Should We be Mapping from Sleep-Specific to Generic Preference-Based Quality-of-Life Instruments? Unravelling the Debate with a Multi-Instrument Mapping Study of 6 Sleep-Specific and 4 Preference-Based Instruments

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Background

- Self-reported quality of life (QoL) is an indicator of a person's overall health status that is useful and applicable in different contexts, including clinical studies, healthcare economic evaluations and population health surveys.
- Within sleep research, several instruments have been used to measure QoL, including:
  - Generic preference-based (GP) ones like the EuroQol 5 dimensions 5 level (EQ5D-5L), the Short Form 6 dimensions (SF-6D), ICEPop CAPability measure for Adults (ICECAP-A) and Assessment of Quality of Life 4 Dimensions (AQoL-4D).
  - Sleep-specific non-preference-based (SSnP) ones like the Epworth Sleepiness Scale (ESS), Insomnia Severity Index (ISI), 10-item Functional Outcomes of Sleep Questionnaire (FOSQ-10), Pittsburgh Sleep Quality Index (PSQI), Sleep Condition Indicator (SCI) and Flinders Fatigue Scale (FFS).
- While SSnP instruments capture unique aspects of sleep disorders or conditions, GP instruments offer a broader perspective and can be converted into Quality-Adjusted Life Years (QALYs), enabling comparisons across diverse health states.
- However, it is not always possible to estimate QALYs as data on GP instruments are not always available. Regression-based mapping from SSnP to GP instruments is one way of estimating QALYs if only the former are available. It is, however, unknown whether SSnP instruments can be adequately mapped onto preference scores or utilities and, if so, which ones perform best.

Objective

- This study answers this question through an extensive multi-instrument mapping exercise where utility scores of four GP instruments (EQ5D-5L, SF-6D, ICECAP-A and AQoL-4D) are mapped from scores of six SSnP instruments (ESS, ISI, FOSQ-10, PSQI, SCI and FFS).

Methods (1)

Study Population and Data Collection

- Data were collected online in July/August 2023 from a QoL survey administered to 1,510 Australians who self-reported having had a sleep disorder.
- Information on all 10 QoL instruments and participant demographic characteristics were obtained. Table 1 provides an overview of these 10 QoL instruments.

Statistical Analysis

Correlation (Spearman & Kendal Tau)

- < 0.3 – Weak.
- 0.3 – 0.5 – Moderate.
- > 0.5 – Strong.

Mapping regression families

- Ordinary least squares (OLS).
- Censored Least Absolute Deviations (CLAD) estimator.
- Generalised linear model (GLM).
- Beta Binomial (BB).
- Robust Minimize-Marjorize (MM) estimator.
- Multinomial logistic (MLOGIT) regression model.

Statistical methods for selecting covariates

- Stepwise regression (SW).
- Multivariable fractional polynomial (MFP).
- Theoretical considerations.

Mapping regression models

- 9 model specifications x 6 regression families x 4 GP instruments = 216 models.

Model Performance Assessment

- Spearman's rank correlation between predicted and observed utilities (Correlation).
- Root mean squared error (RMSE).
- Mean absolute error (MAE).
- Proportions of predictions with absolute errors < 0.05 (%<0.05).

Methods (2)

Validation

Three validation approaches used:

1. *'Hold-out' approach*
   - Estimation = Random sample of 75% of patients (n = 1,132).
   - Validation = Random sample of 25% of patients (n = 378).
2. *Three random sample validation*
   - Estimation = 100% of patients (n = 1,510).
   - Validation = 3 random samples: 600, 900 & 1,200 obs.
3. *K-Fold (10-fold: 10 subsamples)*
   - Estimation = k-1 x 10 times.
   - Validation = k-9 x 10 times.

Results

Table2: Demographic Characteristics

Variable	Mean (SD); Median (min, max)
Age	46 (17); 45 (18, 86)
Generic preference-based QoL	
EQ-5D-5L	0.70 (0.24); 0.75 (-0.31, 1.00)
SF-6D	0.70 (0.14); 0.66 (0.34, 1.00)
ICECAP-A	0.79 (0.20); 0.85 (0.00, 1.00)
AQoL-4D	0.58 (0.28); 0.64 (-0.04, 1.00)
Sleep-specific non-preference-based QoL	
ESS	6.55 (4.54); 6.00 (0.00, 21.00)
ISI	11.44 (6.11); 11.00 (0.00, 28.00)
FOSQ-10	32.53 (7.00); 35.00 (10.00, 40.00)
PSQI	10.84 (4.45); 10.00 (2.00, 25.00)
SCI	19.50 (5.77); 19.00 (8.00, 37.00)
FFS	16.75 (7.12); 17.00 (0.00, 32.00)

Figure 1: Spearman's Rank Correlation between Quality-of-Life Instruments

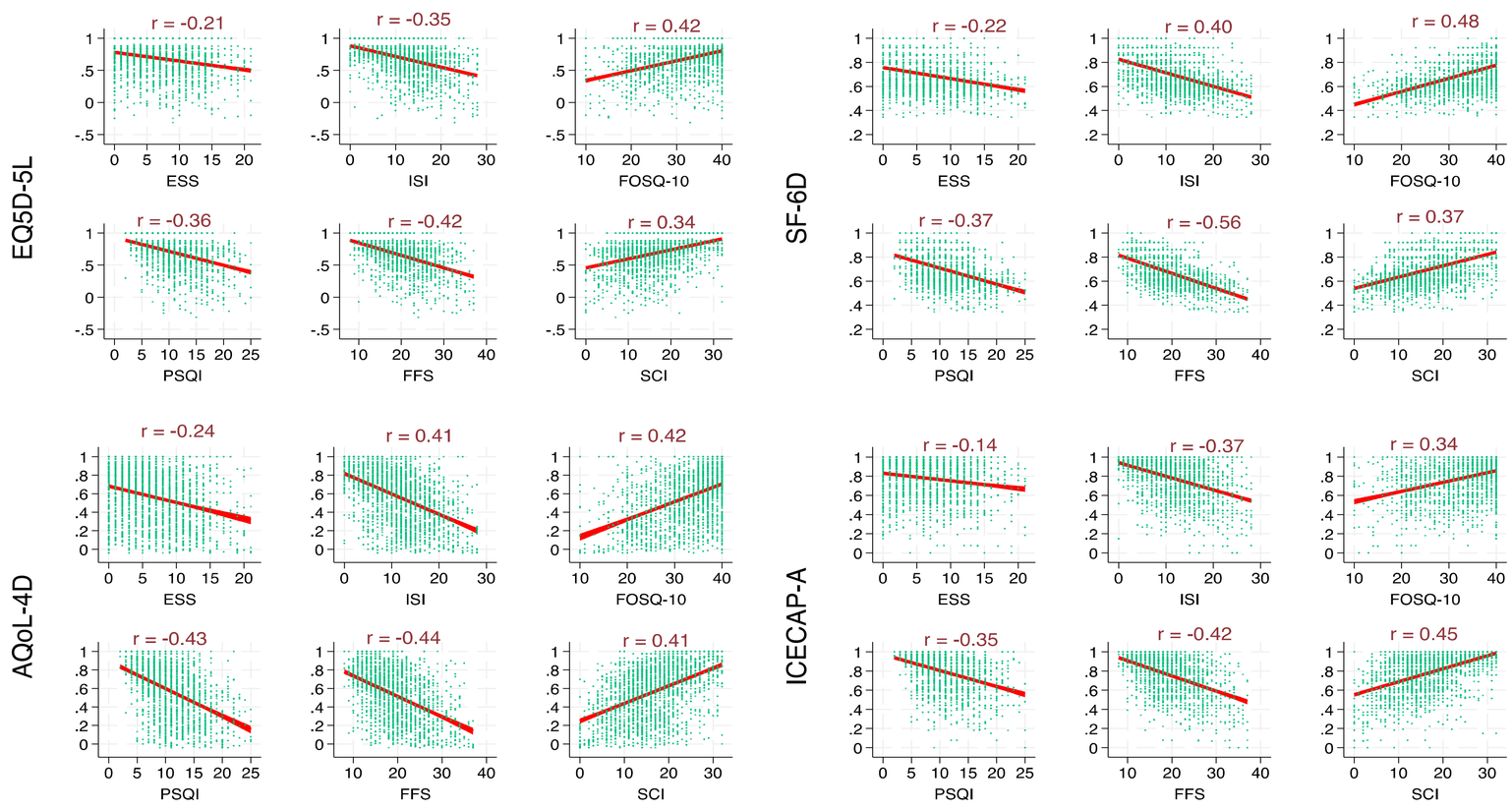

Table3: Model fit of best 10 regression models for predicting each GP instrument

Predictive Index	Range	Best Model		Range	Best Model
	EQ5D-5L			***AQoL-4D***	
Correlation	0.428 – 0.473	FFS-BB	Correlation	0.477 - 0.494	SCI - CLAD
RMSE	0.054 – 0.049	FOSQ - CLAD	RMSE	0.062 -0.075	FFS- CLAD
MAE	0.170 – 0.162	FFS - GLM	MAE	0.200 - 0.222	FOSQ - OLS
%<0.05	24-27	FOSQ-BB	%<0.05	15 - 18	SCI - CLAD
	SF-6D			***ICECAP-A***	
Correlation	0.441 – 0.583	FFS - GLM	Correlation	0.441 - 0.517	SCI - CLAD
RMSE	0.014 – 0.017	FOSQ - BB	RMSE	0.032 - 0.037	FFS – CLAD
MAE	0.099 – 0.110	FFS - BB	MAE	0.138 - 0.152	SCI - OLS
%<0.05	29 - 31	SCI - CLAD	%<0.05	23 - 30	SCI - CLAD

Discussion

- AQoL-4D (ICECAP-A) utility scores were lowest (highest) (Table 2).
- Overall, the FOSQ-10, FFS and SCI had the highest correlation with GP instruments (Figure 1).
- Predictive-ability indices of the best-performing models were within acceptable ranges of published estimates (Table 3).
- Best results were obtained when mapping onto SF6D and ICECAP-A utilities from the FFS, SCI and FOSQ (Table 3).
- Mapping onto the AQoL-4D from the ESS and ISI yielded the worst predictive algorithms and lowest correlations.

Conclusions

- These results suggest that diagnostic tools like the ESS and ISI are unsuitable for mapping onto GP instrument utility scores despite their widespread use in sleep economic evaluations.

Table1: Overview of Instruments

	Generic preference-based (GP) Quality of Life Instruments				Sleep-specific non-preference-based (SSnP) Quality of Life Instruments					
	EQ-5D 5L Health-related QoL **5 Dimensions**	**SF-6D** Health-related QoL **6 Dimensions**	**ICECAP-A** Capability **5 attributes**	**AQoL-4D** Health-related QoL **4 Dimensions**	**ESS** Sleepiness scale **8 subscales**	**ISI** Insomnia **7 Items**	**FOSQ-10** Functional status **5 subscales**	**PSQI** Sleep disturbances **7 Components**	**SCI** Sleep disturbances **8 Items**	**FFS** Daytime Fatigue **7 Items**
Dimensions	1. Mobility 2. Self-care; 3. Usual activities 4. Anxiety/ Depression 5. Pain/discomfort	1. Physical functioning 2. Role limitation 3. Social functioning 4. Pain 5. Mental health 6. Vitality	1. Attachment 2. Stability 3. Achievement 4. Enjoyment 5. Autonomy	1. Independent Living 2. Mental Health 3. Relationships 4. Senses	1. Sitting & Reading 2. Watching TV 3. Sitting inactive 4. Passenger in car 5. Lying down to rest 6. Sitting and talking 7. Sitting quietly 8. Sitting in stationery car	1. Falling asleep 2. Staying asleep 3. Waking up too early 4. Satisfaction with current sleep pattern 5. Noticeability of sleep problems 6. Daytime dysfunction 7. Nighttime awake	1. General productivity 2. Activity level 3. Vigilance 4. Social outcomes 5. Intimacy and sexual relationships	1. Subjective sleep quality 2. Sleep latency 3. Sleep duration 4. Habitual sleep efficiency 5. Sleep disturbances 6. Sleeping medication 7. Daytime dysfunction	1. Falling asleep 2. Waking up in night 3. Waking up too early 4. Feeling unrefreshed 5. Taking daytime naps 6. Concentrating 7. Mood 8. Enjoying activities	1. Problem for you 2. Problems everyday 3. Distress 4. Frequency 5. Time of day 6. Severity 7. Poor sleep
# Questions & Scoring	**5 Questions** **Utilities (-0.59 – 1)**	**12 Questions (from the SF-12)** **Utilities (0.03 – 1)**	**5 Questions** **Utilities (0 – 1)**	**12 Questions** **Utilities (-0.04 – 1)**	**8 Questions** **Summative score (0-24)**	**7 Questions** **Summative score (0-28)**	**10 Questions** **Summative score (0-40)**	**19 Questions** **Summative score (0-21)**	**8 Questions** **Summative score (0-21)**	**7 Questions** **Summative score (0-31)**

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