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Population-Referenced Health-Related Quality of Life Among Adults Receiving Maintenance Dialysis at Three Vietnamese Healthcare Centres: A Multicentre Cross-Sectional Study

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TITLE PAGE

POPULATION-REFERENCED HEALTH-RELATED QUALITY OF LIFE AMONG ADULTS RECEIVING MAINTENANCE DIALYSIS AT THREE VIETNAMESE HEALTHCARE CENTRES: A MULTICENTRE CROSS-SECTIONAL STUDY

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Population-referenced health-related quality of life among adults receiving maintenance dialysis at three Vietnamese healthcare centres: a multicentre cross-sectional study

Running title: Population-referenced HRQoL in dialysis

Abstract

Background Health-related quality of life (HRQoL) is substantially impaired among people receiving maintenance dialysis, but absolute scores do not show how patients' health differs from that expected in the surrounding population. We quantified population-referenced HRQoL deficits among adults receiving maintenance dialysis at three Vietnamese healthcare centres, with particular attention to dimension-specific functional burden and selected social patterning.

Methods We analysed cross-sectional data collected at three healthcare centres between April and June 2026. Vietnamese EQ-5D-5L population reference data collected in 2017 (n=1,200) were used to estimate conditional expected utility and dimension-specific problem prevalence according to age, sex, education and marital status. The primary outcome was expected minus observed EQ-5D-5L utility. Two-stage bootstrap inference used 2,000 replicates with bias-corrected and accelerated confidence intervals. Social patterning was examined in adjusted models, and multiple imputation assessed robustness to missing covariates.

Results The primary analysis included 697 participants. Mean observed utility was 0.703 compared with an expected population-referenced utility of 0.924, corresponding to a mean deficit of 0.221 (95% BCa CI 0.194–0.248). Although pain/discomfort was the most prevalent absolute problem, the largest excess burdens relative to the population reference occurred in usual activities (38.5 percentage points), mobility (34.7) and self-care (33.7). Among 633 complete cases, participants classified as unemployed/dependent had a 0.123 larger adjusted deficit than employed participants (95% BCa CI 0.059–0.179); the estimate was similar after multiple imputation (0.128, 95% CI 0.070–0.186).

Conclusions Adults receiving maintenance dialysis at three Vietnamese healthcare centres experienced substantial HRQoL deficits relative to available Vietnamese population reference data, with disproportionate burden in usual activities, mobility and self-care. Population benchmarking provided information beyond absolute EQ-5D-5L problem prevalence by identifying functional domains with the greatest excess burden. The larger deficit observed in the unemployed/dependent group may identify a potentially vulnerable subgroup but should not be interpreted as an independent effect of unemployment because of the cross-sectional design and residual clinical confounding.

Keywords: health-related quality of life; maintenance dialysis; EQ-5D-5L; population reference data; patient-reported outcomes; Vietnam

Introduction

Kidney failure requiring maintenance dialysis is a chronic treatment state in which life-sustaining therapy is accompanied by substantial symptom, functional and treatment burden. A recent review of 123 studies involving 24,007 people with chronic kidney disease in low- and lower-middle-income countries found progressive HRQoL deterioration, with pooled EQ-5D utility falling to 0.486 among dialysis recipients [1]; this is consistent with broader evidence showing substantial utility loss across chronic kidney disease treatment states [2]. Vietnamese evidence also shows substantial impairment in health- and kidney-related quality of life among people receiving haemodialysis [3], and a single-centre Vietnamese study reported EQ-5D-5L utilities of 0.766 (HD) and 0.848 (PD) [4], both considerably higher than the 0.486 pooled LLMIC estimate. HRQoL is therefore an important patient-reported outcome alongside conventional clinical indicators.

Impaired HRQoL among dialysis recipients is well recognised, but much of the literature reports absolute questionnaire scores or compares subgroups within dialysis populations. These approaches do not quantify how far patients' health falls below what would be expected in the surrounding population. This distinction matters because HRQoL is socially patterned: psychosocial factors are associated with quality of life in dialysis populations [5], and Vietnamese EQ-5D-5L population reference values vary across sociodemographic groups [6].

Vietnam has a country-specific EQ-5D-5L value set [7] and EQ-5D-5L population reference data from a 1,200-adult sample [6]. These resources permit individualised benchmarking rather than comparison with a single unmatched population mean, an approach consistent with previous population-referenced HRQoL studies across chronic diseases, including studies comparing patient groups with matched general-population reference values [8,9]. We define the population-referenced utility deficit as expected population utility minus observed dialysis utility. This is a descriptive measure of excess HRQoL burden, not a causal effect of dialysis.

HRQoL burden may also vary among patients who have already accessed dialysis. Travel distance to haemodialysis has been associated with poorer HRQoL in some international settings [10], although distance measurement and its clinical relevance in this setting are not established, so we treat it here as a secondary, exploratory analysis. Psychosocial and socioeconomic circumstances are more consistently associated with quality of life in dialysis populations [5]; in Vietnam, education and residence have been associated with HRQoL among haemodialysis patients [3], and employment is particularly salient because symptoms, treatment schedules, financial insecurity and workplace constraints can undermine sustained work [11].

Whether such social circumstances are associated with excess population-referenced HRQoL burden remains poorly characterised in Vietnam.

We therefore benchmarked HRQoL among adults receiving maintenance dialysis at three Vietnamese healthcare centres against available Vietnamese EQ-5D-5L population reference data. We aimed to (1) estimate the mean population-referenced utility deficit and dimension-specific excess problem prevalence; and (2) examine selected social patterning of the deficit, with recorded facility distance among haemodialysis participants evaluated as a secondary, exploratory analysis. All subgroup associations were interpreted as descriptive rather than causal.

Materials and methods

Study design and setting

We conducted a multicentre cross-sectional secondary analysis of previously collected data from adults receiving maintenance dialysis at Ba Ria General Hospital (Ho Chi Minh City), Cho Ray Hospital (Ho Chi Minh City) and Thien Hanh General Hospital (Dak Lak). Data were collected concurrently from all three centres between April and June 2026. The cohort was benchmarked against the 2017 Vietnamese EQ-5D-5L reference sample of 1,200 adults [6], with utilities valued using the Vietnamese value set [7]. The analysis therefore compares a 2026 dialysis cohort with the available 2017 population reference rather than a contemporaneous counterfactual; this temporal mismatch is considered further in the Limitations. Core estimands, covariates, harmonisation rules and eligibility criteria were specified in the statistical analysis plan; the HD-only distance restriction was documented before the final restricted model was fitted.

Dialysis cohort and analytic eligibility

Analyses were restricted to adults aged 18-88 years, matching the population-reference age range. The source datasets identified participants as receiving maintenance HD or PD; a minimum treatment-duration criterion was not retained and could not be reconstructed. Maintenance dialysis reflected the classification used in the source studies; a minimum dialysis-duration threshold could not be reconstructed for this secondary analysis.

Potential duplicate or repeated-person records were evaluated using prespecified outcome-independent rules. When duplicate identity was strongly suspected but the canonical record could not be verified, both records were excluded conservatively. Analyses were based on the audited harmonised master dataset and the prespecified adjudication pipeline. The original

centre-specific recruitment procedures and response denominators were not retained in the harmonised dataset and therefore could not be reconstructed for this secondary analysis.

Complete-case eligibility was estimand-specific. The primary utility analysis required a complete EQ-5D-5L health state plus age, sex, education and marital status. Dimension-specific analyses required the relevant EQ-5D-5L dimension and the same normative-model covariates, allowing a participant missing one dimension to remain eligible for other dimension-specific estimands.

Population reference sample

The population reference comprised 1,200 Vietnamese adults aged 18-88 years surveyed in 2017 [6]. A multistage, stratified, cluster probabilistic quota-based sampling method selected urban and rural clusters across six provinces representing six geographic regions [6]. No sampling-weight variable was available in the analytic dataset; normative models were therefore fitted unweighted. One participant lacked education and marital-status data, leaving 1,199 observations for the primary normative models.

HRQoL measures

Generic HRQoL was assessed using the EQ-5D-5L, covering mobility, self-care, usual activities, pain/discomfort and anxiety/depression [12]. Utility was recalculated from the five responses using the Vietnamese value set [7] and cross-validated against the published utility variable in the population-reference data. Questionnaire administration procedures could not be independently verified to be identical across all three centres and are therefore considered in the Limitations.

Each EQ-5D-5L dimension was dichotomised as no problems (level 1) versus any problems (levels 2-5). Excess problem prevalence was observed dialysis prevalence minus model-based expected population prevalence.

Sociodemographic, social and dialysis-related variables

Covariates included age, sex, education, marital status, employment, family support, centre, dialysis modality and dialysis vintage. Education was grouped as high school or below versus post-secondary; employment as employed, unemployed/dependent or retired (coded directly from the source occupation question, which offered "unemployed/dependent" as a single combined response option; the raw field did not distinguish unemployment from dependency due to disability or other inactivity, so this composite could not be disaggregated); family support as living with family and reporting family support, living with family but reporting no

family support, or living alone (coded directly from the source family-support question, which did not distinguish financial, practical and emotional forms of support); and dialysis vintage as <1 year, 1 to <5 years or >=5 years.

Travel distance was taken from the harmonised source variable, recorded in kilometres as distance to the treatment facility. The source metadata available for this analysis did not identify whether the value was self-reported, geocoded straight-line distance or road-network distance. We therefore interpreted it as a pragmatic facility-distance measure rather than a direct measure of travel time or travel burden. Distance was transformed as log2(distance in km + 1) and centred within centre; a one-unit increase represents a doubling of (distance + 1).

Statistical analysis

Participant characteristics were summarised overall in the main manuscript without hypothesis-test P values; centre- and modality-stratified characteristics are provided in Supplementary Table S1. Analyses addressed population-referenced EQ-5D-5L burden and selected social patterning; facility distance was evaluated as a secondary, exploratory analysis.

Population-referenced HRQoL. In the population reference, EQ-5D-5L utility was modelled by unweighted ordinary least squares using age, sex, education and marital status. Age used a restricted cubic spline with fixed knots at 19, 30, 44 and 66 years. The fitted model generated each dialysis participant's expected normative utility; the deficit was expected minus observed utility, with positive values indicating worse-than-expected HRQoL. The primary estimand was the mean deficit.

Five penalised logistic regression models with logit links estimated the expected probability of any problem in each EQ-5D-5L dimension using the same covariates. A fixed negligible L2 (ridge) penalty (alpha=10^-8) was applied because some bootstrap resamples produced quasi-complete separation for low-prevalence dimensions, which would otherwise prevent the logistic model from converging; this penalty is several orders of magnitude smaller than penalties used for genuine shrinkage and was chosen only to stabilise estimation in affected resamples without materially biasing the point estimates.

Uncertainty for the utility deficit used a two-stage nonparametric bootstrap with 2,000 replicates (seed 20260906). The population model was refitted after individual reference participants were resampled, while dialysis participants were independently resampled within centre. The bootstrap therefore propagated uncertainty from the available reference records but did not recreate the original multistage cluster design. Primary 95% confidence intervals were

bias-corrected and accelerated (BCa); dimension-specific analyses used the same procedure with estimand-specific complete cases.

Secondary analyses of social patterning and facility distance used a fully adjusted full-cohort model (M3) that provided the reported employment and family-support estimates, with centre retained only as an adjustment factor; point estimates used OLS. Within-centre facility distance was included as one covariate in this fully adjusted model, and, because facility distance is not a comparable exposure for peritoneal dialysis, a separate sequential model-building sequence was also fitted, as a secondary, exploratory analysis, among participants receiving haemodialysis only: M0 included distance only; M1 added centre, sex, marital status and age modelled with the same restricted cubic spline (knots at 19, 30, 44 and 66 years) as the Stage-1 normative model; M2 added education, employment and family support; and M3 added dialysis vintage. The same sequential model fitted to the full HD+PD cohort, with modality added at M3, was reported as a sensitivity analysis (Supplementary Table S4). Reported 95% CIs were obtained from the full two-stage BCa bootstrap, which refitted both the normative and disparities models in each replicate and resampled dialysis participants within centre. Because 60 of 697 participants (58 at Cho Ray) lacked employment status, a multiple-imputation-by-chained-equations sensitivity analysis was performed for the full-cohort model using 50 imputations. Predictive mean matching was used for distance and multinomial logistic imputation for employment, family support and dialysis vintage, conditional on centre, age, sex, marital status, education, modality and the population-referenced deficit. Estimates were pooled using Rubin's rules to assess whether centre-concentrated missingness materially altered the complete-case employment association.

Primary analyses used estimand-specific complete cases. Analyses were implemented in Python 3.12.3 using NumPy 2.4.4, pandas 3.0.2, patsy 1.0.3, statsmodels 0.15.0 and SciPy 1.17.1. Generative AI tools, including ChatGPT (OpenAI) and Claude (Anthropic), were used during manuscript preparation for drafting support, language refinement, statistical code review and manuscript structuring. All analyses, references, statistical outputs and manuscript content were independently reviewed and verified by the authors, who take full responsibility for the final work.

Ethical considerations

Ethics approval and informed consent. This secondary analysis draws on data originally collected under three studies approved by the Institutional Review Board for Biomedical Research, University of Medicine and Pharmacy at Ho Chi Minh City (IRB-VN01002/IRB00010293/FWA00023448), covering all three participating centres and

permitting secondary use of the collected data for related analyses; full approval numbers are given under Declarations. Written informed consent was obtained from all participants at the study hospitals before data collection, including consent for secondary use of the collected data for related research analyses; the signed consent forms were retained in the study records in accordance with the approved study protocols.

Results

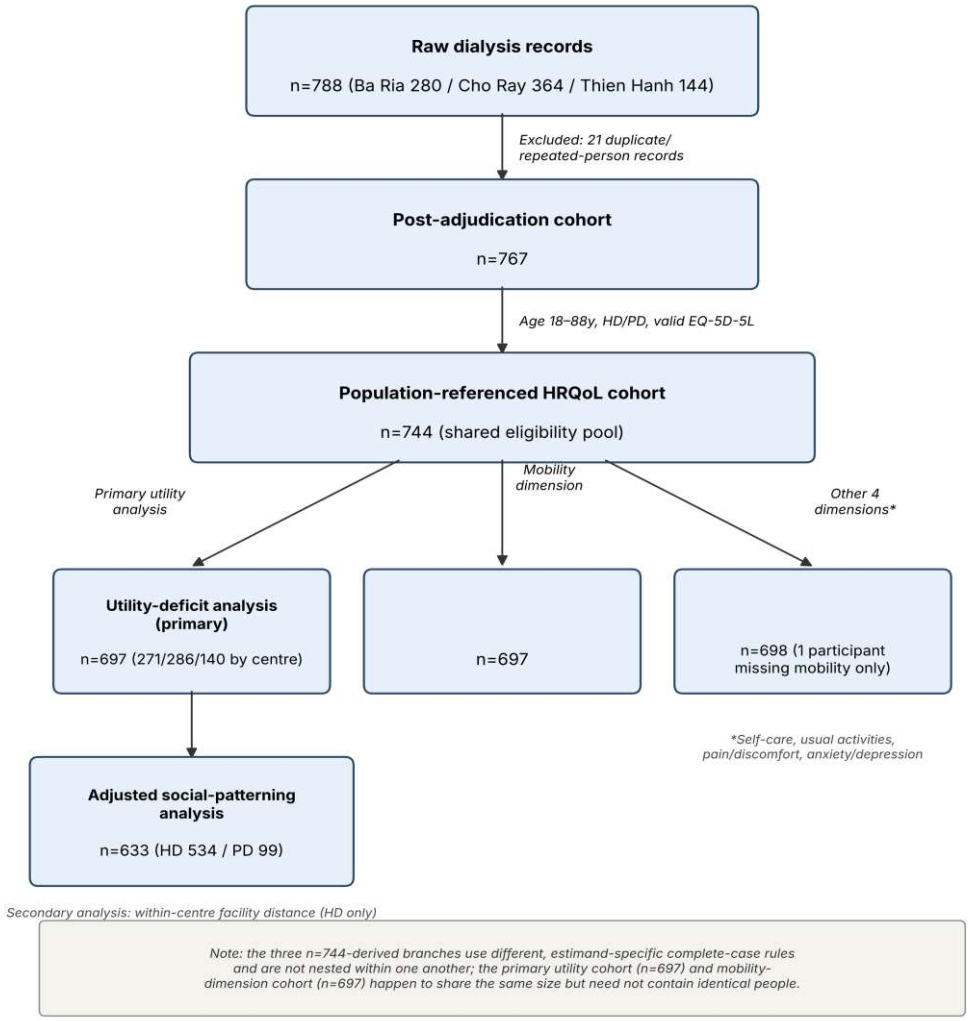


Fig. 1 Analytic cohort derivation. The primary utility-deficit cohort comprised 697 participants after record adjudication and estimand-specific eligibility criteria.

Study sample and participant characteristics

The raw dataset contained 788 records from Ba Ria (n=280), Cho Ray (n=364) and Thien Hanh (n=144). Duplicate/repeated-person adjudication excluded 21 records, leaving 767 post-adjudication records. Of these, 744 met the age, dialysis-modality and valid EQ-5D-5L health-state eligibility criteria; 697 additionally had complete age, sex, education and marital-status

data required for the primary utility analysis (271, 286 and 140 from the three centres, respectively). Of the 697 participants, 581 (83.4%) received HD and 116 (16.6%) PD. Mean age was 51.1 years (SD 15.0), 342 (49.1%) were women, 510 (73.2%) had high-school education or below and 546 (78.3%) were married (Table 1; Figure 1).

Mobility analysis included 697 participants; self-care, usual activities, pain/discomfort and anxiety/depression each included 698 because one participant had missing mobility but valid responses for the other dimensions. The adjusted social-patterning analysis included 633 complete cases (HD n=534; PD n=99). Detailed centre- and modality-stratified characteristics are provided in Supplementary Table S1.

Table 1. Characteristics of the primary utility-analysis cohort (N=697).

Characteristic	**Overall (N=697)**
Demographic characteristics	
Age, years, mean (SD)	51.1 (15.0)
Female, n (%)	342 (49.1)
Male, n (%)	355 (50.9)
Social characteristics	
Education: <= high school, n (%)	510 (73.2)
Education: post-secondary, n (%)	187 (26.8)
Married, n (%)	546 (78.3)
Not married, n (%)	151 (21.7)
Employment status	
Employed, n (%)	126 (18.1)
Unemployed/dependent, n (%)	375 (53.8)
Retired, n (%)	136 (19.5)
Employment missing, n (%)	60 (8.6)
Family support	
Family-supported, n (%)	492 (70.6)
Living with family, no reported support, n (%)	173 (24.8)

Characteristic	Overall (N=697)
Lives alone, n (%)	32 (4.6)
Facility-distance characteristic	
Travel distance to treatment facility, km, median [IQR]	20.5 [10-60]
Distance missing, n (%)	1 (0.1)
Dialysis characteristics	
Haemodialysis (HD), n (%)	581 (83.4)
Peritoneal dialysis (PD), n (%)	116 (16.6)
Dialysis vintage: <1 year, n (%)	84 (12.1)
Dialysis vintage: 1 to <5 years, n (%)	360 (51.6)
Dialysis vintage: >=5 years, n (%)	247 (35.4)
Dialysis vintage missing, n (%)	6 (0.9)
Centre distribution	
Ba Ria, n (%)	271 (38.9)
Cho Ray, n (%)	286 (41.0)
Thien Hanh, n (%)	140 (20.1)

Notes: Percentages use the full cohort denominator; missing values are shown explicitly. Travel distance is summarised as median [IQR] because of right-skew. Centre- and modality-stratified characteristics are reported in Supplementary Table S1. HD, haemodialysis; PD, peritoneal dialysis; IQR, interquartile range.

EQ-5D-5L health profile relative to Vietnamese population reference data

Pain/discomfort was the most common problem (62.9%), followed by mobility (51.1%), anxiety/depression (49.7%), usual activities (45.0%) and self-care (36.8%). After population benchmarking, excess prevalence was greatest for usual activities (38.5 percentage points [pp], 95% BCa CI 34.4 to 42.4), mobility (34.7 pp, 30.1 to 39.2), self-care (33.7 pp, 29.9 to 37.4), anxiety/depression (29.5 pp, 25.1 to 34.1) and pain/discomfort (20.0 pp, 15.1 to 25.0) (Table 2; Figure 2).

Pain/discomfort had the highest absolute prevalence but was also common in the expected population profile (42.9%). Expected problems with usual activities and self-care were only 6.5% and 3.1%, respectively, producing larger excess burdens.

Overall EQ-5D-5L utility and population-referenced HRQoL deficit

Among 697 participants, mean observed EQ-5D-5L utility was 0.703 and mean expected normative utility was 0.924, giving a mean population-referenced deficit of 0.221 (95% BCa CI 0.194 to 0.248); all 2,000 bootstrap replicates completed successfully. The utility distribution was left-skewed with a ceiling at full health (175/697, 25.1%, health state 11111), and 51/697 (7.3%) participants reported utility below zero; distributional detail, five-level responses in the complete-utility cohort and Stage-1 normative-model diagnostics are provided in Supplementary Table S3.

Table 2. EQ-5D-5L HRQoL among adults receiving maintenance dialysis compared with Vietnamese population reference data

Outcome	N	Observed dialysis	Expected reference	Excess/deficit	95% BCa CI
EQ-5D-5L utility	697	0.703	0.924	0.221	0.194 to 0.248
Mobility: any problems	697	51.1%	16.3%	34.7 pp	30.1 to 39.2 pp
Self-care: any problems	698	36.8%	3.1%	33.7 pp	29.9 to 37.4 pp
Usual activities: any problems	698	45.0%	6.5%	38.5 pp	34.4 to 42.4 pp
Pain/discomfort: any problems	698	62.9%	42.9%	20.0 pp	15.1 to 25.0 pp
Anxiety/depression: any problems	698	49.7%	20.2%	29.5 pp	25.1 to 34.1 pp

Notes: Utility deficit = expected normative utility - observed dialysis utility; positive values indicate worse-than-expected utility. For dimensions, any problems = levels 2-5 versus level 1. Excess prevalence = observed dialysis prevalence - expected normative prevalence. Expected values were standardised for age, sex, education and marital status. BCa CIs are from the two-stage bootstrap with 2,000 replicates. pp, percentage points.

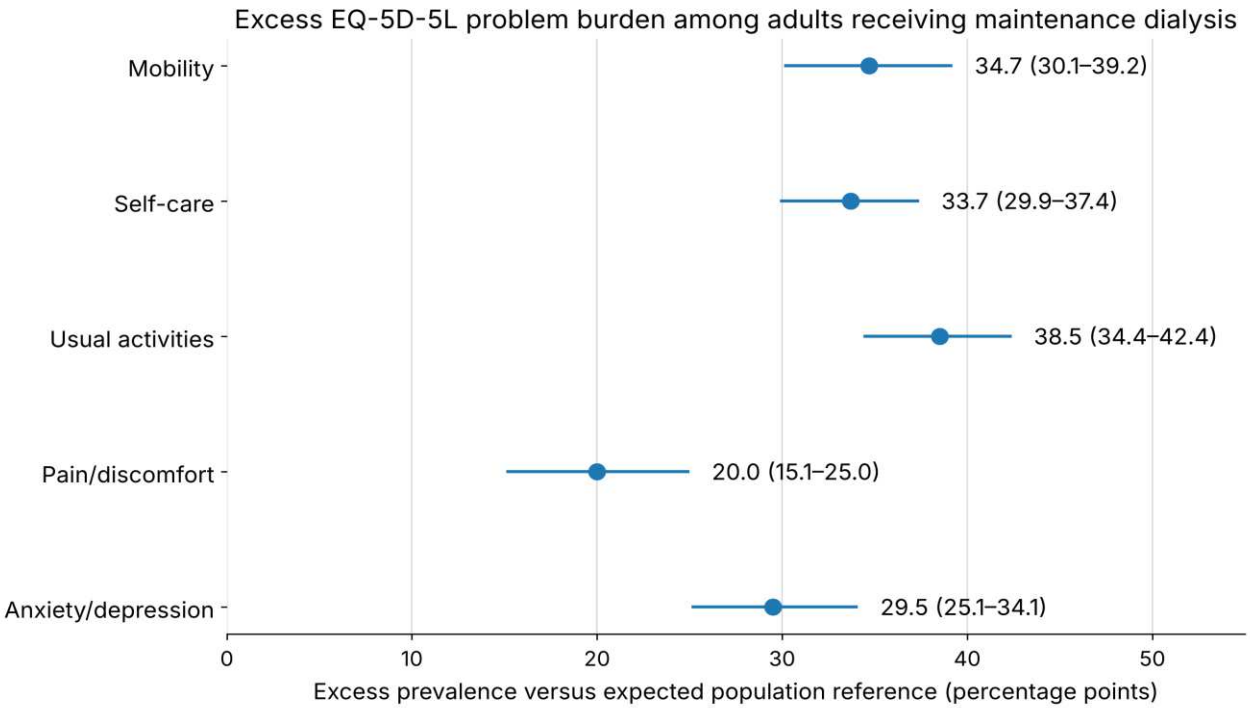


Fig. 2 Population-referenced excess EQ-5D-5L problem burden among adults receiving maintenance dialysis.

Social patterning of the population-referenced HRQoL deficit, including a secondary facility-distance analysis

In the fully adjusted full-cohort model (N=633, M3), participants classified as unemployed/dependent had a 0.123 larger deficit than employed participants (95% BCa CI 0.059 to 0.179); retired versus employed was 0.056 (95% BCa CI -0.052 to 0.153). The employment association was materially unchanged after multiple imputation of missing covariates (pooled estimate 0.128, 95% CI 0.070 to 0.186; Supplementary Table S2). Confidence intervals for sex, marital status, education, family support, PD versus HD, dialysis vintage and within-centre distance included zero. Centre was retained as an adjustment factor; centre coefficients were not interpreted because the study was not designed for between-centre performance comparisons and residual differences in case mix and data-collection procedures

may remain. Age was retained as a restricted-cubic-spline adjustment term, and its individual spline-basis coefficients were not interpreted separately (Table 3).

In a secondary, exploratory analysis among 534 participants receiving HD, recorded within-centre facility distance showed no clear adjusted association with the deficit (β=0.0041, 95% BCa CI -0.0130 to 0.0210); the full sequential model-building sequence and sensitivity analyses are reported in Supplementary Table S4.

Table 3 Adjusted associations with the population-referenced EQ-5D-5L utility deficit in the full dialysis cohort (N=633)

Variable / contrast	Reference / unit	Beta	95% BCa CI
Male	Female	-0.029	-0.083 to 0.028
Post-secondary education	High school or below	0.002	-0.054 to 0.067
Unemployed/dependent	Employed	0.123	0.059 to 0.179
Retired	Employed	0.056	-0.052 to 0.153
Living with family, no reported support	Family-supported	0.017	-0.048 to 0.093
Lives alone	Family-supported	-0.069	-0.175 to 0.068
PD	HD	0.023	-0.048 to 0.106
Vintage 1 to <5 y	<1 y	-0.012	-0.087 to 0.055
Vintage >=5 y	<1 y	0.073	-0.005 to 0.154
Within-centre distance	Per doubling of (distance+1)	0.002	-0.014 to 0.017

Notes: Positive coefficients indicate a larger population-referenced deficit (worse-than-expected HRQoL). Table reports selected coefficients from the fully adjusted full-cohort model (M3, N=633); centre was retained as an adjustment factor; centre coefficients are omitted because the study was not designed for between-centre performance comparisons and residual differences in case mix and data-collection procedures may remain. The within-centre distance coefficient is per one-unit increase in within-centre log2(distance + 1), equivalent to a doubling of (distance + 1); the full sequential model-building sequence for this secondary, haemodialysis-restricted distance analysis (N=534) is reported in Supplementary Table S4. Age, sex, education and marital status were included in the Stage-1 normative model; their Stage-2 coefficients represent departures from the corresponding population patterns rather than total associations with observed utility. Married versus not married was -0.031 (95% BCa CI -0.114 to 0.046), and age was included as a restricted cubic spline; both are omitted from the table for compactness. Reported CIs are from the 2,000-replicate two-stage BCa bootstrap.

The employment association was materially unchanged after multiple imputation (Supplementary Table S2).

Discussion

Principal findings

As summarised in the Abstract, adults receiving maintenance dialysis at three Vietnamese healthcare centres had a substantial population-referenced HRQoL deficit, led by excess burden in usual activities, mobility and self-care, with unemployment/dependency classification showing the clearest social association and, in a secondary exploratory analysis, facility distance showing no clear association. The following sections interpret each of these findings in turn.

Dimension-specific HRQoL burden

Population benchmarking changed the interpretation of the EQ-5D-5L profile: the largest excess burden was functional rather than pain-related. Pain/discomfort affected nearly two thirds of participants but was also common in the expected population profile; its excess prevalence was therefore smaller than for usual activities, mobility or self-care. This is consistent with evidence of substantial physical and functional HRQoL loss in advanced CKD and dialysis [1] and with Vietnamese haemodialysis data [3]. The population-referenced approach distinguishes common absolute problems from dimensions in which dialysis recipients experience disproportionate burden.

Population-referenced utility deficit

The 0.221 mean utility deficit is a sample-average contrast. For each included dialysis participant, observed utility was subtracted from the utility predicted for a person with the same age, sex, education and marital status in the reference sample, and these individual differences were averaged. It is neither a national prevalence estimate nor a causal effect of dialysis or kidney failure.

EQ-5D population benchmarking has also been used in Vietnam among women with breast cancer [8]. Direct numerical comparison is inappropriate because populations and standardisation strategies differ, but both studies illustrate the value of interpreting disease-specific HRQoL against national context. The coexistence of a 25.1% ceiling at health state 11111 with a mean utility of 0.703 reflects marked heterogeneity rather than uniformly preserved HRQoL: while one quarter of participants reported no problems on any dimension, 7.3% had utility values below zero and a substantial proportion reported moderate-to-extreme

limitations on individual dimensions (Fig. 2), so the mean masks a highly heterogeneous distribution rather than a uniformly intermediate burden. Our observed mean utility of 0.703 is considerably higher than the 0.486 pooled estimate for dialysis recipients across low- and lower-middle-income countries [1], but closer to the 0.766 (HD) and 0.848 (PD) reported using a validated Vietnamese EQ-5D-5L instrument in a single-centre Vietnamese study [4]; however, that study's published methods did not explicitly identify the value set used to convert health states into utility scores, so direct numerical comparison should remain cautious. These differences should not be read as evidence that HRQoL or dialysis care in this setting is genuinely better: pooled estimates across many low- and lower-middle-income countries reflect heterogeneous case mix, sampling and measurement, and the gap could equally reflect differences in which patients were sampled rather than differences in care. This pattern suggests observed utility in dialysis populations may depend heavily on setting, case mix and instrument/value-set choice, reinforcing the rationale for a population-referenced rather than an absolute comparison.

Social patterning, including a secondary facility-distance analysis

Employment status showed a clearer pattern. Participants classified as unemployed/dependent had a 0.123 larger adjusted deficit than employed participants, and the association was materially unchanged after multiple imputation (pooled estimate 0.128) of missing employment status, which was concentrated at one centre. This composite source-coded category combines unemployment for economic reasons with dependency due to disability or illness, which could not be disaggregated. This category may identify a clinically and socioeconomically vulnerable subgroup, but cannot distinguish the effect of employment from illness-related dependency or other unmeasured clinical factors. Dialysis symptoms, treatment schedules and financial constraints can restrict work, while employment can support income, identity and social participation [11]. Because the study is cross-sectional, poorer HRQoL may contribute to unemployment/dependency as well as result from it. More generally, age, sex, education and marital status were already used to generate expected utility in Stage 1; their Stage-2 coefficients describe departures from corresponding population patterns and should not be interpreted as total associations with observed utility.

As a secondary, exploratory analysis, the prespecified within-centre distance measure, examined primarily among participants receiving haemodialysis because facility distance is not a comparable exposure for peritoneal dialysis, showed little evidence of association with the HRQoL deficit, contrasting with international haemodialysis evidence linking longer travel time to poorer HRQoL [10]; a pooled HD+PD sensitivity analysis gave a similar pattern. This

null finding does not imply that travel burden is unimportant: the recorded facility-distance variable did not capture travel time, cost, transport mode, reliability or visit frequency, nor its derivation or reference-address status (permanent versus temporary). The result should therefore be interpreted narrowly, as no clear association for this recorded within-centre distance measure rather than as evidence against a role for travel burden.

Strengths and limitations

Strengths include a relatively large multicentre dialysis cohort, Vietnamese EQ-5D-5L population reference data, a country-specific EQ-5D-5L value set, explicit estimands and covariates, conservative duplicate handling and estimand-specific complete-case rules. The two-stage bootstrap propagated uncertainty from the normative model rather than treating expected values as fixed, and multiple-imputation sensitivity analysis addressed centre-concentrated employment missingness.

Limitations include the cross-sectional design, which precludes causal interpretation and is especially important for employment. Only three centres were included, and important clinical confounders, including diabetes, other comorbidity, haemoglobin, albumin, Kt/V and dialysis frequency, were not available consistently in the harmonised analytic dataset and therefore could not be included in the adjusted models. The unemployed/dependent category combined groups that could not be disaggregated in the source data. Missing covariates, particularly employment status, were concentrated at one centre, although multiple imputation produced a materially similar estimate. The population reference was collected in 2017, whereas the dialysis data were collected in 2026; secular changes in population HRQoL could not be assessed. Sampling weights and commune/ward-level cluster identifiers were unavailable in the reference analytic file, so normative models were unweighted; the bootstrap resampled the available reference participants individually rather than reproducing the original multistage cluster sampling design. Recruitment methods, screening counts and response denominators were not retained, so the participant flow begins with harmonised records rather than all eligible patients. Questionnaire version, administration mode and data-entry procedures could not be independently confirmed as identical across centres; centre was therefore treated as an adjustment factor rather than a performance exposure. The derivation method for the recorded facility-distance variable was not retained, and distance did not capture travel time, cost, transport mode, reliability or visit frequency. Finally, age was derived from birth year using 2026 as the reference year; exact age may therefore be overestimated by up to one year for participants whose birthday had not yet occurred at data collection.

Clinical and policy implications

The findings support routine patient-reported outcome assessment alongside clinical indicators in maintenance dialysis, with population benchmarking helping to identify disproportionate limitations in usual activities, mobility and self-care. Unemployment/dependency may help identify patients with greater excess HRQoL burden, but the cross-sectional association does not show that changing employment status would improve HRQoL. Likewise, the null association for recorded facility distance should not be taken to mean that travel burden is unimportant. Future service assessments should measure clinical severity and travel burden more directly, including travel time and cost.

Conclusion

Adults receiving maintenance dialysis at three Vietnamese healthcare centres experienced poorer HRQoL than expected based on available Vietnamese EQ-5D-5L population reference data, with particularly large excess burden in usual activities, mobility and self-care; population benchmarking showed that functional limitations accounted for the largest excess burden, despite pain/discomfort being the most prevalent absolute problem. Participants classified as unemployed/dependent had a larger deficit, materially unchanged after multiple imputation, which may help identify a potentially vulnerable subgroup rather than an independent effect of unemployment. These findings describe population-referenced EQ-5D-5L burden and social patterning in the study sample; they do not establish causal effects or centre-performance differences.

List of abbreviations

HRQoL: health-related quality of life; EQ-5D-5L: EuroQol five-dimension, five-level questionnaire; HD: haemodialysis; PD: peritoneal dialysis; BCa: bias-corrected and accelerated (bootstrap confidence interval); CI: confidence interval; OLS: ordinary least squares; SD: standard deviation; Kt/V: a standard measure of dialysis adequacy (urea clearance × dialysis time / volume of distribution).

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Declarations

Ethics approval and consent to participate: The source studies were approved by the Institutional Review Board for Biomedical Research, University of Medicine and Pharmacy at Ho Chi Minh City (IRB-VN01002/IRB00010293/FWA00023448): approval nos. 4914/ĐHYD-HĐĐĐ (Ba Ria General Hospital), 2576/ĐHYD-HĐĐĐ (Thien Hanh General Hospital, Dak Lak province) and 5165/ĐHYD-HĐĐĐ (Cho Ray Hospital). The approvals permitted secondary use of the collected data for related analyses, including the present study. Written informed consent was obtained from all participants at the study hospitals before data collection, including consent for secondary use of the collected data for related research analyses; the signed consent forms were retained in the study records in accordance with the approved study protocols.

Consent for publication: Not applicable. This manuscript presents only aggregate statistical results and contains no individual images, case descriptions or other identifying information.

Statement on patient, public or community engagement: Patients and members of the public were not involved in setting the research question, designing the study, interpreting the findings or preparing the manuscript.

Availability of data and materials: The datasets analysed in the current study are not publicly available because they contain potentially identifying patient information and their use is restricted under the terms of the original institutional ethics approvals, but de-identified data may be made available from the corresponding author on reasonable request, subject to institutional and ethics committee approval.

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All authors have read and approved the final version of the manuscript.

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Additional file: Additional file 1 (.docx): Supplementary Tables S1–S4, including centre/modality characteristics, multiple-imputation sensitivity analysis, EQ-5D-5L distribution and normative-model diagnostics, and the secondary facility-distance analyses.

Supplementary Files

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