Psychometric Methods: Reliability and Validity

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UC END DISPARITIES: Cardiometabolic disparities research January 30, 2024 (1:00-2:00 pm)



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Acknowledgements

- Peipert, J. D., Bentler, P. M., Klicko, K., & Hays, R. D. (2018). Psychometric properties of the Kidney Disease Quality of Life 36item short-form survey (KDQOLTM-36) in the United States. <u>American Journal of Kidney Disease</u>, 71 (4), 461-468.
- Peipert, J. D., Bentler, P., Klicko, K., & Hays, R. D. (2018) Neglible impact of differential item functioning between black and white dialysis patients on the Kidney Disease Quality of Life 36-item short-form survey (KDQOLTM-36). <u>Quality of Life Research</u>, <u>27</u>(10), 2699-2707.
- Peipert, J. D., Nair, D., Klicko, K., Schatell, D., & Hays, R. D. (2019). Kidney Disease Quality of Life 36-item short form survey (KDQOL-36TM) normative values for the United States dialysis population and new single summary score. <u>J Am Soc Nephrol.</u>, <u>30</u>(4), 654-663.

KDQOL-36™ Survey

- Items 1-12: SF-12 (PCS and MCS)
- Items 13-16: Burden of kidney disease (k=4)
- Items 17-28: Symptoms/problems (k=12)
- Items 29-36: Effects of kidney disease (k=8)

Development of the Kidney Disease Quality of Life (KDQOLTM) Instrument

Research Papers | Published: October 1994

Volume 3, pages 329–338, (1994) Cite this article

Your Kidney Disease



Data

- KDQOL-36 administered by paper
- June 1, 2015, through May 31, 2016.
- n = <u>70,786</u> patients; <u>1,381</u> dialysis facilities
 Average of <u>51</u> patients per clinic
- Medical Education Institute

- https://meiresearch.org/

Characteristic	Value
Age, y	61 ± 14 (18-100)
Race	
White	32,573 (46%)
Black	19,217 (<mark>27%</mark>)
Asian	3,441 (5%)
Native Hawaiian/Pacific Islander	1,496 (2%)
American Indian/Alaska Native	1,060 (2%)
Missing	12,999 (18%)
Ethnicity	
Hispanic/Latino	13,594 (19%)
Not Hispanic/Latino	46,348 (66%)
Missing	10,844 (15%)
Language of survey	
English	62,489 (88%)
Spanish	7,228 (10%)
Other	1,062 (2%)
Dialysis type	
In-center HD	58,763 (<mark>83%</mark>)
PD	8,535 (12%)
Conventional home HD	2,294 (3%)
Other	1,194 (2%)
Dialysis access site	
Arteriovenous fistula	26,499 (37%)
Arteriovenous graft	4,166 (6%)
Venous catheter	14,273 (20%)
PD catheter	7,585 (11%)
Missing	18,263 (26%)
Diabetes status, yes	37,246 (53%)
Employment status	
Retired due to disability	21,647 (31%)
Retired due to age/preference	17,515 (25%)
Unemployed	6,903 (10%)
Employed full-time	4,435 (6%)
Employed part-time	2,447 (4%)
Homemaker	1,578 (2%)
Other	1,542 (2%)
Missing	14,719 (20%)

Table 2. Dialysis Patient Characteristics

Note: n = 70,786. Values for categorical variables are given as number (percentage); for continuous variables, as mean ± standard deviation (range). Abbreviations: HD, hemodialysis; PD, peritoneal dialysis.

Table 1. Summary of Psychometric Methods

Concept	Explanation	Tests	Meaning of Results
Reliability	The ability of a measure to give the same result under the same set of circumstances; eg, a reliable measure would give the same score for 2 patients with the same level of health-related quality of life	Cronbach coefficient alpha 1 way ANOVA	Higher scores indicate higher reliability; reliabilities ≥ 0.70 are needed to be able to compare groups of patients
Factor structure	The underlying concept(s) represented by a set of questions (items); eg, several different questions about how a patient's life activities have been affected by kidney disease (eg, fluid intake, personal appearance) represent the overall effect of kidney disease.	Confirmatory factor analysis	High "loadings" indicate that questions represent the underlying concept to a greater degree
Construct validity	The degree to which a measure represents the concept it is intended to represent; this is determined by examining whether measures expected to be related are actually related; eg, different aspects of quality of life are expected to be correlated with one another	Correlations between measures; "known- groups" analyses	Higher correlations between measures expected to be correlated indicate greater validity; known-groups analyses results support a priori hypotheses

Alpha Reliability Formulas

Model	Reliability	Intraclass Correlation
Two-way random	$\frac{N(MS_{BMS} - MS_{EMS})}{NMS_{BMS} + MS_{JMS} - MS_{EMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS} + k(MS_{JMS} - MS_{EMS})/N}$
Two- way mixed	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS}}$
One- way	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS} + (k-1)MS_{WMS}}$
WMS = JMS	 Between Ratee Mean So Within Mean Square Item or Rater Mean Squ Ratee x Item (Rater) Mea 	k = n of items or raters are

Center-Level Reliability

Model	Reliability	Intraclass Correlation
Two-way random	$\frac{N(MS_{BMS} - MS_{EMS})}{NMS_{BMS} + MS_{JMS} - MS_{EMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS} + k(MS_{JMS} - MS_{EMS})/N}$
Two- way mixed	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS}}$
One- way	$\underbrace{\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS}}}_{MS}$	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS} + (k-1)MS_{WMS}}$
WMS = JMS	 Between Ratee Mean So Within Mean Square Item or Rater Mean Squ Ratee x Item (Rater) Mea 	k = n of items or raters are

Test-Retest Reliability (n = 121, 1-21 days)

Model	Reliability	Intraclass Correlation
Two-way random	$\frac{N(MS_{BMS} - MS_{EMS})}{NMS_{BMS} + MS_{JMS} - MS_{EMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS} + k(MS_{JMS} - MS_{EMS})/N}$
Two- way mixed	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{EMS}}{MS_{BMS} + (k-1)MS_{EMS}}$
One- way	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS}}$	$\frac{MS_{BMS} - MS_{WMS}}{MS_{BMS} + (k-1)MS_{WMS}}$
WMS = JMS	= = Between Ratee Mean So = Within Mean Square = Item or Rater Mean Squ = Ratee x I tem (Rater) Mea	k = n of i tems or raters are <u>Wave/Time point</u> 10

	KDQOL-36 Burden of Kidney Disease	KDQOL-36 Symptoms/ Problems of Kidney Disease	KDQOL-36 Effects of Kidney Disease
tem (item name) ^a			
My kidney disease interferes too much with my life (i13) ^b	0.72	0.39	0.52
Too much time is spent dealing with kidney disease (i14) ^b	0.73	0.37	0.50
I feel frustrated dealing with my kidney disease (i15) ^b	0.72	0.42	0.53
I feel like a burden on my family (i16) ^b	0.56°	0.40	0.48
Soreness in your muscles? (i17) ^d	0.33	0.54°	0.43
Chest pain? (i18) ^d	0.23	_0.44°	0.29
Cramps? (i19)d	0.25	0.46°	0.33
Itchy skin? (i20) ^d	0.26	0.51°	0.35
Dry skin? (i21) ^d	0.28	0.54°	0.39
Shortness of breath? (i22) ^d	0.28	0.51°	0.36
Faintness or dizziness? (i23) ^d	0.28	0.51°	0.36
Lack of appetite? (i24) ^d	0.26	0.45°	0.34
Washed out or drained? (i25) ^d	0.43	0.61°	0.53
Numbness in hands or feet? (i26) ^d	0.29	0.50°	0.38
Nausea or upset stomach? (i27) ^d	0.29	0.53	0.39
Problems with your access/catheter site? (i28)de	0.20	0.31°	0.28
Fluid restriction? (i29)	0.36	0.39	0.54°
Dietary restriction? (i30)	0.38	0.41	0.58°
Your ability to work around the house? (i31)	0.47	0.53	0.60°
Your ability to travel? (i32)	0.45	0.42	0.62°
Being dependent on doctors and other medical staff? (i33)	0.47	0.45	0.63°
Stress or worries caused by kidney disease? (i34)	0.57	0.54	0.68°
Your sex life? (i35)	0.34	0.33	0.47
Your personal appearance? (i36)	0.42	0.45	0.59°
ronbach coefficient alpha	0.85	0.83	0.85
Center-level reliability ⁹	0.75	0.76	0.83
Correlation with KDQOL-36 Burden of Kidney Disease scale	1.0		
Correlation with KDQOL-36 Symptoms/Problems scale	0.48	1.0	
Correlation with KDQOL-36 Effects of Kidney Disease scale	0.62	0.62	1.0

Table 4. Item-to-Total Correlations of KDQOL-36 Scales

Note: Item-to-total correlations are corrected for overlap.

Abbreviations: KDQOL, Kidney Disease Quality of Life; KDQOL-36, Kidney Disease Quality of Life 36-Item Surve "Some items' wording has been reduced to fit table.

"Item context is "How true or false is each of the following statements for you?"

KDOQL-36 scale for each item.

^dItem context is "During the past 4 weeks, to what extent were you bothered by each of the following?" "For hemodialysis patients, access site is asked about; for peritoneal dialysis, catheter site is asked about.

¹Item stem is "How much does kidney disease bother you in each of the following areas?"

⁹Estimated from 1-way analysis of variance partitioning between versus within facility variance. The minimum number (1 - reliability observed)/(0.30 × reliability observed). Therefore, sample sizes required for 0.70 reliability are 40, 3 Effects scales, respectively.

Cronbach's alpha	Internal consistency
0.9 ≤ α	Excellent
0.8 ≤ α < 0.9	Good
0.7 ≤ α < 0.8	Acceptable
0.6 ≤ α < 0.7	Questionable
0.5 ≤ α < 0.6	Poor
α < 0.5	Unacceptable

Peipert et al, AJKD, "Psychometric Properties of the Kidney Disease Quality of Life 36-Item Short-form Survey (KDQOL-36) in the United States"

	KDQOL Burden of Kidney Disease	KDQOL Symptoms/ Problems of Kidney Disease	KDQOL Effects of Kidney Disease
i13	0.87	-	-
i14	0.87	-	-
i15	0.84	-	-
i16	0.67	-	-
i17		0.65	-
i18	-	0.62	-
i19	-	0.53	-
i20	-	0.57	-
i21	-	0.59	-
i22	-	0.63	-
i23	-	0.64	-
i24	-	0.58	-
i25	-	0.73	-
i26	-	0.59	-
i27	-	0.66	-
i28	-	0.45	
i29	-	-	0.61
i30	-	-	0.65
i31	-	-	0.72
i32	-	-	0.72
i33	-	-	0.76
i34	-	-	0.83
i35	-	-	0.59
i36	-	-	0.73
Model Fit	Indexes		
TLI	0.97		
CFI	0.98		
RMSEA	0.05		
AASR	0.03		
		CFI = Comparative	
		error of approxim	ation; $AASR =$
Average al	bsolute standardize	ed residual	

Table S1. Confirmatory Factor Analysis of KDQOL-36 Items

"One rule is to not use complicated techniques unless they are necessary to achieve your goal. First, use simple movements, and if they don't work, then introduce the more complex ones."

Bruce Lee



Confirmatory Factor Analysis Fit Indices



CFI >=0.95 and RMSEA <=0.06

Figure S1. Tests to Determine the Number of Factors to Retain from Exploratory Factor Analysis for KDQOL-36



	SF-12 PCS Score	SF-12 MCS Score		KDQOL-36 Symptoms and Problems of Kidney Disease	KDQOL-36 Effects of Kidney Disease
Sample size	69,686	69,686	70,022	70,004	69,938
Mean score	38	51	52	79	74
Standard deviation	10	10	30	16	22
% at floor	0%	0%	5%	0.03%	0.3%
% at ceiling	0%	0%	9%	4%	10%
Score distribution					
Minimum observed	11	11	0	0	0
25th percentile	30	44	25	71	59
50th percentile (median)	37	53	50	81	78
75th percentile	46	59	75	91	91
Maximum observed	66	72	100	100	100

Table 3. SF-12 Version 1 Physical and Mental Health Component and KDQOL Scale Scores

Abbreviations: KDQOL, Kidney Disease Quality of Life; MCS, Mental Component Summary; PCS, Physical Component Summary; SF-12, 12-Item Short Form Health Survey.

Table 5. Product Moment Correlations of SF-12 PCS and MCS Scores With KDQOL-36 Scales

	SF-12 PCS Score	SF-12 MCS Score
KDQOL-36 Burden of Kidney Disease	0.40	0.52
KDQOL-36 Symptoms and Problems of Kidney Disease	0.47	0.48
KDQOL-36 Effects of Kidney Disease	0.43	0.50
Note: All correlations significant at P < 0.001. Abbreviations: KDQOL, Kidney Disease Quality of Life; KDQOL-36, Kidney Disease Quality Component Summary; SF-12, 12-Item Short Form Health Survey.	of Life 36-Item Survey; MCS, Mental Compone	nt Summary; PCS, Physical

	SF-1	2			KDQOL-36					
	PCS	P	MCS	P	Burden of Kidney Disease	Ρ	Symptoms/ Problems of Kidney Disease	Ρ	Effects of Kidney Disease	P
Dialysis type										
Peritoneal dialysis	39	Reference	51	Reference	56	Reference	80	Reference	76	Reference
In-center HD	38	< 0.001	51	< 0.001	52	< 0.001	79	< 0.001	73	< 0.001
Conventional home HD	39	< 0.001	51	0.05	52	< 0.001	80	0.03	75	< 0.001
Other	38	0.006	51	0.3	52	< 0.001	80	0.5	74	800.0
Diabetes										
Yes	37	Reference	51	Reference	51	Reference	78	Reference	73	Reference
No	39	< 0.001	51	< 0.001	54	< 0.001	80	< 0.001	75	< 0.001
Employment										
Employed full-time	43	Reference	52	Reference	58	Reference	83	Reference	75	Reference
Employed part-time	42	< 0.001	52	0.002	55	< 0.001	81	< 0.001	74	0.06
Retired due to disability	37	< 0.001	50	< 0.001	51	< 0.001	78	< 0.001	73	0.2
Retired due to age/ preference	37	< 0.001	52	<0.001	54	<0.001	80	< 0.001	76	<0.001
Unemployed	39	< 0.001	<mark>4</mark> 9	< 0.001	49	< 0.001	77	< 0.001	71	< 0.001
Homemaker	37	< 0.001	50	< 0.001	52	< 0.001	78	< 0.001	75	0.004
Other	40	< 0.001	50	< 0.001	50	< 0.001	80	< 0.001	72	< 0.001

 Table 6. Known Groups Differences on Scale Scores Between Clinical Subgroups

Abbreviations: HD, hemodialysis; KDQOL, Kidney Disease Quality of Life; MCS, Mental Component Summary; PCS, Physical Component Summary SF-12, 12-Item Short Form Health Survey.

KDQOL-36 Effects R^2 KDQOL-36 KDQOL-36 Symp-Burden of Kidney of Kidney Disease toms and Prob-Disease lems of Kidney Disease White White Black Black White Black White Black My kidney disease interferes too much with my life (i13) 0.83 0.82 0.69 0.68 _ _ _ Too much time is spent dealing with kidney disease (i14) 0.83 0.83 0.69 0.69 _ _ I feel frustrated dealing with my kidney disease (i15) 0.78 0.78 0.61 0.60 _ _ ____ I feel like a burden on my family (i16) 0.59 0.35 0.60 0.36 _ _ _ Soreness in your muscles? (i17) 0.36 0.36 0.60 0.60_ _ _ _ Chest pain? (i18) 0.45 0.480.21 0.23 _ _ Cramps? (i19) 0.47 0.510.22 0.26 _ _ 0.55 0.31 Itchy skin? (i20) 0.52 0.28 _ 0.58 0.34 Dry skin? (i21) 0.57 0.32 _ _ Shortness of breath? (i22) 0.53 0.57 0.28 0.33 _ _ _ Faintness or dizziness? (i23) 0.53 0.570.28 0.32 _ _ _ Lack of appetite? (i24) 0.50 0.52 0.25 0.27 _ _ _ 0.70Washed out or drained? (i25) 0.70 0.500.49 _ _ _ Numbness in hands or feet? (i26) 0.54 0.55 0.29 0.31 _ _ _ 0.580.22 0.33 Nausea or upset stomach? (i27) 0.58 _ _ _ 0.37 0.11 0.14 Problems with your access/catheter site? (i28) 0.32 _ _ _ Fluid restriction? (i29) 0.55 0.59 0.21 0.34 _ Dietary restriction? (i30) 0.35 0.38 0.590.62_ Your ability to work around the house? (i31) 0.69 0.67 0.47 0.45 _ _ Your ability to travel? (i32) 0.69 0.44 0.48 0.66_ _ _ Being dependent on doctors and other medical staff? (i33) 0.69 0.700.48 0.49 _ _ _ Stress or worries caused by kidney disease? (i34) 0.76 0.77 0.58 0.59 _ _ _ _ Your sex life? (i35) 0.51 0.52 0.26 0.27 _ Your personal appearance? (i36) 0.63 0.41 0.39 0.64_

 Table 2 Configural model standardized factor loadings for White versus Black patients on KDQOL-36 Burden, Symptoms and Problems, and Effects of Kidney Disease scales—robust maximum likelihood estimation

	All Races	Hispanic	Asian	Black	White
	α	ά	α	α	α
KDQOL-36 Summary	Score (KSS)	((
All ages	0.91	0.92	0.92	0.91	0.90
18-29	0.90	0.92	0.92	0.91	0.90
30-44	0.91	0.92	0.91	0.91	0.91
45-59	0.91	0.92	0.92	0.91	0.91
60-74	0.91	0.92	0.93	0.91	0.90
75 or greater	0.90	0.91	0.93	0.90	0.89
KDQOL-36 Burdens o	f Kidney Disease Sca	le			
All ages	0.85	0.85	0.87	0.84	0.84
18-29	0.82	0.82	0.78	0.81	0.81
30-44	0.83	0.83	0.85	0.83	0.83
45-59	0.85	0.85	0.86	0.84	0.84
60-74	0.85	0.86	0.88	0.84	0.84
75 or greater	0.85	0.85	0.87	0.83	0.84
KDQOL-36 Symptoms	and Problems of Kid	ney Disease Sc	ale		
All ages	0.83	0.85	0.87	0.84	0.80
18-29	0.86	0.86	0.89	0.86	0.84
30-44	0.84	0.85	0.85	0.84	0.81
45-59	0.84	0.86	0.87	0.84	0.82
60-74	0.83	0.86	0.87	0.83	0.80
75 or greater	0.81	0.83	0.86	0.83	0.77
KDQOL-36 Effects of	Kidney Disease Scale				
All ages	0.85	0.86	0.87	0.85	0.84
18-29	0.83	0.83	0.83	0.84	0.81
30-44	0.85	0.86	0.87	0.85	0.85
45-59	0.86	0.87	0.87	0.86	0.85
60-74	0.85	0.86	0.87	0.85	0.84
75 or greater	0.83	0.85	0.88	0.83	0.82

Mean KDQOL T-Scores by Race/Ethnicity

	Black	White	Hispanic	Asian
SF-12 PCS	39	<u>36</u>	39	38
SF-12 MCS	51	51	<u>49</u>	50
Burden of Kidney Disease	52	50	49	<u>47</u>
Symptom/Problems	50	50	50	49
Effects of Kidney Disease	51	50	49	<u>48</u>

SF-12 scores normed to U.S. general population. KDQOL-36 targeted scales normed to MEI "population."

Weighted to match joint distribution to U.S. general population (USRDS) on ₂₁ Age, sex, race/ethnicity, dialysis type, and etiology of ESRD.

ltem	General Factor	Specific Factor: Burden of Kidney Disease	Specific Factor: Symptoms/Problems of Kidney Disease	Specific Factor: Effects of Kidney Disease
My kidney disease interferes too much with my life (i13)	0.63	0.62	_	_
Too much time is spent dealing with kidney disease (i14)	0.60	0.68	_	
I feel frustrated dealing with my kidney disease (i15)	0.67	0.48	_	_
I feel like a burden on my family (i16)	0.61	0.32	_	_
Soreness in your muscles? (i17)	0.53	_	0.33	_
Chest pain? (i18)	0.46	_	0.39	-
Cramps? (i19)	0.40	_	0.32	_
Itchy skin? (i20)	0.37	_	0.67	_
Dry skin? (i21)	0.41	—	0.65	—
Shortness of breath? (i22)	0.47	—	0.38	—
Faintness or dizziness? (i23)	0.50	—	0.35	—
Lack of appetite? (i24)	0.46	—	0.31	—
Washed out or drained? (i25)	0.65	_	0.30	_
Numbness in hands or feet? (i26)	0.47	_	0.34	—
Nausea or upset stomach? (i27)	0.51	—	0.36	—
Problems with your access/catheter site? (i28)	0.41	—	0.17	
Fluid restriction? (i29)	0.57	—	—	0.50
Dietary restriction? (i30)	0.61	_	_	0.67
Your ability to work around the house? (i31)	0.75		—	-0.01
Your ability to travel? (i32)	0.70	_	—	0.07
Being dependent on doctors and other medical staff? (i33)	0.75	—	—	0.04
Stress or worries caused by kidney disease? (i34)	0.84	_	—	-0.01
Your sex life? (i35)	0.58	_	—	0.02
Your personal appearance? (i36)	0.73	_	_	0.02

Table 1. Bifactor CFA model factor loadings for the KDQOL-36



Email: drhays@ucla.edu

https://labs.dgsom.ucla.edu/hays/pages/