EQ-5D-5L Valuation Studies: Do the Effects of Dimensional Health Problems Interact with Each Other?

MSR23

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INTRODUCTION

- The EQ-5D-5L instrument is commonly used to generate health-state utility values for use in economic evaluations.
- The EQ-5D-5L descriptive system measures health on five dimensions (mobility (MO), self-care (SC), usual activities (UA), pain/discomfort (PD), and anxiety/depression (AD)) and five severity levels (no, slight, moderate, severe, and extreme).
- Studies have shown the disutility of having multiple health problems is usually smaller than the disutility sum of individual component health problems (diminished joint disutility).
- However, existing model specifications for predicting utility values of the multi-dimensional EQ-5D health states do not reflect this phenomenon.
- This study aimed to evaluate the two-way interaction effects between health dimensions on modelling EQ-5D values.

METHODS

- We tested 10 two-way dimensional interactions with 16 EQ-5D-5L valuation datasets, each derived from a different country/district using the same study protocol, the EQ-VTv2. The value sets analysed came from the following settings: Egypt, Ethiopia, France, Germany, Hong Kong, Hungary, Indonesia, Ireland, Italy, Malaysia, Mexico, Poland, Singapore, Taiwan, United States of America, and Vietnam.
- We generated interaction terms by treating dimensional problem levels of EQ-5D-5L health states as continuous independent variables and added them into a 20-parameter (incremental) main-effects model for predicting the dependent variable, the composite time trade-off (cTTO) disutilities (1-value).
- The 10 possible two-way interaction terms included MOSC, MOUA, MOPD, MOAD, SCUA, SCPD, SCAD, UAPD, UAAD, PDAD. For example, PDAD represents the interaction between the PD and AD dimensions.
- We used a random effects model to account for the multiple observations by each respondent. First, all 10 terms were included together. Next, only statistically significant terms were included in the final models. A p-value <0.05 was considered significant.
- Model performance was assessed in terms of: i) parameter statistical significance; ii) predicted health-state values' logical consistency; and iii) out-of-sample prediction accuracy using mean square error (MSQE), and Pearson's R (R), and also compared with that of the main-effects model.

RESULTS

Main effects model:

- **Parameter significance:** The number of significant main effect terms ranged from 13 to 19 in the 16 countries (median: 17, IQR: 15.5-18).
- **Logical inconsistency:** Monotonicity present in all countries
- **Out-of-sample prediction accuracy:** MSQEs ranged from 0.0020 to 0.0150 (mean, SE: 0.0557 (0.0010)) (Table 1).

Comparison between models:

- **Parameter significance:** In 9 countries, including interactions increased the number of significant incremental main-effect terms.
- **Logical inconsistency:** Only present in main effects model.
- **Out-of-sample prediction accuracy:** The model with interaction terms exhibited lower MSQE (mean reduction: 26.86%; SD: 5.47) with higher R (mean increase: 0.60%; SD: 0.76) values in 13 of 14 countries (Table 1). Paired t-test value comparisons on MSQE and R were statistically significant at p-value<0.05.

Two-way dimensional interactions model:

- **Parameter significance:**
  - ❑ The number of significant main effect terms ranged from 12 to 20 (median: 17.5, IQR: 14-20).
  - ❑ Most significant interactions occurred between the PD and AD dimensions (n= 9 countries) and interactions mainly exhibited negative disutility value, opposite from those of the main effect terms (Table 2).
- **Logical inconsistency:** Inconsistent predictions for health-state pairs with dominance relationship was minimal, ranging from 0% to 0.48% (mean, SD: 0.10%, 0.13) for the model with interaction terms (Table 2).
- **Out-of-sample prediction accuracy:** Incorporating interaction terms resulted in increased predictive accuracy values.

Table 1 Predictive accuracy of models with only main effects and with interaction terms

	N	Mean (std error)	Median (IQR)	Range
MSQE				
ME	16	0.0057 (0.0010)	0.0040 (0.0030 - 0.0070)	0.0020 - 0.0150
Int	14	0.0037 (0.0003)	0.0034 (0.0027 - 0.0042)	0.0010 - 0.0060
R				
ME	16	0.9851 (0.0025)	0.9875 (0.9795 - 0.9915)	0.9560 - 0.9970
Int	14	0.9902 (0.0010)	0.9910 (0.9878 - 0.9924)	0.9830 - 0.9980

Notes: Int: two-way interactions model; IQR: Interquartile range; ME: main effects model; MSQE: mean square error; R: Pearson product moment correlation

Table 2 Performance of models with dimensional interaction terms

Country	No. of insignificant main effects parameters		Parameter significance of the interaction terms										Logical inconsistency (%)
	ME	Int	MOSC	MOUA	MOPD	MOAD	SCUA	SCPD	SCAD	UAPD	UAAD	PDAD	Int
Egypt	3	0	-ve	-ve	-ve		-ve					-ve	0.47
Ethiopia	7	8			+ve		+ve						0.02
France	5	4	+ve		-ve							-ve	0.14
Germany	2	4										-ve	0.00
Hong Kong	3	0				-ve		-ve		-ve	-ve	-ve	0.10
Hungary	1	0		-ve	-ve	+ve							0.00
Indonesia	2	4	+ve*						+ve*				0.00
Ireland	4	2				-ve			-ve			-ve	0.33
Italy	5	6	+ve									-ve	0.06
Malaysia	1	-											-
Mexico	3	6	+ve			-ve			+ve			-ve	0.07
Poland	5	6	+ve										0.13
Singapore	3	0			-ve	-ve	-ve	-ve				-ve	0.19
Taiwan	1	0		-ve	-ve		-ve			-ve	-ve		0.01
USA	4	3							-ve	-ve		-ve	0.09
Vietnam	3	2						+ve					0.08

Notes: -ve negative disutility; +ve positive disutility; * indicates not significant in the final model; Int two-way interactions model; ME main effects model; LI logical inconsistency

CONCLUSIONS

- Significant dimensional interaction effects existed in the majority of the 16 EQ-5D-5L health-state valuation studies.
- The presence of two-way interaction terms resulted in statistically significant and better predictive accuracy values, implying relationship of preference and health states are better captured with the dimensional-interactions accounted for.
- The phenomenon of diminished joint disutility was well observed in the EQ-VTv2 value sets and incorporating two-way interaction terms enabled us to explicitly identify and capture dimensions that were more likely to exhibit diminishing joint disutility.
- Further research, especially in terms of effect size is needed to assess whether valuation studies for multi-dimensional health descriptive systems such as EQ-5D should incorporate interaction effects between health dimensions.