

Associations Between Scores from Various WHOQOL- 1 BREF Taiwan Version Domains and EQ-5D-5L Utility Score in Rheumatology Outpatients

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1 **Associations Between Scores from Various WHOQOL-**
2 **BREF Taiwan Version Domains and EQ-5D-5L Utility Score**
3 **in Rheumatology Outpatients**

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1 Abstract

2 Background

3 The World Health Organization Quality of Life-BREF (WHOQOL-BREF) and the
4 EuroQol five-dimensional questionnaire (EQ-5D-5L) are widely used patient-reported
5 outcome measures for assessing health-related quality of life. Although the EQ-5D-5L
6 provides preference-based utility for health economic evaluation, the WHOQOL-BREF
7 captures broader multidimensional aspects of quality of life. Evidence regarding their
8 convergent validity in patients with rheumatic diseases remains limited. This study
9 evaluated the associations between the WHOQOL-BREF Taiwan version and EQ-5D-5L
10 utility among rheumatology outpatients.

11 Methods

12 In this cross-sectional study, rheumatology outpatients at a tertiary medical center in
13 Taiwan completed the WHOQOL-BREF Taiwan version and EQ-5D-5L questionnaires.
14 Associations between WHOQOL-BREF domains and EQ-5D-5L utility were evaluated
15 using Spearman's rank correlation and multivariable linear regression analyses
16 adjusted for age, sex, fracture history, stroke, interstitial lung disease, and disease
17 category.

18 Results

19 A total of 141 participants were included (mean age, 55.5 ± 14.5 years; 61.0%
20 female). All WHOQOL-BREF domains were significantly associated with EQ-5D-5L
21 utility (all $P < 0.001$), with the physical health domain demonstrating the strongest
22 correlation. In separate multivariable models, all four domains remained
23 independently associated with higher EQ-5D-5L utility after adjustment. In an
24 exploratory model including all domains simultaneously, only the physical health
25 domain remained significant, reflecting substantial shared variance rather than
26 excessive multicollinearity.

27 Conclusions

28 The WHOQOL-BREF Taiwan version demonstrated good convergent validity with EQ-
29 5D-5L utility in rheumatology outpatients. While the physical health domain showed
30 the strongest association with preference-based health utility, the remaining

1 domains provided complementary information beyond physical functioning,
2 supporting the complementary use of both instruments in rheumatology research
3 and clinical practice.

4 Keyword: WHOQOL-BREF, EQ-5D-5L, Rheumatic diseases, Health-related quality of
5 life

6

1 **Introduction**

2

3 Rheumatic diseases are chronic conditions that frequently result in substantial
4 impairment in physical function, psychological well-being, social participation, and
5 overall quality of life [1,2,3]. In addition to disease activity and organ involvement,
6 chronic pain, fatigue, disability, treatment burden, and comorbidities may
7 substantially influence patients' perception of health status and daily functioning [3].
8 Consequently, patient-reported outcome measures (PROMs) have become
9 increasingly important in rheumatology research and clinical care [4].

10 The EuroQol five-dimensional questionnaire (EQ-5D-5L) is one of the most widely
11 used preference-based instruments for measuring health utility and is commonly
12 applied in health economic evaluation and cost-utility analysis [5,6,7]. The EQ-5D-5L
13 evaluates five dimensions of health, including mobility, self-care, usual activities,
14 pain/discomfort, and anxiety/depression, and allows derivation of utility scores
15 reflecting overall health preference [5,6]. However, although EQ-5D utility scores are
16 useful for economic and policy analyses, the instrument primarily focuses on health
17 utility and functional health status and may not fully capture broader
18 multidimensional aspects of quality of life [7].

19 In contrast, the World Health Organization Quality of Life-BREF (WHOQOL-BREF)
20 evaluates multidimensional quality of life across four domains, including physical
21 health, psychological health, social relationships, and environment [8]. Compared
22 with utility-based instruments, WHOQOL-BREF captures broader subjective
23 experiences and environmental perceptions that may influence patients' overall well-
24 being [8,9]. The Taiwan version of WHOQOL-BREF has undergone cultural adaptation
25 and psychometric validation and has been widely used in Taiwanese populations
26 [10].

27 Previous studies have explored associations between WHOQOL-BREF and EQ-5D
28 utility in general population and chronic disease settings [11,12]. These studies
29 suggested that WHOQOL-BREF domain scores may correlate with preference-based
30 utility measures. However, evidence regarding the relationship between WHOQOL-
31 BREF and EQ-5D utility remains limited in rheumatic disease populations, in whom

1 multidimensional disease burden involving pain, fatigue, psychological distress, social
2 participation, and treatment-related impairment frequently coexist [13,14].
3 Rheumatic diseases are often associated with substantial impairment in physical
4 function, psychosocial well-being, and overall quality of life, making comprehensive
5 patient-reported outcome assessment particularly important [1,2,3].

6 Furthermore, the relationship between culturally adapted WHOQOL-BREF
7 instruments and EQ-5D utility has not been well characterized in rheumatology
8 settings. The Taiwan version of the WHOQOL-BREF has undergone cultural
9 adaptation and psychometric validation in Taiwanese populations [10], while EQ-5D-
10 5L utility scores can be estimated using validated Taiwanese population preference
11 weights [15,16]. Understanding the relationship between these instruments may
12 provide important evidence regarding convergent validity between multidimensional
13 quality-of-life assessment and preference-based utility measurement.

14 Therefore, the present study aimed to evaluate the convergent validity between
15 WHOQOL-BREF Taiwan version domain scores and EQ-5D-5L utility among
16 rheumatology outpatients. We additionally investigated the associations between
17 individual WHOQOL-BREF domains and EQ-5D-5L utility after adjustment for
18 demographic characteristics and clinical comorbidities.

19

20 **Methods**

21

22 **Study design and participants**

23 This cross-sectional study enrolled consecutive patients attending rheumatology
24 outpatient clinics at a tertiary medical center in Taiwan. This study was approved by
25 the Institutional Review Board of Taichung Veterans General Hospital (IRB approval
26 number: CE26134C). The study was conducted in accordance with the Declaration of
27 Helsinki and relevant institutional guidelines and regulations. Written informed
28 consent was obtained from all participants before study enrollment. Patients with
29 rheumatic diseases who were able to complete self-administered questionnaires
30 during routine outpatient visits were included. Demographic characteristics, disease

1 duration, comorbidities, medication use, and patient-reported outcome
2 questionnaires were collected at the time of assessment.

3 Patients were categorized into four disease groups according to their predominant
4 rheumatic diagnosis:

- 5 1. Inflammatory arthritis, including rheumatoid arthritis (RA), psoriatic arthritis
6 (PsA), ankylosing spondylitis (AS), spondyloarthritis (SpA);
- 7 2. Connective tissue diseases (CTD), including Sjögren syndrome (SjS), systemic
8 lupus erythematosus (SLE), systemic sclerosis/progressive systemic sclerosis
9 (PSS), mixed connective tissue disease (MCTD), undifferentiated connective
10 tissue disease (UCTD);
- 11 3. Systemic inflammatory autoimmune diseases (SIAID), including idiopathic
12 inflammatory myopathies (dermatomyositis [DM], polymyositis [PM],
13 amyopathic dermatomyositis [ADM], antisynthetase syndrome [ASSD]),
14 antineutrophil cytoplasmic antibody-associated vasculitis (AAV), urticarial
15 vasculitis, and other systemic vasculitic disorders;
- 16 4. Other rheumatic or immune-related conditions, including gout,
17 osteoarthritis/degenerative joint disease (OA/DJD), adult-onset Still's disease
18 (AOSD), antiphospholipid syndrome (APS), chronic urticaria, common variable
19 immunodeficiency (CVID), autoimmune dermatologic diseases, and
20 miscellaneous immune-related conditions.

21 Patients with overlapping autoimmune features were classified according to the
22 predominant clinical diagnosis determined by treating rheumatologists. Overlap
23 syndrome was additionally recorded as a separate clinical variable. Because this was
24 an exploratory cross-sectional study based on consecutive outpatient recruitment,
25 no formal a priori sample size calculation was performed. However, the sample size
26 was considered adequate for correlation and exploratory regression analyses.

27

28 Quality-of-life assessment

29 Health-related quality of life was assessed using the WHOQOL-BREF Taiwan version
30 [10], which includes four domains: physical health, psychological health, social
31 relationships, and environment. Domain scores were calculated according to

1 standard scoring procedures, with higher scores indicating better perceived quality of
2 life.

3 Preference-based health utility was evaluated using the EQ-5D-5L Taiwan version.
4 Utility scores were calculated using the Taiwanese EQ-5D-5L valuation set [15]. EQ
5 visual analogue scale (EQVAS) scores were additionally recorded.

6

7 Clinical variables

8 Clinical variables included age, sex, disease duration, hypertension, diabetes mellitus,
9 fibromyalgia, fracture history, stroke, cardiovascular disease, chronic kidney disease,
10 chronic lung disease, interstitial lung disease (ILD), cancer history, steroid use,
11 disease category, and overlap syndrome. Cardiovascular disease included non-
12 cerebrovascular cardiovascular disorders such as ischemic heart disease, myocardial
13 infarction, coronary artery disease, heart failure, and peripheral arterial occlusive
14 disease, but excluded stroke and transient ischemic attack. Chronic lung disease
15 referred to non-ILD chronic pulmonary disorders, such as chronic obstructive
16 pulmonary disease, bronchiectasis, asthma, and chronic airway disease. Disease
17 category referred to the primary rheumatic diagnosis and was classified as
18 inflammatory arthritis, connective tissue disease, systemic inflammatory
19 autoimmune disease, or other rheumatic or immune-related conditions.

20

21 Statistical analysis

22 Continuous variables are presented as mean $\pm$ standard deviation (SD) or median
23 (interquartile range [IQR]), as appropriate, whereas categorical variables are
24 summarized as frequencies and percentages. Differences in WHOQOL-BREF domain
25 scores across disease categories were evaluated using the Kruskal–Wallis test
26 followed by Dunn–Bonferroni post hoc comparisons. Associations between
27 WHOQOL-BREF domain scores and EQ-5D-5L utility were assessed using Spearman's
28 rank correlation coefficients. Univariable and multivariable linear regression analyses
29 were performed to identify factors associated with EQ-5D-5L utility. Two
30 multivariable modeling strategies were applied. In the simultaneous-domain model,

all four WHOQOL-BREF domains were entered simultaneously to estimate their independent associations with EQ-5D-5L utility, whereas separate-domain models included each WHOQOL-BREF domain individually while adjusting for age, sex, fracture history, stroke, interstitial lung disease (ILD), and disease category. Multicollinearity in the simultaneous-domain model was assessed using variance inflation factors (VIFs) and generalized variance inflation factors (GVIFs) for multi-level categorical variables. Two-sided P values <0.05 were considered statistically significant. All analyses were performed using R version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Patient characteristics

A total of 141 rheumatology outpatients were included in the study. The mean age was 55.47 ± 14.48 years, and 61.0% were female. Median disease duration was 6.60 years (IQR 1.60–10.75). Patients were classified into four disease groups: inflammatory arthritis (39.0%), connective tissue diseases (CTD, 24.8%), systemic inflammatory autoimmune diseases (SIAID, 14.2%), and other rheumatic or immune-related conditions (22.0%). Overlap syndrome was identified in 19.1% of patients. Common comorbidities included hypertension (34.0%), fracture history (16.3%), diabetes mellitus (12.1%), chronic kidney disease (12.1%), interstitial lung disease (ILD, 7.8%), and cancer (7.8%). Steroid use was reported in 29.1% of patients. The mean WHOQOL-BREF domain scores were 13.23 ± 2.80 for physical health, 13.26 ± 2.84 for psychological health, 13.70 ± 2.47 for social relationships, and 14.46 ± 2.35 for environment. Mean EQVAS was 75.06 ± 17.16 , and mean EQ-5D-5L utility was 0.73 ± 0.30 (Table 1).

Comparison among disease categories

WHOQOL-BREF domain scores and EQVAS did not significantly differ among disease categories. However, EQ-5D-5L utility demonstrated significant differences across

disease groups ($p=0.022$) (Table 2). Post-hoc analysis revealed significantly lower utility scores in patients with SIAID compared with patients categorized as other rheumatic or immune-related conditions. This finding may reflect greater systemic disease burden and functional impairment among patients with SIAID which included inflammatory myopathies and systemic vasculitic disorders.

Correlations between WHOQOL-BREF domains and EQ-5D-5L measures

All WHOQOL-BREF domains were significantly positively correlated with both EQVAS and EQ-5D-5L utility (all $P<0.001$) (Table 3). Correlations between WHOQOL-BREF domains and EQ-5D-5L utility ranged from $r_s=0.327$ to 0.604 , while correlations with EQVAS ranged from $r_s=0.508$ to 0.640 . Among the four domains, physical health demonstrated the strongest correlation with EQ-5D-5L utility ($r_s=0.604$), whereas psychological health showed the strongest correlation with EQVAS ($r_s=0.640$). These findings support the convergent validity of the WHOQOL-BREF by demonstrating moderate-to-strong associations with both EQ-5D-5L utility and EQVAS in rheumatology outpatients.

Correlations between WHOQOL-BREF domains and EQ-5D-5L dimensions

To further examine the conceptual relationships between WHOQOL-BREF domains and EQ-5D-5L dimensions, Spearman correlation analyses were performed between the four WHOQOL-BREF domains and the five EQ-5D-5L dimensions (Supplementary Table S1). All WHOQOL-BREF domains were significantly inversely correlated with the EQ-5D-5L dimensions, indicating that higher WHOQOL-BREF scores were associated with fewer reported health problems. Among the four domains, physical health demonstrated the strongest correlations, particularly with anxiety/depression ($r_s = -0.545$), usual activities ($r_s = -0.518$), and pain/discomfort ($r_s = -0.514$). Psychological health also showed moderate inverse correlations across all EQ-5D-5L dimensions, with the strongest associations observed for anxiety/depression ($r_s = -0.503$) and pain/discomfort ($r_s = -0.408$). Social relationships and environment demonstrated weaker but consistently significant correlations, particularly with usual activities, anxiety/depression, and pain/discomfort, supporting conceptual overlap

1 between WHOQOL-BREF domains and the functional and psychosocial dimensions
2 captured by the EQ-5D-5L.

3

4 Factors associated with EQ-5D-5L utility

5 In univariable linear regression analyses, fracture history, stroke, and interstitial lung
6 disease (ILD) were associated with lower EQ-5D-5L utility using conventional
7 standard errors, although these associations were attenuated after applying HC3
8 robust standard errors (Supplementary Table S2). All four WHOQOL-BREF domains
9 were significantly positively associated with EQ-5D-5L utility in both conventional and
10 HC3 robust regression analyses (all $P < 0.001$). Among the four domains, physical
11 health demonstrated the strongest association with EQ-5D-5L utility ($\beta = 0.065$,
12 adjusted $R^2 = 0.371$), followed by psychological health ($\beta = 0.051$, adjusted $R^2 =$
13 0.235), environment ($\beta = 0.048$, adjusted $R^2 = 0.138$), and social relationships ($\beta =$
14 0.040 , adjusted $R^2 = 0.104$).

15

16 Primary analysis

17 In separate multivariable models, each WHOQOL-BREF domain remained
18 independently associated with higher EQ-5D-5L utility after adjustment for age, sex,
19 and disease category (Table 4). Physical health demonstrated the largest effect size
20 and explained the greatest proportion of variance, followed by psychological health,
21 environment, and social relationships.

22

23 Sensitivity analysis

24 Additional adjustment for disease duration, fracture history, and ILD produced similar
25 estimates, indicating that the observed associations were robust to further clinical
26 adjustment (Supplementary Table S4).

27

28 Exploratory simultaneous-domain analysis

29 When all four WHOQOL-BREF domains were entered simultaneously into the same

1 model, only the physical health domain remained independently associated with EQ-
2 5D-5L utility, whereas the associations for the remaining domains were attenuated
3 (Table 5). Collinearity diagnostics demonstrated acceptable GVIF values
4 (Supplementary Table S5), suggesting that the attenuation was more likely
5 attributable to substantial shared variance among the WHOQOL-BREF domains than
6 to excessive multicollinearity.

8 **Discussion**

10 In this cross-sectional study of rheumatology outpatients, we demonstrated good
11 convergent validity between the WHOQOL-BREF Taiwan version and the EQ-5D-5L.
12 All four WHOQOL-BREF domains were positively associated with EQ-5D-5L utility in
13 both correlation analyses and separate multivariable regression models after
14 adjustment for age, sex, and disease category. Together, these findings support a
15 consistent relationship between multidimensional quality-of-life assessment and
16 preference-based health utility measurement in patients with rheumatic diseases.

18 Among the WHOQOL-BREF domains, physical health demonstrated the strongest
19 association with EQ-5D-5L utility and explained the largest proportion of variance in
20 utility scores. This finding is clinically plausible because the EQ-5D-5L primarily
21 reflects functional health status through dimensions including mobility, self-care,
22 usual activities, pain/discomfort, and anxiety/depression. Consistent with this
23 conceptual framework, analyses of individual EQ-5D-5L dimensions showed that the
24 physical health domain was most strongly associated with anxiety/depression, usual
25 activities, and pain/discomfort, whereas the psychological health domain also
26 demonstrated moderate associations across all five EQ-5D-5L dimensions,
27 particularly anxiety/depression and pain/discomfort. In addition, the social
28 relationships and environment domains were significantly associated with EQ-5D-5L
29 utility despite not being explicitly represented within the five EQ-5D-5L dimensions.
30 These findings suggest that the WHOQOL-BREF and EQ-5D-5L measure related but
31 not identical constructs, with the WHOQOL-BREF providing a broader assessment of

1 patients' multidimensional quality of life beyond physical functioning alone [8,9].

2

3 To further explore the relationships among the four WHOQOL-BREF domains, we

4 performed an exploratory model in which all domains were entered simultaneously.

5 In this analysis, only the physical health domain remained independently associated

6 with EQ-5D-5L utility, whereas the associations for the psychological, social, and

7 environmental domains were attenuated. Importantly, collinearity diagnostics

8 demonstrated acceptable GVIF values, indicating that these findings were unlikely to

9 be explained by excessive statistical multicollinearity. Rather, they most likely reflect

10 the substantial shared variance among the WHOQOL-BREF domains, which represent

11 closely related components of the same multidimensional quality-of-life construct.

12 Collectively, these findings suggest that physical health contributes most directly to

13 preference-based health utility, whereas the remaining domains provide

14 complementary information regarding psychosocial and environmental aspects of

15 quality of life that are not fully captured by the EQ-5D-5L.

16

17 Our findings are consistent with previous studies demonstrating associations

18 between WHOQOL-BREF and EQ-5D across different populations [12]. However,

19 evidence evaluating the relationship between these two instruments in patients with

20 rheumatic diseases remains limited [13,14]. Unlike the previous Thai study, which

21 developed a mapping algorithm to estimate EQ-5D-5L utility from WHOQOL-BREF

22 scores in the general population [12], our study focused on evaluating convergent

23 validity in a real-world rheumatology outpatient population rather than developing a

24 utility prediction model. This distinction is clinically important because rheumatic

25 diseases impose a multidimensional burden extending beyond physical impairment

26 to include chronic pain, fatigue, disability, psychological distress, treatment burden,

27 and reduced social participation, all of which substantially influence patients' quality

28 of life [1–4,13,14]. Our findings therefore provide disease-specific evidence

29 supporting the convergent validity of the WHOQOL-BREF Taiwan version and EQ-5D-

30 5L utility in rheumatology outpatients.

31

1 An additional strength of this study is the use of the WHOQOL-BREF Taiwan version,
2 a culturally adapted instrument with established validity and reliability in the
3 Taiwanese population [10]. Despite incorporating culturally specific items, the
4 WHOQOL-BREF demonstrated consistent associations with preference-based EQ-5D-
5 5L utility, suggesting that the conceptual relationship between multidimensional
6 quality of life and health utility is preserved across cultural adaptations. These
7 findings support the cross-cultural applicability of the WHOQOL framework and
8 indicate that culturally adapted patient-reported outcome measures can be
9 meaningfully interpreted alongside preference-based utility instruments in
10 rheumatology research.

11
12 Several limitations should be acknowledged. First, the cross-sectional design
13 precludes causal inference and does not permit evaluation of longitudinal
14 responsiveness or changes in health utility over time. Second, this was a single-
15 center study with a moderate sample size, which may limit the generalizability of the
16 findings and reduce statistical power for exploratory simultaneous-domain analyses.
17 Third, disease-specific activity indices and severity measures were unavailable across
18 all diagnostic groups and therefore could not be incorporated into the regression
19 models. Fourth, the heterogeneous composition of the "other rheumatic or immune-
20 related conditions" category may have introduced additional variability. Finally, this
21 study was designed to evaluate convergent validity rather than to develop or validate
22 a utility mapping algorithm; therefore, the findings should not be interpreted as
23 supporting direct conversion of WHOQOL-BREF scores into EQ-5D-5L utility values.

24
25 In conclusion, the WHOQOL-BREF Taiwan version demonstrated good convergent
26 validity with EQ-5D-5L utility among rheumatology outpatients. Although the
27 physical health domain showed the strongest relationship with preference-based
28 health utility, the psychological, social, and environmental domains provided
29 complementary information beyond physical functioning alone. These findings
30 support the complementary use of the WHOQOL-BREF and EQ-5D-5L in
31 rheumatology research and clinical practice. Whereas the EQ-5D-5L provides a
32 preference-based utility measure suitable for health economic evaluation, the

1 WHOQOL-BREF offers a broader assessment of patients' multidimensional quality of
2 life. Future longitudinal studies are warranted to determine whether changes in
3 WHOQOL-BREF domains predict subsequent changes in EQ-5D-5L utility and to
4 evaluate whether disease-specific quality-of-life domains provide incremental value
5 beyond preference-based health utility measures.

6

7 **Declarations**

8

9 Ethics approval and consent to participate

10 The study protocol was reviewed and approved by the Institutional Review Board of
11 Taichung Veterans' General Hospital (approval number: CE26134C). The study was
12 conducted in accordance with the Declaration of Helsinki and all relevant
13 institutional guidelines and regulations. Written informed consent was obtained from
14 all participants prior to participation in the study.

15

16 Consent for publication

17 Not applicable

18

19 Availability of data and materials

20 The datasets generated and/or analyzed during the current study are not publicly
21 available due to patient privacy and ethical restrictions but are available from the
22 corresponding author on reasonable request, subject to approval by the relevant
23 institutional review board and applicable institutional requirements.

24

25 Competing interests

26 The authors declare that they have no competing interests.

27

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2 This research received no specific grant from any funding agency in the public,
3 commercial, or not-for-profit sectors.

4

5 Authors' contributions

6 CWT conceived and designed the study, obtained ethical approval, performed the
7 statistical analyses, interpreted the findings, and drafted the manuscript. JPC
8 contributed to data management, statistical analyses, and interpretation of the
9 results. YTT contributed to questionnaire administration, data collection, and
10 database maintenance. CYL contributed to the study conception and methodology,
11 supervised the statistical analyses, interpreted the findings, and critically revised the
12 manuscript for important intellectual content. All authors read and approved the
13 final manuscript.

14

15 Acknowledgements

16 Not applicable

17

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Table1. Baseline Characteristics of Rheumatology Outpatients (N=141)

Variables	N	%
Age, mean $\pm$ SD	55.47 $\pm$ 14.48	
Gender		
Female	86	(61.0%)
Male	55	(39.0%)
Disease duration, median (IQR)	6.60	(1.60-10.75)
HTN	48	(34.0%)
DM	17	(12.1%)
Fibromyalgia	4	(2.8%)
Fracture	23	(16.3%)
Stroke	4	(2.8%)
Cardiovascular disease	10	(7.1%)
Chronic kidney disease	17	(12.1%)
Chronic lung disease	9	(6.4%)
ILD	11	(7.8%)
Cancer	11	(7.8%)
Steroid	41	(29.1%)
Disease category		
Inflammatory Arthritis	55	(39.0%)
CTD	35	(24.8%)
SIAID	20	(14.2%)
Others	31	(22.0%)
Overlap syndrome	27	(19.1%)
Physical Health, mean $\pm$ SD	12.40 $\pm$ 1.98	
Psychological Health, mean $\pm$ SD	13.14 $\pm$ 2.36	
Social Relationships, mean $\pm$ SD	13.70 $\pm$ 2.47	
Environment, mean $\pm$ SD	14.46 $\pm$ 2.35	
EQVAS, mean $\pm$ SD	75.06 $\pm$ 17.16	
Utility score, mean $\pm$ SD	0.73 $\pm$ 0.30	

Data are presented as mean $\pm$ standard deviation (SD), median (interquartile range, IQR), or number (%), as appropriate. CTD = connective tissue diseases; SIAID = systemic inflammatory autoimmune diseases; HTN = hypertension; DM = diabetes mellitus; CVD = cardiovascular disease; CKD = chronic kidney disease; CLD = chronic lung disease; ILD = interstitial lung disease; EQVAS = EuroQol visual analogue scale.

Table2. WHOQOL-BREF and EQ-5D-5L Scores Across Disease Categories

	Arthritis (n=55)		CTD (n=35)		SIAID (n=20)		Others (n=31)		p value
Physical Health	12.57	(11.43- 14.86)	13.71	(11.71- 16.00)	12.29	(9.57- 14.43)	13.71	(12.29- 15.43)	0.269
Psychological Health	13.33	(12.00- 15.33)	14.00	(11.33- 16.00)	12.67	(9.67- 14.17)	13.33	(12.33- 14.00)	0.424
Social Relationships	13.00	(12.00- 15.00)	14.00	(12.00- 16.00)	13.50	(12.00- 15.25)	14.00	(12.00- 15.00)	0.596
Environment	14.67	(12.44- 16.00)	14.22	(13.11- 16.00)	14.00	(12.33- 16.00)	14.22	(13.11- 16.00)	0.934
EQVAS	80.00	(70.00- 82.50)	80.00	(70.00- 85.00)	79.00	(60.00- 91.50)	80.00	(67.50- 80.00)	0.944
EQ-5D-5L Utility score	0.78	(0.57- 0.91)	0.85	(0.70- 0.93)	0.69	(0.57- 0.87)	0.91	(0.79- 1.00)	0.022*

Data are presented as median (interquartile range, IQR). Comparisons among disease categories were performed using the Kruskal–Wallis test. Post-hoc pairwise comparisons were conducted using Dunn–Bonferroni correction when overall group differences were statistically significant. CTD = connective tissue diseases; SIAID = Systemic inflammatory autoimmune diseases. *p<0.05. Overall group differences were significant for the EQ-5D-5L utility index (Kruskal–Wallis p = 0.022). Post-hoc Dunn's test with Bonferroni correction showed a significant difference only between the SIAID and Other disease groups (adjusted p = 0.0495).

Table3. Correlations Between WHOQOL-BREF Domains and EQ-5D-5L Measures

	EQVAS		Utility	
	r_s	p	r_s	p
Physical Health	.425	<0.001**	.429	<0.001**
Psychological Health	.556	<0.001**	.413	<0.001**
Social Relationships	.508	<0.001**	.327	<0.001**
Environment	.516	<0.001**	.375	<0.001**

Correlations were assessed using Spearman's rho coefficients. EQVAS = EuroQol visual analogue scale. EQ-5D-5L utility refers to the Taiwanese utility value set. * $p < 0.05$, ** $p < 0.01$.

Supplementary Table S1. Correlations with the five EQ-5D dimensions

WHOQOL domain	Mobility	Self-care	Usual activities	Pain/discomfort	Anxiety/depression
Physical	-0.353	-0.368	-0.518	-0.514	-0.545
Psychological	-0.318	-0.245	-0.376	-0.408	-0.503
Social relationships	-0.174	-0.244	-0.384	-0.277	-0.325
Environment	-0.201	-0.230	-0.377	-0.314	-0.346

Data are presented as Spearman's rank correlation coefficients (r_s). Negative correlation coefficients indicate that higher WHOQOL-BREF domain scores were associated with lower levels of problems in the corresponding EQ-5D-5L dimensions. All correlations were statistically significant ($P < 0.001$).

Supplementary Table S2. Univariable Linear Regression Analyses for EQ-5D-5L Utility

Variable	β	(Conventional 95% CI)	<i>p</i> value	(HC3 95% CI)	HC3 <i>p</i> value	Adjusted R ²
Age	-0.0023	(-0.0057, 0.0010)	0.180	(-0.0062, 0.0016)	0.242	0.006
Male sex	0.0556	(-0.0452, 0.1565)	0.277	(-0.0379, 0.1491)	0.241	0.001
Disease duration	-0.0038	(-0.0115, 0.0039)	0.332	(-0.0106, 0.0030)	0.269	0.000
HTN	-0.0899	(-0.1931, 0.0132)	0.087	(-0.2028, 0.0230)	0.118	0.014
DM	-0.0997	(-0.2506, 0.0511)	0.193	(-0.3289, 0.1294)	0.391	0.005
Fibromyalgia	-0.1272	(-0.4240, 0.1697)	0.398	(-0.2933, 0.0390)	0.132	-0.002
Fracture history	-0.1972	(-0.3268, -0.0676)	0.003	(-0.3940, -0.0003)	0.050	0.054
Stroke	-0.3109	(-0.6039, -0.0178)	0.038	(-1.2970, 0.6753)	0.534	0.024
CVD	-0.1630	(-0.3535, 0.0275)	0.093	(-0.4974, 0.1714)	0.337	0.013
CKD	0.0078	(-0.1439, 0.1596)	0.919	(-0.2148, 0.2304)	0.945	-0.007
CLD	-0.1767	(-0.3766, 0.0233)	0.083	(-0.3490, -0.0043)	0.045	0.014
ILD	-0.2220	(-0.4024, -0.0415)	0.016	(-0.5264, 0.0825)	0.152	0.034
Cancer	-0.1187	(-0.3018, 0.0645)	0.202	(-0.4677, 0.2303)	0.503	0.005
Steroid use	-0.0197	(-0.1285, 0.0890)	0.721	(-0.1403, 0.1009)	0.747	-0.006
Overlap disease	-0.0147	(-0.1403, 0.1108)	0.817	(-0.1212, 0.0917)	0.785	-0.007
Disease category			0.182		0.086	0.014
CTD vs IA	0.0111	(-0.1144, 0.1367)	0.861	(-0.1394, 0.1617)	0.884	0.014
SIAID vs IA	-0.0662	(-0.2178, 0.0854)	0.390	(-0.2167, 0.0843)	0.386	0.014
Others vs IA	0.1104	(-0.0201, 0.2408)	0.100	(0.007, 0.2142)	0.037	0.014
Physical health	0.0648	(0.0508, 0.0788)	<0.001	(0.0406, 0.0890)	<0.001	0.371
Psychological health	0.0510	(0.0358, 0.066)	<0.001	(0.0303, 0.0717)	<0.001	0.235
Social relationships	0.0397	(0.0208, 0.0586)	<0.001	(0.0182, 0.0612)	<0.001	0.104
Environment	0.0477	(0.0283, 0.0672)	<0.001	(0.0238, 0.0716)	<0.001	0.138

Table 4. Association between WHOQOL-BREF domains and EQ-5D-5L utility

WHOQOL-BREF domain	β	(HC3 95% CI)	HC3 p value	Partial R ²	Adjusted R ²
Physical Health	0.064	(0.038, 0.089)	<0.001	0.372	0.378
Psychological Health	0.053	(0.031, 0.076)	<0.001	0.267	0.273
Social Relationships	0.044	(0.020, 0.068)	<0.001	0.130	0.138
Environment	0.049	(0.023, 0.074)	<0.001	0.155	0.163

All models were adjusted for age, sex, and disease category. Regression coefficients, confidence intervals, and p values were estimated using HC3 heteroskedasticity-robust standard errors.

Supplementary Table S3. Primary multivariable linear regression models evaluating the association between each WHOQOL-BREF domain and EQ-5D-5L utility.

Variable	Physical health	Psychological health	Social relationships	Environment
WHOQOL-BREF domain score	0.064 (0.038, 0.089)	0.053 (0.031, 0.076)	0.044 (0.020, 0.068)	0.049 (0.023, 0.074)
Age	−0.002 (−0.005, 0.001)	−0.002 (−0.006, 0.001)	−0.001 (−0.005, 0.003)	−0.002 (−0.006, 0.002)
Male	0.063 (−0.009, 0.135)	0.088 (0.006, 0.169)	0.106 (0.016, 0.196)	0.084 (−0.002, 0.170)
CTD vs IA	0.019 (−0.105, 0.143)	0.042 (−0.088, 0.173)	0.034 (−0.105, 0.173)	0.056 (−0.077, 0.189)
SIAID vs IA	0.005 (−0.095, 0.105)	0.029 (−0.095, 0.153)	−0.042 (−0.173, 0.089)	−0.025 (−0.149, 0.099)
Others vs IA	0.063 (−0.035, 0.160)	0.135 (0.039, 0.232)	0.112 (0.006, 0.218)	0.103 (−0.004, 0.210)
Adjusted R ²	0.378	0.273	0.138	0.163
Overall disease category (HC3 Wald p)	0.638	0.051	0.112	0.192

Values are presented as β (HC3 95% confidence interval) and HC3 robust p values. Four separate multivariable linear regression models were fitted, each including one WHOQOL-BREF domain together with age, sex, and disease category. IA was used as the reference category. Overall disease category p values were obtained using heteroskedasticity-consistent (HC3) Wald tests jointly evaluating all disease-category coefficients.

Supplementary Table S4. Sensitivity analyses of the associations between WHOQOL-BREF domains and EQ-5D utility with additional clinical adjustment.

Variable	Physical health	Psychological health	Social relationships	Environment
WHOQOL-BREF domain score	0.061 (0.036, 0.087)	0.051 (0.029, 0.072)	0.041 (0.018, 0.065)	0.043 (0.019, 0.067)
Age, years	−0.001 (−0.005, 0.002)	0.001 (−0.004, 0.002)	0.000 (−0.004, 0.004)	−0.001 (−0.005, 0.003)
Male vs female	0.065 (−0.012, 0.143)	0.085 (−0.000, 0.169)	0.105 (0.011, 0.199)	0.081 (−0.011, 0.173)
Disease category, overall	0.729	0.118	0.311	0.331
CTD vs IA	0.023 (−0.103, 0.149)	0.040 (−0.091, 0.170)	0.051 (−0.084, 0.186)	0.066 (−0.068, 0.201)
SIAID vs IA	0.027 (−0.101, 0.155)	0.046 (−0.118, 0.210)	0.023 (−0.153, 0.198)	0.019 (−0.141, 0.179)
Others vs IA	0.056 (−0.047, 0.159)	0.124 (0.023, 0.225)	0.107 (−0.005, 0.219)	0.103 (−0.009, 0.215)
Disease duration, years	−0.002 (−0.009, 0.005)	−0.003 (−0.010, 0.005)	−0.001 (−0.009, 0.006)	−0.001 (−0.008, 0.007)
Fracture, yes vs no	−0.033 (−0.192, 0.127)	−0.120 (−0.296, 0.056)	−0.122 (−0.313, 0.069)	−0.104 (−0.300, 0.092)
ILD, yes vs no	−0.084 (−0.365, 0.196)	−0.072 (−0.412, 0.268)	−0.183 (−0.540, 0.174)	−0.123 (−0.450, 0.204)
Adjusted R²	0.372	0.289	0.172	0.173

Values are presented as unstandardized regression coefficients (β), HC3 heteroskedasticity-robust 95% confidence intervals, and HC3 robust *p* values. Each column represents a separate multivariable linear regression model with EQ-5D utility as the dependent variable. Each model included one WHOQOL-BREF domain score and was adjusted for age, sex, disease category, disease duration, history of fracture, and interstitial lung disease. The *p* values shown in the “Disease category, overall” row were obtained from HC3 heteroskedasticity-robust Wald tests jointly evaluating all disease-

category coefficients; therefore, no regression coefficient or confidence interval is reported for this row. Female sex, IA, absence of fracture, and absence of ILD were the reference categories. Abbreviations: CI, confidence interval; CTD, connective tissue disease; HC3, heteroskedasticity-consistent covariance estimator type 3; IA, inflammatory arthritis; ILD, interstitial lung disease; SIAID, systemic inflammatory and autoinflammatory disease; WHOQOL-BREF, World Health Organization Quality of Life–BREF.

Table 5. Exploratory multivariable regression model including all four WHOQOL-BREF domains simultaneously for EQ-5D-5L utility.

Variable	β (HC3 95% CI)	HC3 <i>p</i> value	Partial R^2
Physical health	0.061 (0.027–0.094)	<0.001	0.163
Psychological health	0.020 (–0.009–0.049)	0.183	0.019
Social relationships	–0.004 (–0.027–0.019)	0.729	0.001
Environment	–0.016 (–0.054–0.021)	0.388	0.011
Age	–0.002 (–0.005–0.001)	0.195	0.016
Male	0.060 (–0.014–0.134)	0.112	0.014
CTD vs IA	0.016 (–0.112–0.145)	0.802	0.001
SIAID vs IA	0.024 (–0.086–0.133)	0.669	0.001
Others vs IA	0.077 (–0.021–0.176)	0.124	0.015
Adjusted R^2	0.379		

All four WHOQOL-BREF domains were entered simultaneously into the same multivariable linear regression model together with age, sex, and disease category. Values are presented as β (HC3 95% confidence interval) and HC3 robust *p* values. IA was used as the reference disease category. Because the four WHOQOL-BREF domains represent correlated dimensions of the same construct, this

simultaneous model was performed as an exploratory analysis and should not be interpreted as the primary analysis.

Supplementary Table S5. Multicollinearity diagnostics for the simultaneous-domain multivariable linear regression model.

Predictor	GVIF	Df	Adjusted GVIF
Psychological health	3.209	1	1.791
Physical health	2.912	1	1.706
Environment	2.620	1	1.619
Social relationships	2.251	1	1.500
Sex	1.231	1	1.110
Disease category	1.328	3	1.048
Age	1.090	1	1.044

GVIF, generalized variance inflation factor. The simultaneous-domain model included all four WHOQOL-BREF domain scores together with age, sex, and disease category. For predictors with one degree of freedom, the GVIF is equivalent to the conventional variance inflation factor. For multi-degree-of-freedom categorical predictors, the adjusted GVIF was calculated as $GVIF^{(1/[2 \times Df])}$. No evidence of problematic multicollinearity was observed.

Table 5. WHOQOL-BREF Domains and EQ-5D-5L Utility

WHOQOL-BREF domain	Univariate β (95% CI)	<i>p</i> value	Simultaneous model β (95% CI)	<i>p</i> value	Separate adjusted model β (95% CI)	<i>p</i> value
Physical health	0.06 (0.03, 0.08)	<0.001**	0.02 (-0.01, 0.05)	0.185	0.05 (0.03, 0.07)	<0.001**
Psychological health	0.05 (0.03, 0.07)	<0.001**	0.02 (-0.01, 0.05)	0.133	0.05 (0.03, 0.07)	<0.001**
Social	0.04 (0.02, 0.06)	<0.001**	0.01 (-0.02, 0.04)	0.499	0.04 (0.02, 0.06)	<0.001**

WHOQOL-BREF domain	Univariate β (95% CI)	<i>p</i> value	Simultaneous model β (95% CI)	<i>p</i> value	Separate adjusted model β (95% CI)	<i>p</i> value
relationships						
Environment	0.05 (0.03, 0.07)	<0.001**	0.01 (-0.02, 0.04)	0.561	0.04 (0.02, 0.06)	<0.001**

Linear regression analyses were performed with EQ-5D-5L utility as the dependent variable. The simultaneous model included all four WHOQOL-BREF domains in the same model and was adjusted for age, sex, fracture history, stroke, interstitial lung disease, and disease category. Separate adjusted models entered each WHOQOL-BREF domain individually and were adjusted for the same covariates. Adjusted R^2 for the simultaneous model was 0.246.

** $p < 0.01$.

Supplementary Table S2. Collinearity diagnostics for the simultaneous-domain regression model

Outcome: EQ-5D-5L utility score

Variable	GVIF	Df	Adjusted GVIF
Age	1.206	1	1.098
Sex	1.254	1	1.120
Fracture history	1.233	1	1.111
Stroke	1.063	1	1.031
Interstitial lung disease	1.408	1	1.187
Disease category	1.550	3	1.076
Physical Health domain	2.148	1	1.465
Psychological Health domain	2.627	1	1.621
Social Relationships domain	2.307	1	1.519
Environment domain	2.713	1	1.647

GVIF, generalized variance inflation factor; Df, degrees of freedom; Adjusted GVIF, $GVIF^{1/(2 \times Df)}$. Adjusted GVIF values <2 indicate low collinearity and suggest that severe multicollinearity is unlikely.

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