Mapping the HAQ-DI to the EQ-5D-5L and SF-6Dv2 among Chinese Patients with Gout

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OBJECTIVES

- This study aimed to develop mapping algorithms to predict EQ-5D-5L and SF-6Dv2 utility values from health assessment questionnaire-disability index (HAQ-DI) scores in gout patients in China.

METHODS

- Respondents recruited from the representative regions of China completed an online survey and the sample was randomly divided into development (80%) and validation (20%) datasets.
- Spearman's correlation analyses were conducted to assess the conceptual overlap for HAQ-DI with the EQ-5D-5L and SF-6Dv2.
- **Seven models**, including OLS, Tobit, CLAD, GLM, TPM, ALDVMM, BM, were explored.
- **Five predictor sets** including 1) HAQ-DI total score, 2) 1) plus total score square, 3) 2) plus total score cubic, 4) HAQ-DI subscale score, 5) HAQ-DI subscale score after stepwise regression were explored to estimate mapping algorithms using the development dataset.
- The MAE, RMSE, AIC, BIC, and ICC were used to calculate the average rank (AR) to assess the model performance. Model interpretability was also incorporated into the evaluation.

RESULTS

Socio-demographic characteristics of respondents

- A total of 1,000 patients with gout (**69.7% male, mean [SD] age 54.5 [13.4] years**) were included in this study..
- The average score (SD) of HAQ-DI was **0.742 (0.583)** and the mean utility value (SD) of EQ-5D-5L and SF-6Dv2 was **0.772(0.189)** and **0.658 (0.156)**, respectively.

Conceptual overlap

- As shown in Table 1, the Spearman's correlation coefficients for HAQ-DI score with EQ-5D-5L and SF-6Dv2 utilities were **0.725** and **0.571**, respectively.

Table 1 Spearman's correlation coefficients between HAQ-DI and EQ-5D-5L/SF-6Dv2

HAQ-DI	EQ-5D-5L						SF-6Dv2						
	MO	SC	UA	PD	AD	Utility	PF	RL	SF	PA	MH	VI	Utility
Dressing and Grooming	**-0.535**	**-0.613**	**-0.554**	-0.379	-0.411	**-0.615**	-0.295	-0.387	-0.391	-0.360	-0.364	-0.255	-0.457
Arising	-0.431	**-0.521**	-0.489	-0.373	-0.401	**-0.559**	-0.194	-0.380	-0.362	-0.309	-0.368	-0.260	-0.408
Eating	-0.404	**-0.587**	-0.453	-0.282	-0.328	-0.489	-0.213	-0.283	-0.273	-0.281	-0.254	-0.152	-0.330
Walking	-0.462	-0.449	-0.494	-0.482	-0.453	**-0.603**	-0.376	-0.429	-0.441	-0.413	-0.448	-0.340	**-0.536**
Hygiene	-0.460	**-0.555**	**-0.509**	-0.421	-0.426	**-0.600**	-0.266	-0.385	-0.369	-0.375	-0.389	-0.273	-0.463
Reach	-0.453	-0.475	-0.492	-0.443	-0.444	**-0.591**	-0.318	-0.426	-0.432	-0.412	-0.445	-0.351	**-0.524**
Grip	-0.412	**-0.554**	-0.463	-0.309	-0.342	**-0.506**	-0.230	-0.285	-0.299	-0.261	-0.266	-0.161	-0.343
Common daily activities	-0.493	-0.487	**-0.540**	-0.487	-0.489	**-0.643**	-0.341	-0.432	-0.456	-0.381	-0.479	-0.361	**-0.535**
Total score	**-0.569**	**-0.644**	**-0.625**	**-0.502**	**-0.520**	**-0.725**	-0.362	-0.482	-0.480	-0.434	-0.482	-0.349	**-0.571**

Table 2 Model performance of seven regression methods for mapping HAQ-DI to the EQ-5D-5L

Mapping	Development group (N=800)										Validation group (N=200)							
Methods	Mean	SD	Min	Max	MAE	RMSE	AIC	BIC	ICC	AR	Mean	SD	Min	Max	MAE	RMSE	ICC	AR
OLS1	0.769	0.137	0.330	0.945	0.096	0.131	-958	-948	0.682	5	0.780	0.1327	0.389	0.945	0.092	0.125	0.684	10
OLS2	0.769	0.137	0.303	0.940	0.096	0.131	-957	-943	0.683	7	0.780	0.1329	0.370	0.940	0.092	0.126	0.682	13
OLS3	0.769	0.138	0.287	0.941	0.096	0.132	-955	-936	0.683	11	0.780	0.1331	0.363	0.941	0.092	0.126	0.682	16
OLS4	0.769	0.139	0.318	0.947	0.095	0.131	-959	-917	0.690	3	**0.779**	**0.1328**	**0.383**	**0.947**	**0.088**	**0.122**	**0.702**	**1**
OLS5	**0.769**	**0.138**	**0.322**	**0.948**	**0.095**	**0.131**	**-961**	**-928**	**0.689**	**1**	**0.779**	**0.1327**	**0.380**	**0.948**	**0.087**	**0.122**	**0.701**	**3**
Tobit1	0.765	0.135	0.310	0.924	0.097	0.133	-677	-663	0.678	29	0.776	0.1302	0.373	0.924	0.093	0.126	0.675	29
Tobit2	0.765	0.134	0.335	0.927	0.097	0.133	-676	-657	0.677	30	0.776	0.1296	0.389	0.927	0.093	0.126	0.676	25
Tobit3	0.765	0.134	0.261	0.931	0.098	0.133	-676	-652	0.677	31	0.775	0.1300	0.354	0.931	0.093	0.126	0.676	26
Tobit4	0.765	0.136	0.299	0.927	0.097	0.133	-678	-631	0.685	27	**0.775**	**0.1300**	**0.362**	**0.927**	**0.089**	**0.122**	**0.694**	**7**
Tobit5	**0.765**	**0.136**	**0.303**	**0.928**	**0.097**	**0.133**	**-680**	**-642**	**0.684**	**24**	0.775	0.1299	0.359	0.928	0.089	0.122	0.694	8
CLAD1	0.777	0.136	0.344	0.951	0.095	0.132	--	--	0.679	14	**0.788**	**0.1310**	**0.402**	**0.951**	**0.091**	**0.125**	**0.681**	**12**
CLAD2	**0.775**	**0.141**	**0.258**	**0.942**	**0.095**	**0.133**	--	--	**0.687**	**9**	0.787	0.1365	0.339	0.942	0.092	0.127	0.682	22
CLAD3	**0.777**	**0.140**	**0.423**	**0.942**	**0.095**	**0.132**	--	--	**0.683**	**9**	0.790	0.1344	0.431	0.942	0.091	0.126	0.682	16
CLAD4	0.774	0.137	0.331	0.942	0.095	0.133	--	--	0.677	20	0.788	0.1291	0.357	0.942	0.090	0.126	0.672	22
GLM1	0.769	0.137	0.330	0.945	0.096	0.131	-958	-948	0.682	5	0.780	0.1327	0.389	0.945	0.092	0.125	0.684	10
GLM2	0.769	0.137	0.303	0.940	0.096	0.131	-957	-943	0.683	7	0.780	0.1329	0.370	0.940	0.092	0.126	0.682	13
GLM3	0.769	0.138	0.287	0.941	0.096	0.132	-955	-936	0.683	11	0.780	0.1331	0.363	0.941	0.092	0.126	0.682	16
GLM4	0.769	0.139	0.318	0.947	0.095	0.131	-959	-917	0.690	3	**0.779**	**0.1328**	**0.383**	**0.947**	**0.088**	**0.122**	**0.702**	**1**
GLM5	**0.769**	**0.138**	**0.322**	**0.948**	**0.095**	**0.131**	**-961**	**-928**	**0.689**	**1**	0.779	0.1327	0.380	0.948	0.087	0.122	0.701	3
PTM1	0.769	0.140	0.337	0.953	0.096	0.131	-536	-518	0.685	17	0.780	0.1351	0.394	0.953	0.092	0.125	0.689	9
PTM2	0.769	0.137	0.378	0.945	0.096	0.132	-558	-529	0.681	24	0.780	0.1336	0.378	0.945	0.092	0.126	0.683	15
PTM3	0.769	0.138	0.302	0.945	0.096	0.132	-559	-521	0.683	20	0.780	0.1329	0.367	0.945	0.092	0.126	0.681	21
PTM4	**0.769**	**0.141**	**0.327**	**0.955**	**0.095**	**0.132**	**-539**	**-454**	**0.692**	**15**	**0.780**	**0.1349**	**0.393**	**0.955**	**0.088**	**0.122**	**0.703**	**5**
PTM5	0.769	0.130	0.389	0.959	0.103	0.140	-428	-391	0.622	32	0.771	0.1297	0.389	0.959	0.094	0.129	0.660	31
ALDVMM1	0.776	0.125	0.357	0.925	0.096	0.132	-802	-769	0.659	24	0.786	0.1211	0.414	0.925	0.093	0.126	0.659	28
ALDVMM2	0.765	0.141	0.316	0.931	0.096	0.132	-789	-747	0.686	15	0.777	0.1355	0.373	0.931	0.092	0.126	0.684	19
ALDVMM3	0.776	0.125	0.214	0.943	0.096	0.132	-795	-743	0.656	28	0.775	0.1382	0.309	0.937	0.093	0.127	0.687	22
ALDVMM4	**0.769**	**0.132**	**0.322**	**0.931**	**0.095**	**0.131**	**-769**	**-670**	**0.679**	**11**	**0.779**	**0.1264**	**0.380**	**0.931**	**0.089**	**0.122**	**0.691**	**6**
BM1	0.770	0.131	0.202	0.901	0.099	0.135	-2602	-2569	0.661	23	0.781	0.1280	0.297	0.901	0.097	0.131	0.646	32
BM2	**0.769**	**0.128**	**0.373**	**0.916**	**0.098**	**0.134**	**-2625**	**-2582**	**0.665**	**18**	0.781	0.1232	0.422	0.916	0.093	0.126	0.663	29
BM3	0.769	0.130	0.317	0.922	0.098	0.134	-2632	-2580	0.669	19	0.780	0.1252	0.398	0.922	0.093	0.126	0.668	26
BM4	0.770	0.137	0.177	0.910	0.098	0.136	-2627	-2529	0.675	22	**0.781**	**0.1295**	**0.262**	**0.910**	**0.092**	**0.126**	**0.674**	**20**

Table 3 Model performance of seven regression methods for mapping HAQ-DI to the SF-6Dv2

Mapping	Development group (N=800)										Validation group (N=200)							
Methods	Mean	SD	Min	Max	MAE	RMSE	AIC	BIC	ICC	AR	Mean	SD	Min	Max	MAE	RMSE	ICC	AR
OLS1	0.658	0.084	0.391	0.765	0.099	0.129	-1013	-1003	0.459	24	0.665	0.081	0.427	0.765	0.100	0.132	0.489	27
OLS2	0.658	0.084	0.469	0.780	0.098	0.129	-1017	-1003	0.466	17	0.665	0.081	0.480	0.780	0.099	0.131	0.502	15
OLS3	0.658	0.085	0.327	0.793	0.098	0.128	-1024	-1005	0.475	12	0.663	0.083	0.412	0.793	0.100	0.130	0.510	18
OLS4	0.658	0.090	0.366	0.797	0.096	0.125	-1057	-1015	0.516	5	**0.661**	**0.087**	**0.390**	**0.789**	**0.095**	**0.126**	**0.552**	**3**
OLS5	**0.658**	**0.090**	**0.368**	**0.787**	**0.096**	**0.125**	**-1063**	**-1040**	**0.514**	**2**	**0.661**	**0.088**	**0.386**	**0.787**	**0.095**	**0.126**	**0.552**	**7**
Tobit1	0.658	0.084	0.389	0.765	0.099	0.129	-948	-934	0.460	26	0.665	0.081	0.425	0.765	0.100	0.132	0.490	26
Tobit2	0.658	0.085	0.472	0.780	0.098	0.128	-953	-934	0.467	19	0.665	0.081	0.482	0.780	0.099	0.131	0.503	12
Tobit3	0.658	0.086	0.323	0.794	0.098	0.128	-961	-937	0.476	15	0.663	0.084	0.411	0.794	0.100	0.130	0.511	17
Tobit4	0.658	0.091	0.364	0.797	0.097	0.125	-992	-945	0.516	9	**0.662**	**0.088**	**0.388**	**0.789**	**0.095**	**0.126**	**0.553**	**2**
Tobit5	**0.658**	**0.090**	**0.366**	**0.786**	**0.096**	**0.125**	**-999**	**-971**	**0.515**	**7**	0.661	0.088	0.384	0.786	0.095	0.126	0.552	5
CLAD1	0.650	0.083	0.385	0.756	0.099	0.129	--	--	0.456	31	0.657	0.080	0.420	0.756	0.100	0.132	0.488	29
CLAD2	0.651	0.083	0.432	0.766	0.098	0.129	--	--	0.461	22	0.658	0.080	0.453	0.766	0.100	0.131	0.495	20
CLAD3	0.652	0.081	0.268	0.777	0.099	0.129	--	--	0.460	29	0.657	0.080	0.377	0.777	0.101	0.132	0.491	30
CLAD4	**0.648**	**0.090**	**0.368**	**0.778**	**0.097**	**0.126**	--	--	**0.500**	**8**	**0.653**	**0.086**	**0.391**	**0.769**	**0.097**	**0.127**	**0.536**	**8**
GLM1	0.658	0.085	0.425	0.774	0.098	0.128	-1018	-1009	0.467	14	0.665	0.082	0.450	0.774	0.099	0.131	0.500	18
GLM2	0.658	0.085	0.467	0.784	0.098	0.128	-1019	-1005	0.468	12	0.664	0.082	0.481	0.784	0.099	0.130	0.505	13
GLM3	0.658	0.086	0.350	0.796	0.098	0.128	-1025	-1006	0.476	11	0.663	0.084	0.415	0.796	0.100	0.130	0.511	16
GLM4	0.658	0.090	0.413	0.811	0.096	0.125	-1059	-1017	0.517	4	**0.661**	**0.088**	**0.428**	**0.797**	**0.095**	**0.126**	**0.554**	**1**
GLM5	**0.658**	**0.090**	**0.414**	**0.796**	**0.096**	**0.125**	**-1065**	**-1042**	**0.516**	**1**	0.661	0.088	0.426	0.796	0.095	0.126	0.553	3
PTM1	0.658	0.084	0.401	0.774	0.099	0.129	-939	-920	0.465	30	0.665	0.081	0.435	0.774	0.100	0.131	0.496	23
PTM2	0.658	0.084	0.457	0.785	0.099	0.129	-939	-911	0.469	27	**0.664**	**0.081**	**0.472**	**0.785**	**0.099**	**0.130**	**0.505**	**11**
PTM3	**0.658**	**0.085**	**0.339**	**0.798**	**0.099**	**0.129**	**-952**	**-923**	**0.476**	**23**	0.663	0.083	0.416	0.798	0.100	0.130	0.511	14
PTM4	0.677	0.091	0.378	0.972	0.110	0.146	-980	-934	0.467	28	0.679	0.088	0.404	0.989	0.100	0.133	0.505	25
ALDVMM1	0.657	0.086	0.381	0.766	0.099	0.129	-979	-947	0.466	25	0.664	0.083	0.418	0.766	0.100	0.132	0.497	23
ALDVMM2	0.660	0.083	0.508	0.783	0.098	0.129	-995	-953	0.460	20	0.666	0.079	0.509	0.783	0.100	0.131	0.496	22
ALDVMM3	0.657	0.080	0.359	0.781	0.098	0.128	-998	-946	0.459	18	0.662	0.078	0.433	0.781	0.101	0.131	0.491	27
ALDVMM4	**0.659**	**0.090**	**0.357**	**0.800**	**0.096**	**0.126**	**-1024**	**-926**	**0.515**	**9**	**0.662**	**0.087**	**0.393**	**0.791**	**0.095**	**0.126**	**0.550**	**6**
BM1	0.659	0.084	0.356	0.752	0.100	0.130	-1556	-1523	0.449	21	0.666	0.082	0.396	0.752	0.101	0.134	0.474	31
BM2	0.662	0.085	0.530	0.787	0.099	0.129	-1585	-1543	0.460	16	0.669	0.081	0.530	0.787	0.100	0.131	0.499	20
BM3	0.658	0.087	0.365	0.792	0.098	0.128	-1577	-1526	0.478	6	0.665	0.084	0.444	0.792	0.099	0.130	0.514	10
BM4	**0.661**	**0.090**	**0.315**	**0.785**	**0.096**	**0.125**	**-1612**	**-1514**	**0.504**	**2**	**0.665**	**0.085**	**0.357**	**0.779**	**0.096**	**0.128**	**0.534**	**9**

Mapping HAQ-DI onto EQ-5D-5L utility value

- The model performance was summarized in Table 2. 3 regression models (CLAD5, ALDVMM5, BM5) were not presented due to not fit.
- No predictor set consistently demonstrated superiority.
- As the optimal GLM specification (normal distribution with identity link) corresponded to OLS, their results are identical.
- **OLS4 and OLS5** showed superior performance than others. However, HAQ-DI's multidimensionality may cause a risk of overfitting. Therefore, **OLS5** was selected as the final algorithm to enhance model robustness.

Mapping HAQ-DI onto SF-6Dv2 utility value

- The model performance was summarized in Table 3.
- **OLS4, OLS5, GLM4, and GLM5** showed better performance than others. When model performance are similar, prioritizing **OLS5** (same predictor set and model with EQ-5D-5L mapping algorithm) ensures comparability.

Use of optimal mapping algorithms

- The final mapping algorithms from HAQ-DI to EQ-5D-5L and SF-6Dv2 utility values are defined as follows:

$$EQ-5D-5L\ Utility\ value = 0.94764 - 0.05787 * HAQ-DIDressing_{g\ and\ Grooming} - 0.04104 * HAQ-DIArising - 0.02118 * HAQ-DIWalking - 0.02733 * HAQ-DIReach - 0.03197 * HAQ-DIGrip - 0.05338 * HAQ-DI_{Common\ daily\ activities}$$

$$SF-6Dv2\ Utility\ value = 0.78658 - 0.01740 * HAQ-DIDressing_{g\ and\ Grooming} - 0.03222 * HAQ-DIWalking - 0.04641 * HAQ-DIReach - 0.04334 * HAQ-DI_{Common\ daily\ activities}$$

CONCLUSION

- This study provides evidence to estimate EQ-5D-5L and SF-6Dv2 utility values from HAQ-DI scores. OLS and model with the HAQ-DI subscale score from stepwise regression can be used to predict the EQ-5D-5L and SF-6Dv2 utility values among patients with gout in China.