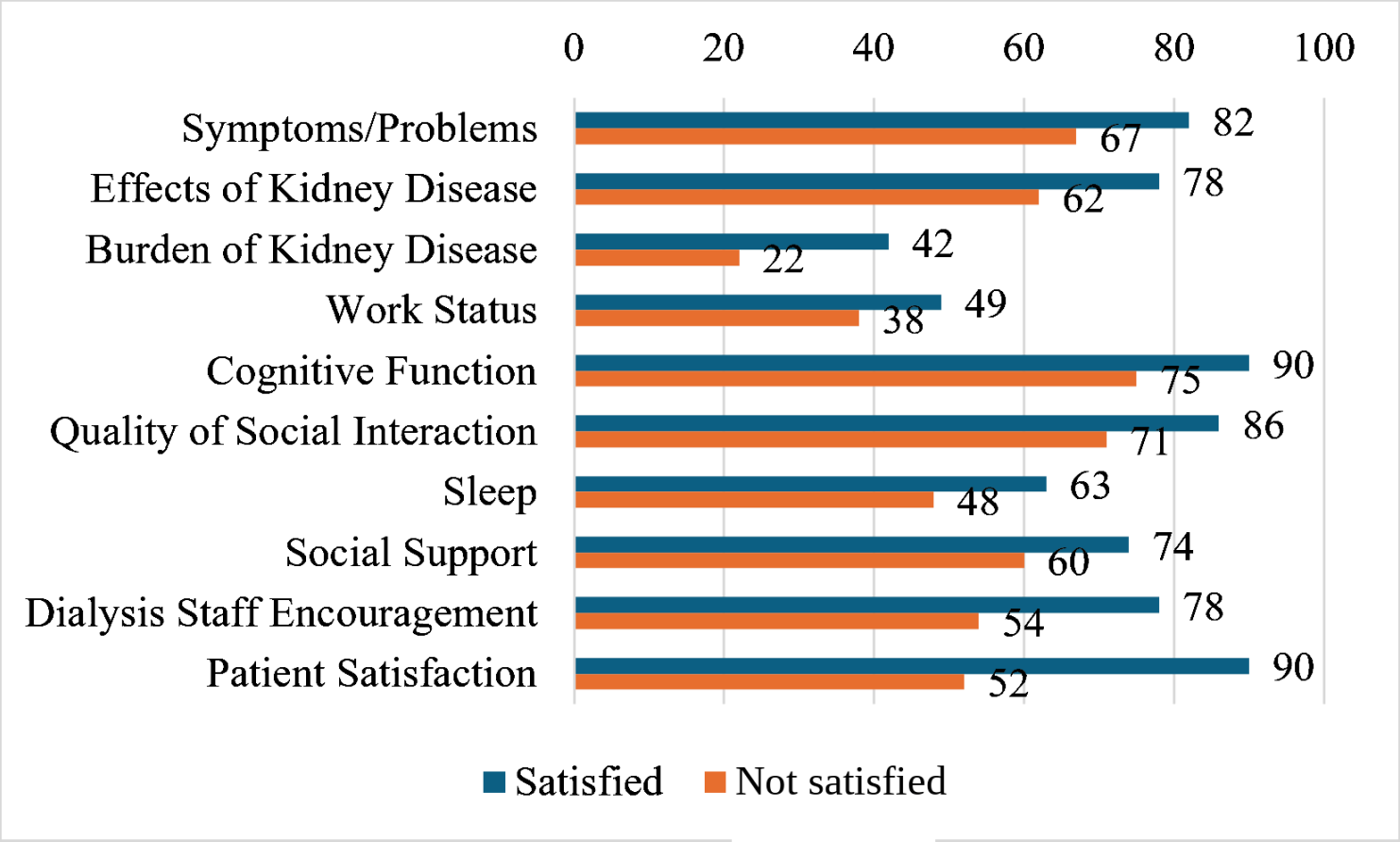

Figure 2

Associations between treatment satisfaction and KDQOL scores

Note: Mean domain scores of KDQOL according to treatment satisfaction. The Satisfied Group showed significantly higher scores in all domains ($p < 0.05$, Kruskal–Wallis test).

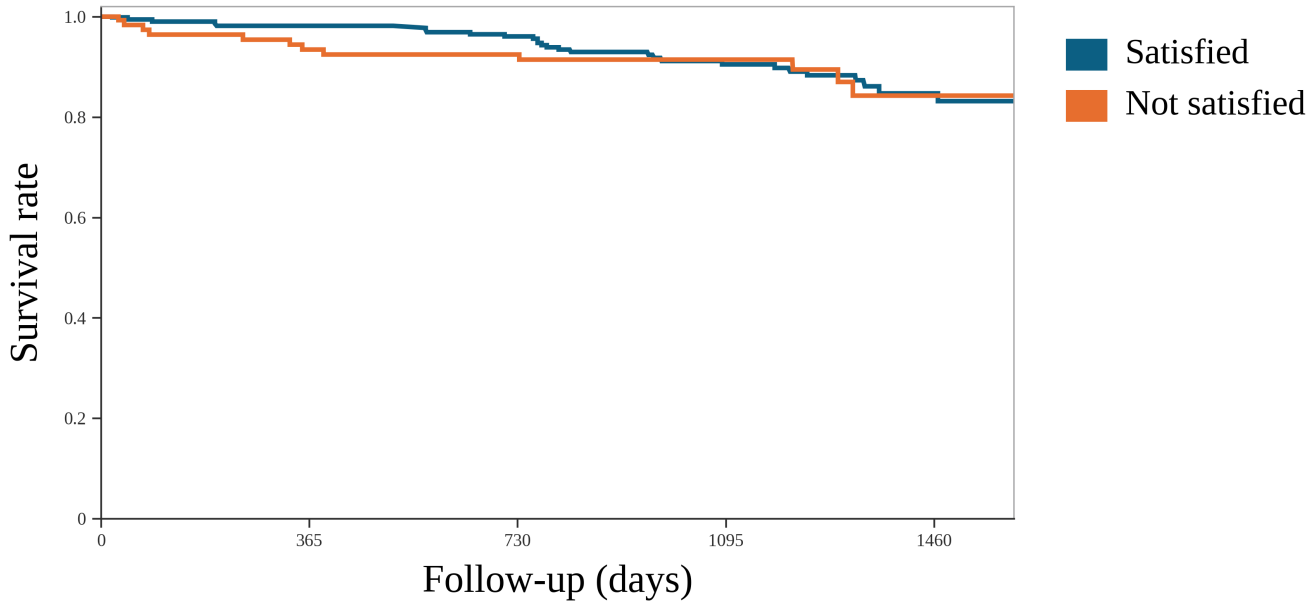

Figure 3

Kaplan–Meier survival curves according to treatment satisfaction

Note: Survival rates were compared between the Satisfied and Not Satisfied Groups using the Kaplan–Meier method and the log-rank test.

Supplementary Files

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