

# BMJ Open Factors associated with disease-specific quality of life in Taiwanese patients with ankylosing spondylitis: a cross-sectional study

Ming-Chi Lu,<sup>1,2</sup> Kuang-Yung Huang,<sup>1,2</sup> Chien-Hsueh Tung,<sup>1</sup> Bao-Bao Hsu,<sup>1</sup> Cheng-Han Wu,<sup>1</sup> Malcolm Koo,<sup>3,4</sup> Ning-Sheng Lai<sup>1,2</sup>

**To cite:** Lu M-C, Huang K-Y, Tung C-H, *et al.* Factors associated with disease-specific quality of life in Taiwanese patients with ankylosing spondylitis: a cross-sectional study. *BMJ Open* 2019;9:e028966. doi:10.1136/bmjopen-2019-028966

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2019-028966>).

Received 5 January 2019  
Revised 4 May 2019  
Accepted 9 May 2019



© Author(s) (or their employer(s)) 2019. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Division of Allergy, Immunology and Rheumatology, Dalin Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Dalin, Taiwan

<sup>2</sup>School of Medicine, Tzu Chi University, Hualien City, Taiwan

<sup>3</sup>Graduate Institute of Long-term Care, Tzu Chi University of Science and Technology, Hualien City, Taiwan

<sup>4</sup>Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

## Correspondence to

Dr Malcolm Koo;  
[m.koo@utoronto.ca](mailto:m.koo@utoronto.ca) and  
Dr Ning-Sheng Lai;  
[tzu-chilai@gmail.com](mailto:tzu-chilai@gmail.com)

## ABSTRACT

**Objective** The aim of this study was to assess the factors associated with disease-specific quality of life in Taiwanese patients with ankylosing spondylitis.

**Design** A cross-sectional study.

**Setting** A regional teaching hospital in southern Taiwan.

**Participants** Adult patients with ankylosing spondylitis recruited from the outpatient rheumatology clinics of the study hospital.

**Primary outcome measure** Disease-specific quality of life assessed by the Evaluation of Ankylosing Spondylitis Quality of Life (EASI-QoL).

**Results** Of the 265 patients, 57% were 20–49 years of age, with a male preponderance (75.5%). Multiple stepwise linear regression analysis indicated that a higher disease activity, assessed by the Ankylosing Spondylitis Disease Activity Score, was significantly and independently associated with a lower quality of life in all four domains (physical function, disease activity, emotional well-being and social participation) of the EASI-QoL. In addition, various independent factors, including educational level, nature of occupation, disease duration, dietary habit and body mass index, were significantly associated with different domains of the EASI-QoL.

**Conclusions** Our findings indicated that, in addition to disease activity and perceived health status, a number of other factors could significantly impact the different aspects of quality of life in patients with ankylosing spondylitis, which warrant special consideration and support from healthcare providers.

## INTRODUCTION

Ankylosing spondylitis (AS) is a chronic inflammatory disease characterised by low back pain, and its prognosis varies depending on its extraspinal manifestations, age at diagnosis, lifestyle and treatment.<sup>1</sup> The main goal of its treatment includes the control of symptoms and inflammation and maintenance of the physical function. Over time, progressive structural and functional impairments can affect the quality of life (QoL) of patients with AS.<sup>2</sup> Specifically, stiffness, pain, fatigue, poor sleep, concerns about appearance,

## Strengths and limitations of this study

- The Evaluation of Ankylosing Spondylitis Quality of Life was translated to Chinese and used for the first time in Chinese patients with ankylosing spondylitis.
- Disease activity was measured by the Ankylosing Spondylitis Disease Activity Score instead of the conventional disease activity measure of Bath Ankylosing Spondylitis Disease Activity Index.
- This study used a cross-sectional study, and therefore causal relationship could not be established.
- All participants were recruited from a single regional hospital, thus limiting the generalisability of the results.

worry about the future and side effects of medications have been found to be common QoL concerns in patients with AS.<sup>3</sup> A recent meta-analysis of 38 studies revealed that generic health-related QoL was significantly lower in patients with AS compared with the general population. In addition, disease activity was significantly associated with body pain, vitality, social function and mental health domains of the Medical Outcomes Survey Short Form-36 (SF-36) questionnaire.<sup>4</sup> Health-related QoL has been increasingly recognised as both an important indicator of the burden of the AS<sup>5</sup> and a highly relevant outcome in AS disease treatment.<sup>6</sup>

In previous studies assessing the health-related QoL of patients with AS, generic QoL, such as the SF-36,<sup>7 8</sup> and AS disease-specific QoL index, such as the Ankylosing Spondylitis Quality of Life (ASQoL),<sup>9 10</sup> were commonly used measurements. However, concerns over their low responsiveness to changes<sup>11</sup> and the lack of questions on areas of QoL deemed important by patients<sup>12</sup> have prompted the development of new instruments that aim to address these issues, such as the Evaluation of Ankylosing Spondylitis Quality of

**Table 1** Demographic and clinical characteristics of patients with AS (N=265)

Variable	n (%)
<b>Sex</b>	
Male	200 (75.5)
Female	65 (24.5)
<b>Age category, years</b>	
20–29	38 (14.3)
30–39	59 (22.3)
40–49	54 (20.4)
50–59	70 (26.4)
≥60	44 (16.6)
<b>Body mass index category</b>	
Normal	101 (38.3)
Underweight	10 (3.8)
Overweight	70 (26.5)
Obese	83 (31.4)
<b>Educational level</b>	
Junior high school or below	51 (19.2)
Senior high school	83 (31.3)
College, university and above	131 (49.4)
<b>Marital status</b>	
Never married	78 (29.4)
Being married	166 (62.6)
Divorced or widowed	21 (7.9)
<b>Occupation type</b>	
Seated work	50 (19.1)
Seated and standing work	94 (35.9)
Standing and walking work	25 (9.5)
Walking and strenuous work	53 (20.2)
Not working	40 (15.3)
<b>Perceived health status</b>	
Very good or good	80 (30.2)
Fair	133 (50.2)
Poor or very poor	52 (19.6)
<b>Smoking in the past month</b>	
No	187 (70.6)
Occasionally	20 (7.5)
Almost daily	58 (21.9)
<b>Alcohol use</b>	
No	157 (59.2)
Yes	108 (40.8)
<b>Vegetarian diet</b>	
No	159 (60.0)
Occasionally	92 (34.7)
Yes	14 (5.3)
<b>Exercise</b>	
No	102 (40.2)
Yes	152 (59.8)

Continued

**Table 1** Continued

Variable	n (%)
Mean duration of sleep (SD) (median, min–max), hours	6.8 (1.4) (7, 0–12)
Mean duration of AS (SD) (median, min–max), years	12.9 (10.3) (10, 0.3–50)
Mean fatigue score (SD) (median, min–max)	4.7 (2.2) (5, 0–10)
Mean back pain severity score (SD) (median, min–max)	4.2 (2.4) (4, 0–10)
Mean patient global assessment of disease activity score (SD) (median, min–max)	3.8 (2.5) (4, 0–10)
Mean CRP (SD) (median, min–max), mg/L	7.42 (13.20) (2.40, 2.0–114.0)
Mean mSASSS (SD) (median, min–max)	12.8 (11.1) (9, 0–36)
Mean ASDAS-CRP (SD) (median, min–max)	2.20 (0.83) (2.15, 0.64–4.75)
<b>Mean EASi-QoL (SD) (median, min–max)</b>	
Physical function	3.7 (4.0) (2.0, 0–22)
Disease activity	5.0 (3.0) (5.0, 0–15)
Emotional well-being	4.8 (4.1) (4.0, 0–19)
Social participation	4.8 (4.0) (4.0, 0–19)

Missing values: 1 in body mass index, 3 in occupation type, 11 in exercise, 1 in duration of AS and 5 in mSASSS.

AS, ankylosing spondylitis; ASDAS, Ankylosing Spondylitis Disease Activity Score; CRP, C reactive protein; EASi-QoL, Evaluation of Ankylosing Spondylitis Quality of Life; max, maximum; min, minimum; mSASSS, modified Stoke Ankylosing Spondylitis Spinal Score.

Life (EASi-QoL) questionnaire.<sup>13</sup> The EASi-QoL is a patient-reported measure of QoL specific to AS, and its psychometric properties have been evaluated in 1000 patients with AS in the UK. Confirmatory factor analysis and Rasch analysis of the 20-item questionnaire revealed four domains of AS-related QoL: physical function, disease activity, emotional well-being and social participation. Cronbach's  $\alpha$  and 2-week test–retest reliability estimates were found to be 0.88–0.92 and 0.88–0.93, respectively. Good construct validity of the EASi-QoL was also demonstrated by its correlations with the ASQoL questionnaire, Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Functional Index, SF-36, European QoL 5-Domain (EQ-5D) survey, Hospital Anxiety and Depression Scale, and the Ankylosing Spondylitis Disease Activity Score (ASDAS).<sup>13 14</sup> Furthermore, the responsiveness of EASi-QoL was found to be superior or similar to other commonly used measures in patients reporting improvement during routine clinical practice or following treatment with etanercept or sulfasalazine.<sup>15</sup> To the best of our knowledge, no studies have evaluated the QoL of Taiwanese patients with AS using EASi-QoL.

While it is well known that high AS disease activity is associated with poor QoL,<sup>16</sup> the impact of other demographic and lifestyle factors, including body mass index (BMI), occupation type and dietary habit, on different aspects of disease-related QoL is less studied. Therefore, the aim

**Table 2** Simple linear and multiple linear regression analyses of demographic and clinical variables in relation to the EASI-QoL physical function domain

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
Sex				–	–	–
Male	Reference					
Female	0.67	0.071	0.247			
Age category, years				–	–	–
20–29	Reference					
30–59	0.381	0.044	0.594			
≥60	2.054	0.189	0.021			
Body mass index category				–	–	–
Normal and underweight	Reference					
Overweight	0.139	0.015	0.82			
Obese	1.406	0.161	0.016			
Educational level						
College, university and above	Reference			Reference		
Senior high school	0.383	0.044	0.49	0.054	0.006	0.912
Junior high school or below	2.548	0.249	<0.001	1.912	0.19	0.001
Marital status				–	–	–
Never married, divorced or widowed	Reference					
Being married	–0.568	–0.068	0.27			
Occupation type						
Seated work	Reference			Reference		
Seated and standing work	0.461	0.055	0.504	0.616	0.074	0.292
Standing and walking work	0.98	0.072	0.31	0.647	0.048	0.43
Walking and strenuous work	–0.654	–0.066	0.4	–0.042	–0.004	0.951
Not working	2.08	0.188	0.013	1.657	0.149	0.023
Perceived health status						
Very good or good	Reference			Reference		
Fair	2.107	0.261	<0.001	0.883	0.111	0.078
Poor or very poor	5.553	0.546	<0.001	3.211	0.319	<0.001
Smoking in the past month				–	–	–
No	Reference					
Occasionally	–0.099	–0.006	0.918			
Almost daily	–0.145	–0.015	0.812			
Alcohol use				–	–	–
No	Reference					
Yes	–0.572	–0.070	0.259			
Vegetarian diet				–	–	–
No	Reference					
Occasionally	–0.104	–0.012	0.844			
Yes	2.682	0.148	0.017			
Exercise				–	–	–
No	Reference					
Yes	–0.044	–0.005	0.933			
Duration of sleep, hours	0.17	0.06	0.327	–	–	–
Duration of AS, years	0.042	0.107	0.082	–	–	–
mSASSS	0.072	0.196	0.001	–	–	–

Continued

Table 2 Continued

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
ASDAS-CRP	2.221	0.456	<0.001	1.527	0.318	<0.001

Adjusted R<sup>2</sup>=0.327.

AS, ankylosing spondylitis; ASDAS-CRP, Ankylosing Spondylitis Disease Activity Score-C reactive protein; EASi-QoL, Evaluation of Ankylosing Spondylitis Quality of Life; mSASSS, modified Stoke Ankylosing Spondylitis Spinal Score.

of this study was to assess the influence of demographic and lifestyle factors, in addition to AS disease activity, on disease-specific QoL in Taiwanese patients with AS.

## MATERIALS AND METHODS

### Study design and patients

Study participants were recruited from the outpatient rheumatology clinics of a regional teaching hospital in southern Taiwan. Between 4 November 2016 and 23 January 2017, consecutive patients were approached by the study research assistants to assess their eligibility and willingness to participate in the study. The following were the inclusion criteria: (1) aged 20 years or older, (2) fulfilled the 1984 modified New York criteria for AS,<sup>17</sup> (3) able to communicate verbally in Mandarin or Taiwanese, (4) had no discernible cognitive impairment and (5) willing to give a written informed consent. We invited 350 patients with AS who met the inclusion criteria, and 265 of them completed the questionnaire (response rate 75.7%).

### Questionnaire

Using a paper-based questionnaire, the following information was ascertained from the enrolled patients: basic characteristics (age, sex, body weight, body height, educational levels, marital status and occupational type), personal health status (perceived health status and duration of AS), lifestyle factors (smoking, alcohol use, type of diet, exercise, duration of sleep), AS disease activity and AS QoL. In addition, blood samples were obtained at the time of questionnaire administration for measurement of C reactive protein (CRP) levels. Radiographic progression was assessed using lumbar and cervical lateral radiographs using the modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS).<sup>18</sup> The questionnaire was completed with the assistance of the study research assistants.

### Measurement of AS disease activity

The ASDAS, which combines both patient-reported items and objective assessment, was used to evaluate disease activity in this study.<sup>19</sup> The index consists of questions on total back pain, duration of morning stiffness, peripheral joint complaints, patient global assessment of disease activity and a serological marker of inflammation (CRP or erythrocyte sedimentation rate, with the former as the preferred version).<sup>20</sup> The index is endorsed by the

Assessment of SpondyloArthritis international Society and by the Outcome Measures in Rheumatology.<sup>21</sup> The ASDAS was calculated using the following formula:  $0.121 \times \text{backpain} + 0.058 \times \text{duration of morning stiffness} + 0.110 \times \text{patient global assessment} + 0.073 \times \text{peripheral pain or swelling} + 0.579 \times \ln(\text{CRP} + 1)$ .<sup>20</sup> The ASDAS has been used in several studies on Chinese patients with AS and has shown good psychometric properties compared with the conventional disease activity measure of BASDAI.<sup>22 23</sup>

### Measurement of disease-specific QoL

The disease-specific QoL of patients with AS was assessed with the EASi-QoL questionnaire.<sup>13</sup> The EASi-QoL consists of 20 questions with a 5-point Likert response scale (0–4) on four domains: physical function (six items), disease activity (four items), emotional well-being (five items) and social participation (five items). The four domains were separately scored and analysed, as recommended, so that differences among the domains will not be masked by the use of a single summation index. A lower EASi-QoL score indicates a better QoL.

Permission to translate the original English version of the EASi-QoL to Chinese was obtained from the developer of the original questionnaire, Dr Kirstie Haywood.<sup>13</sup> The translation was performed using a standard procedure of translation and blind back-translation. The content validity was assessed by four experts in rheumatology. In addition, internal reliability and test–retest reliability of the translated scale was measured with Cronbach's  $\alpha$  coefficient and intraclass correlation coefficient (ICC), respectively, on a subset of 90 patients.

### Measurement of radiographic progression

The mSASSS assesses structural damage in the cervical and lumbar spine according to a nominal scoring system: 0=no abnormality; 1=erosion, sclerosis or squaring; 2=syndesmophyte; and 3=total bony bridging. The total score for a total of 24 anterior vertebral corners (cervical segment: lower border of C2 to the upper border of T1; lumbar segment: lower border of T12 to the upper border of S1) ranges from 0 to 72. Good reliability and sensitivity to change of the mSASSS for use in clinical trials have been demonstrated.<sup>18</sup>

### Statistical analysis

For descriptive statistics, categorical variables were expressed as counts and percentages. Continuous

**Table 3** Simple linear and multiple linear regression analyses of demographic and clinical variables in relation to the EASI-QoL disease activity domain

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
Sex				–	–	–
Male	Reference					
Female	0.637	0.091	0.138			
Age category, years				–	–	–
20–29	Reference					
30–59	0.75	0.116	0.162			
≥60	0.117	0.015	0.86			
Body mass index category				–	–	–
Normal and underweight	Reference					
Overweight	–0.084	–0.012	0.854			
Obese	0.706	0.109	0.105			
Educational level				–	–	–
College, university and above	Reference					
Senior high school	0.214	0.033	0.613			
Junior high school or below	0.385	0.051	0.44			
Marital status				–	–	–
Never married, divorced or widowed	Reference					
Being married	–0.163	–0.026	0.67			
Occupation type				–	–	–
Seated work	Reference					
Seated and standing work	0.209	0.033	0.691			
Standing and walking work	1.02	0.1	0.167			
Walking and strenuous work	–0.336	–0.045	0.57			
Not working	–0.190	–0.023	0.766			
Perceived health status						
Very good or good	Reference			Reference		
Fair	2.058	0.343	<0.001	1.633	0.217	<0.001
Poor or very poor	3.903	0.517	<0.001	2.088	0.578	<0.001
Smoking in the past month				–	–	–
No	Reference					
Occasionally	1.089	0.096	0.124			
Almost daily	0.311	0.043	0.491			
Alcohol use				–	–	–
No	Reference					
Yes	0.278	0.046	0.461			
Vegetarian diet				–	–	–
No	Reference					
Occasionally	1.401	0.104	0.094			
Yes	0.562	0.089	0.153			
Exercise				–	–	–
No	Reference					
Yes	–0.016	–0.003	0.967			
Duration of sleep, hours	0.111	0.053	0.39	–	–	–

Continued

Table 3 Continued

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
Duration of AS, years	-0.008	-0.029	0.643	-0.028	-0.094	0.04
mSASSS	0.017	0.062	0.316	-	-	-
ASDAS-CRP	2.409	0.666	<0.001	2.088	0.578	<0.001

Adjusted R<sup>2</sup>=0.469.

AS, ankylosing spondylitis; ASDAS-CRP, Ankylosing Spondylitis Disease Activity Score-C reactive protein; EASi-QoL, Evaluation of Ankylosing Spondylitis Quality of Life; mSASSS, modified Stoke Ankylosing Spondylitis Spinal Score.

variables were reported as mean, SD, median and range. For the evaluation of factors associated with each of the four domains of EASi-QoL, simple and multiple stepwise linear regression analyses were used. An entrance and exit tolerances on the p values of 0.05 and 0.10, respectively, were used in the stepwise linear regression analyses.

Cronbach's  $\alpha$  coefficient was used to assess the internal consistency of the EASi-QoL. Generally, values greater than 0.70 are indicative that the scale items are sufficiently correlated. In addition, ICC based on the absolute agreement, two-way, mixed-effects model was used to quantify the test-retest reliability of the EASi-QoL.<sup>24</sup> ICC estimates greater than 0.70 can be considered as having good reliability. Statistical significance was inferred at a two-tailed p value of <0.05. All statistical analyses were conducted using IBM SPSS Statistics V.24.0 software package.

### Patient and public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient-relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

### RESULTS

Of the 265 patients, 57% were 20–49 years of age, with a male preponderance (75.5%). The mean AS disease duration was 12.9 years (SD 10.3 years). The demographic and clinical characteristics of the patients are shown in table 1.

Regarding the psychometric properties of the Chinese version of the EASi-QoL, all members of the expert panel agreed that the translation and the flow of the questions were highly satisfactory. The Cronbach's  $\alpha$  coefficients of the Chinese version of the EASi-QoL for the physical function, disease activity, emotional well-being and social participation domains were 0.86, 0.88, 0.91 and 0.91, respectively, indicating that the items were well interrelated within each of the four domains. Test-retest reliability of the scale in a subset of 90 patients with a median interval of 28 days (range 20–70 days) apart for the physical function, disease activity, emotional well-being and social participation domains was 0.75, 0.64, 0.76 and 0.71, respectively. Since the disease activity could

change substantially over the test-retest time interval, we further conducted an ICC analysis including only the 65 patients who had less than 1 SD (0.69) change in the ASDAS between the two time points. The ICC for physical function, disease activity, emotional well-being and social participation domains in these 65 patients increased to 0.84, 0.80, 0.86 and 0.82, respectively.

The results of the simple and multiple stepwise linear regression analyses for the four domains of the EASi-QoL are shown in tables 2–5. Multiple stepwise linear regression analysis indicated that a higher ASDAS-CRP was significantly and independently associated with a higher score (ie, a low QoL) in all four domains of EASi-QoL ( $p<0.001$ ) (tables 2–5). The standardised coefficients of ASDAS-CRP for physical function, disease activity, emotional well-being and social participation domains were 0.32, 0.58, 0.36 and 0.42, respectively. In other words, when the levels of ASDAS-CRP increase by 1 SD, the scores of physical function, disease activity, emotional well-being and social participation domains of the EASi-QoL will increase by 0.32 SD, 0.58 SD, 0.36 SD and 0.42 SD, respectively. Similarly, poor or very poor perceived health status was significantly associated with a higher score in all four domains of the EASi-QoL ( $p<0.001$ ), while a fair perceived health status was significantly associated with a higher score in the disease activity ( $p<0.001$ ), emotional well-being ( $p=0.001$ ) and social participation ( $p=0.009$ ) domains of the EASi-QoL.

Compared with patients who engaged in seated work, those who were not working had significantly higher scores in the physical function ( $p=0.023$ ) (table 2) and social participation ( $p=0.030$ ) (table 5) domains of the EASi-QoL, and those who were engaged in seated and standing work also had a significantly higher scores in the social participation ( $p=0.007$ ) (table 5) domain of the EASi-QoL.

Patients who were habitual vegetarians for the past 6 months had a significantly higher score in the emotional well-being ( $p=0.014$ ) (table 4) and social participation ( $p=0.003$ ) (table 5) domains of the EASi-QoL. In addition, patients with an educational level of junior high school or below had a significantly higher score in the physical function domain of the EASi-QoL compared with those with college, university and above education

**Table 4** Simple linear and multiple linear regression analyses of demographic and clinical variables in relation to the EASI-QoL emotional well-being domain

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
Sex				–	–	–
Male	Reference					
Female	0.366	0.039	0.531			
Age category, years				–	–	–
20–29	Reference					
30–59	0.829	0.094	0.257			
≥60	0.554	0.051	0.542			
Body mass index category				–	–	–
Normal and underweight	Reference					
Overweight	0.046	0.005	0.94			
Obese	1.107	0.126	0.062			
Educational level				–	–	–
College, university and above	Reference					
Senior high school	0.748	0.085	0.192			
Junior high school or below	1.037	0.1	0.125			
Marital status				–	–	–
Never married, divorced or widowed	Reference					
Being married	–0.052	–0.006	0.921			
Occupation type				–	–	–
Seated work	Reference					
Seated and standing work	1.202	0.142	0.09			
Standing and walking work	1.44	0.104	0.147			
Walking and strenuous work	–0.057	–0.006	0.943			
Not working	1.25	0.111	0.146			
Perceived health status						
Very good or good	Reference			Reference		
Fair	2.797	0.343	<0.001	1.678	0.206	0.001
Poor or very poor	6.005	0.585	<0.001	3.737	0.364	<0.001
Smoking in the past month				–	–	–
No	Reference					
Occasionally	0.994	0.064	0.303			
Almost daily	–0.051	–0.005	0.934			
Alcohol use				–	–	–
No	Reference					
Yes	–0.643	–0.077	0.209			
Vegetarian diet						
No	Reference			Reference		
Occasionally	1.091	0.127	0.039	0.571	0.067	0.184
Yes	3.358	0.184	0.003	2.258	0.124	0.014
Exercise				–	–	–
No	Reference					
Yes	0.205	0.024	0.7			
Duration of sleep, hours	0.169	0.06	0.333	–	–	–
Duration of AS, years	0.017	0.042	0.5	–	–	–
mSASSS	0.049	0.133	0.032	–	–	–

Continued

Table 4 Continued

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
ASDAS-CRP	2.59	0.527	<0.001	1.792	0.364	<0.001

Adjusted R<sup>2</sup>=0.368.

AS, ankylosing spondylitis; ASDAS-CRP, Ankylosing Spondylitis Disease Activity Score-C reactive protein; EASi-QoL, Evaluation of Ankylosing Spondylitis Quality of Life; mSASSS, modified Stoke Ankylosing Spondylitis Spinal Score.

( $p=0.001$ ) (table 2). Furthermore, a longer AS disease duration was significantly associated with a lower score in the disease activity domain of the EASi-QoL ( $p=0.040$ ) (table 3). Finally, a BMI category of obese was significantly associated with a higher score in the social participation domain of the EASi-QoL ( $p=0.026$ ) (table 5).

## DISCUSSION

In this cross-sectional study of patients with AS, disease-related QoL was significantly associated with AS disease activity, even after adjusting for perceived health status and other relevant independent factors. A higher disease activity, as measured by the ASDAS-CRP, was significantly associated with poorer physical function, disease activity, emotional well-being and social participation domains of the EASi-QoL. Our results were in line with previous research based on various measures of QoL.<sup>49 10 16</sup> We also noted that disease activity and perceived health status were the two strongest factors associated with the EASi-QoL, as indicated by the relatively large standardised coefficients for these two variables.

In addition to disease activity and perceived health status, the nature of occupation was also found to be associated with physical function and social participation domains of the EASi-QoL. It has been estimated that the risk of permanent work disability was three times greater in patients with AS than expected in the general population of similar age and sex. In addition, previous research has shown that patients with AS without a job because of work disability was associated with a lower QoL.<sup>25</sup> In the present study, we also found that patients who were not working had a significantly poorer physical function and social participation QoL compared with those who were engaged in seated work. Patients who are capable of remaining in the workforce mean that their physical function is not severely impaired, and their family life and friendships should be less interfered by AS. In addition, patients engaged in seated and standing work had poorer social participation QoL compared with those engaged in seated work. Work activities that require standing can affect the axial skeleton differently from those who require only manual dexterity and arm-hand movement in seated work.<sup>26</sup> It is possible that the former type of work activities can lead to poorer functional outcomes over time and impact on QoL.

Moreover, patients with AS who were habitual vegetarians in the past 6 months had a worse emotional well-being and social participation QoL compared with omnivores or occasional vegetarians. In Chinese societies, the main reasons for adopting a vegetarian lifestyle were religion and health-seeking.<sup>27</sup> Results from the National Health Interview Survey in Taiwan showed that long-term vegetarian dietary habits were associated with religious beliefs, older age, not being married, absence of chronic diseases, and non-users of alcohol and cigarettes.<sup>28</sup> Therefore, vegetarians might be more likely to adopt other healthy lifestyle factors, and it is difficult to separate their effects. In addition, because of the cross-sectional nature of the present study, it could not be determined whether the poor emotional well-being and social participation QoL were the consequence of a vegetarian diet and its associated lifestyle. Further prospective studies will be required to establish the causal relationship between vegetarian dietary habit and QoL in patients with AS.

Patients with a lower educational level had a poor physical function QoL. A cross-sectional survey of 175 patients with AS reported that those with 12 years of education or less had significantly lower scores of QoL compared with those with some college education on all domains of the Medical Outcomes Survey SF-36, except general health.<sup>3</sup> Results from a telephone survey of a nationally representative sample of US adults showed that those with less than a high school education had significantly worse health-related QoL, as measured by the EQ-5D survey and Health Utilities Index Mark 3 scores, than those with a college degree.<sup>29</sup> Although the exact mechanisms linking health and education are not clear, it has been hypothesised that education can shape healthy lifestyle behaviours and provide better decision-making abilities, which in turn can lead to positive health outcomes and improved health-related QoL.<sup>30</sup>

Furthermore, a longer AS disease duration was significantly associated with a better disease activity QoL. It is plausible that AS has a tendency to be more active in the early period after the diagnosis, which can lead to a poor disease activity QoL. In addition, the high level of anxiety in the earlier period<sup>31</sup> may subside once the disease is adequately controlled with regular treatment. Our finding is consistent with a cross-sectional study of Swedish patients with Crohn's disease and ulcerative colitis showing that patients with longer disease duration (>5 years) experience better



**Table 5** Simple linear and multiple linear regression analyses of demographic and clinical variables in relation to the EASI-QoL social participation domain

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
Sex				–	–	–
Male	Reference					
Female	–0.090	–0.010	0.875			
Age category, years				–	–	–
20–29	Reference					
30–59	0.688	0.079	0.337			
≥60	0.691	0.064	0.437			
Body mass index category						
Normal and underweight	Reference			Reference		
Overweight	–0.146	–0.016	0.809	–0.033	–0.004	0.943
Obese	1.421	0.165	0.014	0.995	0.117	0.026
Educational level				–	–	–
College, university and above	Reference					
Senior high school	0.875	0.102	0.118			
Junior high school or below	1.42	0.14	0.032			
Marital status				–	–	–
Never married, divorced or widowed	Reference					
Being married	–0.362	–0.044	0.478			
Occupation type						
Seated work	Reference			Reference		
Seated and standing work	1.274	0.155	0.066	1.455	0.177	0.007
Standing and walking work	1.48	0.11	0.126	1.187	0.088	0.109
Walking and strenuous work	0.172	0.017	0.825	1.052	0.107	0.081
Not working	1.515	0.138	0.071	1.415	0.129	0.03
Perceived health status						
Very good or good	Reference			Reference		
Fair	2.678	0.335	<0.001	1.208	0.153	0.009
Poor or very poor	5.97	0.593	<0.001	3.231	0.324	<0.001
Smoking in the past month				–	–	–
No	Reference					
Occasionally	0.907	0.06	0.338			
Almost daily	0.188	0.019	0.756			
Alcohol use				–	–	–
No	Reference					
Yes	–0.205	–0.025	0.683			
Vegetarian diet						
No	Reference			Reference		
Occasionally	0.675	0.08	0.192	0.278	0.034	0.493
Yes	3.495	0.195	0.002	2.568	0.146	0.003
Exercise				–	–	–
No	Reference					
Yes	0.157	0.019	0.763			
Duration of sleep, hours	0.037	0.013	0.828	–	–	–
Duration of AS, years	0.008	0.021	0.738	–	–	–
mSASSS	0.061	0.168	0.007	–	–	–

Continued

Table 5 Continued

Variable	Simple linear regression			Multiple linear regression		
	B	Standardised coefficient	P value	B	Standardised coefficient	P value
ASDAS-CRP	2.746	0.569	<0.001	1.99	0.419	<0.001

Adjusted R<sup>2</sup>=0.425.

AS, ankylosing spondylitis; ASDAS-CRP, Ankylosing Spondylitis Disease Activity Score-C reactive protein; EASi-QoL, Evaluation of Ankylosing Spondylitis Quality of Life; mSASSS, modified Stoke Ankylosing Spondylitis Spinal Score.

health-related QoL than those with shorter duration (<2 years).<sup>32</sup> Similarly, a prospective study on 90 patients with systemic lupus erythematosus reported that improved physical health QoL was associated with longer disease duration.<sup>33</sup> Nevertheless, a recent study on 360 patients with a diverse rheumatic diseases found that increased disease duration was a significant independent prognostic factor of impaired QoL.<sup>34</sup> It appeared that the direction of the association depends on both the disease and observed period of disease duration.

Finally, a BMI category of obese was significantly associated with a higher score in the social participation QoL. While it is known that a higher BMI correlates with a greater burden of symptoms in patients with AS,<sup>35</sup> the role of adiposity in the QoL of patients with AS has not been widely investigated. Toy and colleagues<sup>36</sup> reported in their study that while all of the SF-36 QoL criteria were significantly lower in the preobese patients with AS compared with healthy controls, no significant relationships were observed between patients with AS whose BMI was between 27.1 and 29.9 and those whose BMI was in the range of 25–27. The underlying link between low social participation QoL and obesity observed in the present study will require further investigation, in particular whether the relationship is mediated through obesity-related body image dissatisfaction or physical immobility.<sup>37</sup> AS belongs to a large family of spondyloarthritis, and many questionnaires, including SF-36, EQ-5D or Health Assessment Questionnaire, have been validated for evaluating various domains regarding the QoL of spondyloarthritis in the Chinese society.<sup>38–40</sup> Although these tools might exhibit some differences in their subdomains, the overall differences are minimal.<sup>41</sup> Additional studies are needed to further evaluate the performance of the EASi-QoL in patients with spondyloarthritis.

Several limitations in our study should be taken into account when interpreting the results. First, all the data were collected in a cross-sectional survey, and therefore causal relationships could not be established. Second, all patients were recruited from a single regional hospital, and as a result our findings need to be confirmed in other settings to assess their generalisability. Third, subdomains of axial spondyloarthritis, including entheses and spinal mobility, were not assessed in our study.<sup>42</sup> Fourth, although good construct validity has been reported for the EASi-QoL, its psychometric properties in the Chinese setting still require additional investigation. Finally,

patients with AS often suffer from poor quality of sleep as a result of back pain, depressive mood and mobility restrictions, which in turn could adversely affect their QoL.<sup>43</sup> However, we have included only measurement on the duration of sleep, but not on the quality of sleep in our study, and therefore the presence of potential confounding effect of sleep quality on EASi-QoL scores could not be completely ruled out.

In summary, in this cross-sectional study of 265 Taiwanese patients with AS, disease-related QoL was found to be significantly associated with AS disease activity, even after adjusting for perceived health status. In addition, a number of different independent factors, including educational level, nature of occupation, disease duration, dietary habit and BMI, were significantly associated with the four domains of QoL, as measured by the EASi-QoL. Future studies should explore the relationship between vegetarian dietary habit and obesity on the emotional and social participation QoL as these factors are potentially modifiable, and may therefore help to improve QoL of patients with AS.

**Contributors** M-CL and N-SL made substantial contributions to the conception and design of the study. M-CL, K-YH, C-HT, B-BH, C-HW and N-SL participated in data collection and drafted the manuscript. MK conducted the statistical analysis and revised the manuscript. M-CL provided substantial supervision and interpretation of the statistical analysis. All authors have critically read this manuscript and approved the final version.

**Funding** This work was supported by grants from the Tzu Chi Medical Mission Project 105-01-01 and 105-01-02, Buddhist Tzu Chi Medical Foundation.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** The study protocol was reviewed and approved by the institutional review board of the Dalin Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taiwan (No B10502003). All participants gave written informed consent prior to the start of the study.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** Data are available from the corresponding author upon reasonable request.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## REFERENCES

1. Dean LE, Jones GT, MacDonald AG, *et al*. Global prevalence of ankylosing spondylitis. *Rheumatology* 2014;53:650–7.

2. Kotsis K, Voulgari PV, Drosos AA, *et al.* Health-related quality of life in patients with ankylosing spondylitis: a comprehensive review. *Expert Rev Pharmacoecon Outcomes Res* 2014;14:857–72.
3. Ward MM. Health-related quality of life in ankylosing spondylitis: a survey of 175 patients. *Arthritis Care Res* 1999;12:247–55.
4. Yang X, Fan D, Xia Q, *et al.* The health-related quality of life of ankylosing spondylitis patients assessed by SF-36: a systematic review and meta-analysis. *Qual Life Res* 2016;25:2711–23.
5. Kobelt G, Andlin-Sobocki P, Maksymowych WP. Costs and quality of life of patients with ankylosing spondylitis in Canada. *J Rheumatol* 2006;33:289–95.
6. Ertenli I, Ozer S, Kiraz S, *et al.* Infliximab, a TNF- $\alpha$  antagonist treatment in patients with ankylosing spondylitis: the impact on depression, anxiety and quality of life level. *Rheumatol Int* 2012;32:323–30.
7. Jajić Z, Rajnpreht I, Kovačić N, *et al.* Which clinical variables have the most significant correlation with quality of life evaluated by SF-36 survey in Croatian cohort of patient with ankylosing spondylitis and psoriatic arthritis? *Rheumatol Int* 2012;32:3471–9.
8. Ozdemir O. Quality of life in patients with ankylosing spondylitis: relationships with spinal mobility, disease activity and functional status. *Rheumatol Int* 2011;31:605–10.
9. Yılmaz O, Tutoğlu A, Garip Y, *et al.* Health-related quality of life in Turkish patients with ankylosing spondylitis: impact of peripheral involvement on quality of life in terms of disease activity, functional status, severity of pain, and social and emotional functioning. *Rheumatol Int* 2013;33:1159–63.
10. Bodur H, Ataman S, Rezvani A, *et al.* Quality of life and related variables in patients with ankylosing spondylitis. *Qual Life Res* 2011;20:543–9.
11. Haywood KL, Garratt AM, Dziedzic K, *et al.* Generic measures of health-related quality of life in ankylosing spondylitis: reliability, validity and responsiveness. *Rheumatology* 2002;41:1380–7.
12. Haywood KL, Garratt AM, Dziedzic K, *et al.* Patient centered assessment of ankylosing spondylitis-specific health related quality of life: evaluation of the Patient Generated Index. *J Rheumatol* 2003;30:764–73.
13. Haywood KL, Garratt AM, Jordan KP, *et al.* Evaluation of ankylosing spondylitis quality of life (EASI-QoL): reliability and validity of a new patient-reported outcome measure. *J Rheumatol* 2010;37:2100–9.
14. Di Carlo M, Lato V, Carotti M, *et al.* Clinimetric properties of the ASAS health index in a cohort of Italian patients with axial spondyloarthritis. *Health Qual Life Outcomes* 2016;14:78.
15. Packham JC, Jordan KP, Haywood KL, *et al.* Evaluation of Ankylosing Spondylitis Quality of Life questionnaire: responsiveness of a new patient-reported outcome measure. *Rheumatology* 2012;51:707–14.
16. Huang JC, Qian BP, Qiu Y, *et al.* Quality of life and correlation with clinical and radiographic variables in patients with ankylosing spondylitis: a retrospective case series study. *BMC Musculoskelet Disord* 2017;18:352.
17. van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. *Arthritis Rheum* 1984;27:361–8.
18. Creemers MC, Franssen MJ, van't Hof MA, *et al.* Assessment of outcome in ankylosing spondylitis: an extended radiographic scoring system. *Ann Rheum Dis* 2005;64:127–9.
19. Lukas C, Landewé R, Sieper J, *et al.* Development of an ASAS-endorsed disease activity score (ASDAS) in patients with ankylosing spondylitis. *Ann Rheum Dis* 2009;68:18–24.
20. van der Heijde D, Lie E, Kvien TK, *et al.* ASDAS, a highly discriminatory ASAS-endorsed disease activity score in patients with ankylosing spondylitis. *Ann Rheum Dis* 2009;68:1811–8.
21. Zochling J. Measures of symptoms and disease status in ankylosing spondylitis: Ankylosing Spondylitis Disease Activity Score (ASDAS), Ankylosing Spondylitis Quality of Life Scale (ASQoL), Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Functional Index (BASFI), Bath Ankylosing Spondylitis Global Score (BAS-G), Bath Ankylosing Spondylitis Metrology Index (BASMI), Dougados Functional Index (DFI), and Health Assessment Questionnaire for the Spondyloarthropathies (HAQ-S). *Arthritis Care Res* 2011;63(Suppl 11):S47–58.
22. Au YL, Wong WS, Mok MY, *et al.* Disease activity assessment in ankylosing spondylitis in a Chinese cohort: BASDAI or ASDAS? *Clin Rheumatol* 2014;33:1127–34.
23. Xu M, Lin Z, Deng X, *et al.* The Ankylosing Spondylitis Disease Activity Score is a highly discriminatory measure of disease activity and efficacy following tumour necrosis factor- $\alpha$  inhibitor therapies in ankylosing spondylitis and undifferentiated spondyloarthropathies in China. *Rheumatology* 2011;50:1466–72.
24. Scholtes VA, Terwee CB, Poolman RW. What makes a measurement instrument valid and reliable? *Injury* 2011;42:236–40.
25. Boonen A, Chorus A, Miedema H, *et al.* Withdrawal from labour force due to work disability in patients with ankylosing spondylitis. *Ann Rheum Dis* 2001;60:1033–9.
26. Ward MM, Reveille JD, Learch TJ, *et al.* Occupational physical activities and long-term functional and radiographic outcomes in patients with ankylosing spondylitis. *Arthritis Rheum* 2008;59:822–32.
27. Mao X, Shen X, Tang W, *et al.* [Prevalence of vegetarians and vegetarian's health dietary behavior survey in Shanghai]. *Wei Sheng Yan Jiu* 2015;44:237–41.
28. Huang CH, Mc L, Koo M. Dietary patterns of habitual vegetarians—findings from the 2009 National Health Interview Survey. *NutrSci J* 2015;40:94–106.
29. Robert SA, Cherepanov D, Palta M, *et al.* Socioeconomic status and age variations in health-related quality of life: results from the national health measurement study. *J Gerontol B Psychol Sci Soc Sci* 2009;64:378–89.
30. Cutler DM, Lleras-Muney A. *Health: evaluating theories and evidence*. Cambridge, MA: National Bureau of Economic Research, 2006.
31. Vignola A, Guzzo A, Calvo A, *et al.* Anxiety undermines quality of life in ALS patients and caregivers. *Eur J Neurol* 2008;15:1231–6.
32. Jäghult S, Saboonchi F, Johansson UB, *et al.* Identifying predictors of low health-related quality of life among patients with inflammatory bowel disease: comparison between Crohn's disease and ulcerative colitis with disease duration. *J Clin Nurs* 2011;20:1578–87.
33. Thumboo J, Fong KY, Chan SP, *et al.* A prospective study of factors affecting quality of life in systemic lupus erythematosus. *J Rheumatol* 2000;27:1414–20.
34. Anyfanti P, Triantafyllou A, Panagopoulos P, *et al.* Predictors of impaired quality of life in patients with rheumatic diseases. *Clin Rheumatol* 2016;35:1705–11.
35. Durcan L, Wilson F, Conway R, *et al.* Increased body mass index in ankylosing spondylitis is associated with greater burden of symptoms and poor perceptions of the benefits of exercise. *J Rheumatol* 2012;39:2310–4.
36. Toy S, Ozbag D, Altay Z. The effects of pre-obesity on quality of life, disease activity, and functional status in patients with ankylosing spondylitis. *North Clin Istanb* 2017;4:52–9.
37. Kushner RF, Foster GD. Obesity and quality of life. *Nutrition* 2000;16:947–52.
38. Kwan YH, Fong W, Lui NL, *et al.* Validity and reliability of the Health Assessment Questionnaire among patients with spondyloarthritis in Singapore. *Int J Rheum Dis* 2018;21:699–704.
39. Tsang HHL, Cheung JPY, Wong CKH, *et al.* Psychometric validation of the EuroQoL 5-dimension (EQ-5D) questionnaire in patients with spondyloarthritis. *Arthritis Res Ther* 2019;21:41.
40. Law L, Beckman Rehnman J, Deminger A, *et al.* Factors related to health-related quality of life in ankylosing spondylitis, overall and stratified by sex. *Arthritis Res Ther* 2018;20:284.
41. Kwan YH, Fong W, Leung YY, *et al.* A qualitative study of quality of life domains and subdomains relevant to patients with spondyloarthritis. *Int J Rheum Dis* 2019;22:242–51.
42. Sieper J, Rudwaleit M, Baraliakos X, *et al.* The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. *Ann Rheum Dis* 2009;68(Suppl 2):ii1–44.
43. Batmaz I, Saryildiz MA, Dilek B, *et al.* Sleep quality and associated factors in ankylosing spondylitis: relationship with disease parameters, psychological status and quality of life. *Rheumatol Int* 2013;33:1039–45.