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ORIGINAL ARTICLE

Fatigue and contributing factors in Chinese patients with ankylosing spondylitis

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Abstract

Objectives Fatigue is a common symptom in patients with ankylosing spondylitis (AS). However, fatigue of AS patients has not been well elucidated in China. This study aimed to evaluate the predictors of fatigue and the effects of fatigue on health-related quality of life among patients with AS.

Method A total of 150 AS patients were involved in the study. A series of questionnaires included the following: Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Metrology Index (BASMI), Bath Ankylosing Spondylitis Functional Index (BASFI), the 10-cm Visual Analog Scale (VAS), the Self-Rating Anxiety Scale (SAS), the Self-Rating Depression Scale (SDS), the Pittsburgh Sleep Quality Index (PSQI), the Health Assessment Questionnaire-Disability Index (HAQ-DI), the Short Form 36 Health Survey (SF-36), and the Fatigue Severity Scale (FSS). Independent samples *t* test, Mann-Whitney *U* test, chi-square analysis, Pearson/Spearman correlation, and binary logistic regression were used to analyze the data.

Results The results demonstrated that 48.7% individuals with AS suffered from fatigue. Binary logistic regression indicated that waist-to-hip ratio, BASDAI, and sleep disturbance were independent predictors of fatigue in AS patients. Meanwhile, severe fatigue led to lower quality of life.

Conclusion These findings suggested that medical personnel should pay more attention to AS patients with fatigue and take effective measures to relieve fatigue.

Key Points
- *Incidence of fatigue in AS patients is 48.7% according to this cross-sectional study.*
- *The occurrence of fatigue was associated with higher WHR, higher BASDAI, and sleep disturbance.*
- *We also found that the occurrence of fatigue significantly reduced the quality of life in AS patients both physically and psychologically.*

Keywords Ankylosing spondylitis · BASDAI · Fatigue · Quality of life

Ankylosing spondylitis (AS) is a systemic chronic inflammatory disease, which most likely occurs in young men. It mainly affects sacroiliac joints, axial skeleton, thoracic cage, and seriously decreasing quality of life in AS patients [1, 2]. Our studies have confirmed that AS patients have suffered from body image disturbance and sexual dysfunction, which lead to anxiety and depression as well as reduction in quality of life in patients with AS [3, 4]. In recent years, fatigue of AS patients has been paid more and more attention [5, 6]. Fatigue is a complex feeling; diseased individuals describe fatigue as a sense of tiredness at rest, exhaustion with activity, lack of energy which affects daily work, inertia, or lack of endurance, or as loss of vitality. It has been confirmed that fatigue not only is a symptom but also may be quantified by fatigue scores and

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can be modified by various measures depending on the underlying cause.[7] It includes complex interactions between social, demographic, biological, disease-related, and behavioral processes [8]. A research in Turkey has estimated that fatigue occurred in more than half of patients with AS, which has a serious impact on the work, family, daily activities, emotions, and cognition of AS patients, and significantly reduces the quality of life in AS patients [9]. A longitudinal observation cohort in Canada showed that severely fatigued patients with AS tended to have higher disease activity scores, increased acute-phase proteins, and decreased QoL [10]. Schneeberger et al. [11] confirmed that fatigue in AS patients was correlated with quality of life, functional capacity, and depression. A cross-sectional study of 385 patients with AS emphasized pain as a major factor associated with fatigue, which calls for more pain management [12]. Aissaoui et al. [13] found that disease activity was the most powerful predictor of fatigue in AS patients. However, another research pointed that even though disease activity had great influence on fatigue, the effects of psychogenic factors should be taken into consideration as well [9]. At present, the factors to predict fatigue in AS patients are still controversial. Therefore, it is necessary to strengthen the study of fatigue in AS patients and release the symptoms of fatigue, so as to improve the quality of life of patients.

Although patients with AS suffer from severe fatigue, there has been no study about fatigue in AS patients in China. The aims of our study are (1) to explore the fatigue status of AS patients in China, (2) to explore the predictors of fatigue in AS patients, and (3) to investigate the effects of fatigue on the quality of life of AS patients in China.

Methods

Participants

Patients were recruited from the Affiliated Hospital of Nantong University from February 2017 to February 2018. A total of 156 AS patients from the outpatient department or inpatient ward of the Department of Rheumatology and Immunology were invited to participate in this study. Six patients were excluded because they did not complete the questionnaire. Eventually, 150 patients with AS were enrolled in the cross-sectional study. All patients met the criteria for AS. The exclusion criteria for AS individuals include (1) age ≤ 18 years old, (2) patients with hearing or cognitive impairment, and cannot cooperate with the completion of the questionnaire. This cross-sectional study was approved by the Ethics Committee of the Affiliated Hospital of Nantong University (2017-K003). All of the participants were informed about the study and sign an informed consent.

Demographic and clinical characteristics

Demographic variables include age, gender, body mass index (BMI), waist-to-hip ratio (WHR), tobacco use, alcohol use, marital status, education level, employment, yearly per capita income, medical insurance, place of residence, and exercise therapy (Table 1).

Clinical variables include disease duration, comorbidity, hospitalization, family history of AS, Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Functional Index (BASFI), Bath Ankylosing Spondylitis Metrology Index (BASMI), Visual Analog Scale (VAS), anxiety, depression, sleep disturbance, Health Assessment Questionnaire (HAQ), and sexual dysfunction. ESR and CRP values were obtained by viewing patients' medical reports.

Self-reported questionnaires

We used the 10-cm VAS to evaluate total pain. Patients self-reported overall pain, and the higher scores indicate the more severe pain [8].

The BASFI was used to determine functional status. It includes 8 items concerning activities related to the functional anatomy of the patients (bending, reaching, changing position, standing, turning, and climbing steps), and 2 items assessing the patients' ability to deal with daily activities. It was measured on a scale of 0–10, and higher scores indicate worse function [14].

The BASDAI was used to evaluate disease activity. It includes six questions regarding fatigue, spinal pain, joint pain or swelling of peripheral joints, haphalgesia or tenderness, severity, and duration of morning stiffness which is scored using a 10-cm VAS for each question. The BASDAI has been confirmed for the measurement of disease activity [15].

The BASMI was used to evaluate the mobility of the axial skeleton in AS patients and allow objective assessment of clinically significant changes in spinal movement. It includes 5 items, clinical measures of cervical rotation, tragus to wall distance, lumbar flexion, lumbar side flexion, and intermalleolar distance [16].

We used Zung Self-Rating Anxiety Scale (SAS) and Zung Self-Rating Depression Scale (SDS) to evaluate psychological status. SAS is a 20-item scale to evaluate anxiety. Each question scores from 1 to 4 (rarely, sometimes, frequently, and always). The higher the scores, the more severe the anxiety.

SDS is a 20-item scale to assess depression. Half of the items are scored positively and half negatively. Each item scores from 1 to 4. The total score varies from 20 to 80. Higher scores indicate more severe depression [17].

The Pittsburgh Sleep Quality Index (PSQI) Questionnaire was used to measure the sleep quality over a 1-month period which includes nineteen individual items. Each answer

Table 1 Demographic and clinical characteristics of AS patients

Characteristic	AS patients ($N = 150$)
Age[b]	32 (27.44)
Gender, male[c]	118 (78.7)
BMI, kg/m^2[b]	23.32 (20.7, 25.35)
WHR[a]	0.88 ± 0.82
Tobacco use, yes[c]	47 (31.3)
Alcohol use, yes[c]	37 (24.7)
Marital status[c]	
Married	112 (74.7)
Other	38 (25.3)
Education level[c]	
≤ 9 years	52 (34.7)
> 9 years	98 (65.3)
Employment[c]	
Employed	112 (75.7)
Unemployed	36 (24.3)
Yearly per capita income, yuan[c]	
< 15,000	53 (35.3)
15,000–33,000	40 (26.7)
> 33,000 yuan	57 (38)
Medical insurance[c]	103 (68.7)
Place of residence[c]	
Urban	80 (53.3)
Rural	70 (46.7)
Exercise therapy, yes[c]	40 (35.1)
Disease duration, year[b]	5 (2.10)
Comorbidity, yes[c]	23 (15.3)
Hospitalization, yes[c]	50 (33.3)
Family history of AS[c]	19 (12.7)
BASFI[b]	1 (0, 2.63)
BASMI[b]	1 (0.3)
BASDAI[a]	3.09 ± 2.02
VAS, mm[b]	4 (1.75, 6)
Fatigue score[a]	3.87 ± 1.45
Fatigue, yes[c]	73 (48.67)
Anxiety, yes[c]	31 (20.7)
Depression, yes[c]	47 (31.3)
Sleep disturbance, yes[c]	92 (61.3)
HAQ[b]	0.13 (0.5)
ESR, mm/h[b]	17 (7.40)
CRP, mg/L[b]	12.95 (5.24, 26.98)
Sexual dysfunction, yes[c]	32 (43.9)

BMI body mass index, *WHR* waist-to-hip ratio

[a] Values are presented as the mean ± SD and analyzed by independent samples *t* test

[b] Values are presented as the median (25th and 75th percentiles) and analyzed by Mann-Whitney

[c] Values are presented as the number (%) analyzed by chi-square tests

provided a score ranges from 0 to 3. Higher scores represent poorer subjective sleep quality. Sleep disturbance was defined as a PSQI score of > 5 [18].

Functional disability was evaluated by the Health Assessment Questionnaire-Disability Index (HAQ-DI). It includes 20 questions to assess the functional status of patients in the 8 dimensions of dressing, grooming, arising, eating, walking, hygiene, reaching, gripping, and common daily activities. Higher scores indicate severe disability [19].

SF-36 is an internationally recognized universal scale for assessing quality of life. It mainly includes 8 dimensions, physical function, role limitations due to physical problems, body pain, general health perception, energy, social function, role limitations due to emotional problems, and mental health. The scores of each dimension ranged from 0 to 100. The higher the dimensions and total scores, the better the quality of life; conversely, the worse the quality of life [20].

The Fatigue Severity Scale (FSS) was performed to evaluate motivation, physical activity, and social and functional effects of fatigue. It includes 9 questions, which scored from 1 to 7, and the total score is the average of all questions. Higher scores indicate higher fatigue levels, and the scores ≥ 4 were defined as fatigued [10].

Statistical analysis

SPSS 21.0 was conducted to analyze data. Kolmogorov-Smirnov test was used to evaluate normal distribution. The normal distribution is expressed by mean (± standard deviation), while the non-normal distribution is expressed by median (25th and 75th percentiles) or number (percentage). Categorical variables are presented as numerical value and percentage. Double-tailed *t* test, chi-square test, and/or Mann-Whitney *U* test were used to evaluate the difference between continuous and categorical variables in the fatigued patients with AS and non-fatigued patients with AS. Spearman correlation coefficient and/or Pearson correlation coefficient was used to analyze the correlation between all statistical variables and fatigue in AS patients. Using binary stepwise logistic regression to determine predictors of fatigue in AS patients, we considered a significance level of $P < 0.05$ to be statistically significant.

Results

Patient characteristics

A total of 150 AS patients were investigated in the study. The median age of AS patients was 32 years old, and 78.7% of them were males. The mean (SD) of WHR was 0.88 ± 0.82. The median disease duration of AS patients was 5 years. 15.3% patients had comorbidities, and the mean (SD) of

Table 2 Differences between demographic, psychological, and clinical characteristics of AS patients grouped by fatigue ($N = 150$)

Characteristic	AS with fatigue ($N = 73$)	AS without fatigue ($N = 77$)	P
Age[b]	32 (27.48)	32 (26.42)	0.498
Gender, male[c]	56 (76.7)	62 (80.5)	0.569
BMI, kg/m^2[b]	23.55 (21.01, 26.33)	23.05 (20.29, 24.95)	0.130
WHR[a]	0.90 ± 0.90	0.87 ± 0.07	*0.045*
Tobacco use, yes[c]	24 (32.9)	23 (29.9)	0.692
Alcohol use, yes[c]	16 (21.9)	21 (27.3)	0.447
Marital status[c]			0.571
Married	53 (72.6)	59 (76.6)	
Other	20 (27.4)	18 (23.4)	
Education level[c]			0.355
≤ 9 years	28 (38.4)	24 (31.2)	
> 9 years	45 (61.6)	53 (68.8)	
Employment[c]			0.507
Employed	52 (73.2)	60 (77.9)	
Unemployed	19 (26.8)	17 (22.1)	
Yearly per capita income, yuan[c]			0.420
< 15,000	27 (37)	26 (33.8)	
15,000–33,000	22 (30.1)	18 (23.4)	
> 33,000 yuan	24 (32.9)	33 (42.9)	
Medical insurance[c]	45 (61.6)	58 (75.3)	0.071
Place of residence[c]			0.106
Urban	34 (46.6)	46 (59.7)	
Rural	39 (53.4)	31 (40.3)	
Exercise therapy, yes[c]	16 (27.1)	24 (43.6)	0.065
Disease duration, year[b]	5 (2.8)	5 (2.10)	0.970
Comorbidity, yes[c]	13 (17.8)	10 (13)	0.413
Hospitalization, yes[c]	23 (31.5)	27 (35.1)	0.644
Family history of AS[c]	8 (11)	11 (14.3)	0.54
BASFI[b]	1.4 (0.05, 4.1)	0.6 (0.2)	*0.029*
BASMI[b]	1 (0.3)	1 (0.3)	0.37
BASDAI[a]	3.76 ± 2.06	2.46 ± 1.77	< *0.01*
VAS, mm[b]	5 (3.7)	3 (1.5)	*0.002*
Fatigue score[a]	5.06 ± 0.87	2.74 ± 0.85	< *0.001*
Anxiety, yes[c]	23 (31.5)	8 (10.4)	*0.001*
Depression, yes[c]	28 (38.4)	19 (24.7)	0.071
Sleep disturbance, yes[c]	55 (75.3)	37 (48.1)	*0.001*
HAQ[b]	0.25 (0, 0.69)	0.(0, 0.31)	*0.001*
ESR, mm/h[b]	20.5 (8.25, 42.25)	14 (6.39)	0.07
CRP, mg/L[b]	14.1 (8.61, 39.3)	11.6 (4.6, 24.9)	0.169
Sexual dysfunction, yes[c]	19 (67.9)	13 (44.8)	0.08

Values presented as italicized data are considered statistically significant

[a] Values are presented as the mean ± SD and analyzed by independent samples t test

[b] Values are presented as the median (25th and 75th percentiles) and analyzed by Mann-Whitney

[c] Values are presented as the number (%) analyzed by chi-square tests

BASDAI was 3.09 ± 2.02. The incidence of fatigue in AS patients was 48.7%.

Differences in demographic, psychological, and clinical characteristics of AS patients between two groups

Compared with AS patients without fatigue, AS patients with fatigue showed higher WHR ($P < 0.05$), increased BASDAI ($P < 0.01$), and poorer BASFI ($P < 0.05$). Meanwhile, AS patients with fatigue tended to have more severe pain ($P < 0.05$), higher degree of anxiety ($P = 0.001$), more serious functional disability ($P = 0.001$), and worse sleep quality ($P = 0.001$). There were no statistical significances in disease duration, hospitalization, depression, and other variables. The results were shown in Table 2.

Correlations between clinical, psychological characteristics and fatigue in AS patients

Taking fatigue as a continuous variable to explore correlations between clinical, psychological characteristics and fatigue in AS patients. We found a positive correlation between BASFI ($P < 0.05$), BASDAI ($P < 0.01$), VAS

Table 3 Correlations between clinical, psychological characteristics and fatigue in AS patients ($N = 150$)

Characteristic	Fatigue score	
	r	*P*
Age[a]	0.135	0.1
Gender[b]	0.123	0.133
BMI[a]	0.122	0.138
WHR[a]	0.071	0.405
Tobacco use[b]	− 0.041	0.617
Alcohol use[b]	− 0.120	0.145
Exercise therapy[b]	− 0.165	0.079
Disease duration[a]	0.052	0.528
Comorbidity[b]	0.061	0.461
Hospitalization[b]	− 0.018	0.824
Family history of gout[b]	− 0.030	0.713
BASFI[a]	0.247	*0.002*
BASMI[a]	0.148	0.071
BASDAI[a]	0.403	*< 0.01*
VAS[a]	0.233	*0.004*
Anxiety[b]	0.300	*< 0.01*
Depression[b]	0.125	0.128
Sleep disturbance[b]	0.371	*< 0.01*
HAQ[a]	0.228	*0.005*
ESR[a]	0.162	0.064
CRP[a]	0.141	0.121
Sexual dysfunction[b]	0.277	*0.037*

Values presented as italicized data are considered statistically significant

[a] Values are analyzed by Pearson correlation analysis

[b] Values are analyzed by Spearman correlation analysis

($P < 0.05$), anxiety ($P < 0.01$), sleep disturbance ($P < 0.01$), HAQ ($P < 0.05$), sexual dysfunction ($P < 0.05$), and fatigue (Table 3).

Higher WHR, higher BASDAI, and sleep disturbance predicted fatigue in AS patients

Binary logistic regression indicated that WHR (OR = 1.78, $P < 0.05$), BASDAI (OR = 1.34, $P = 0.01$), and sleep disturbance (OR = 2.35, $P < 0.05$) were independent predictors of fatigue in AS patients (Table 4).

Table 4 Analysis of logistic regression models in AS patients with fatigue

	Beta	Standard error	*P* value	Exp (B)	(95% CI)
WHR*10	0.58	0.24	0.02	1.78	(1.11, 2.86)
BASDAI	0.29	0.11	0.01	1.34	(1.09, 1.64)
PSQI					
Sleep disturbance	0.85	0.40	0.03	2.35	(1.07, 5.12)

WHR waist-to-hip ratio, *BASDAI* Bath Ankylosing Spondylitis Disease Activity Index

Effects of fatigue on quality of life in AS patients

Comparison of non-fatigued patients and fatigued patients in terms of quality of life was exhibited in Table 5. The occurrence of fatigue significantly reduced the quality of life in AS patients both physically and psychologically.

Discussion

Previous studies have shown that the prevalence of fatigue in AS patients range from 53 to 65% [8, 21, 22]. As we all know, this is the first study to investigate that the incidence of fatigue in AS patients was 48.7% in China. Higher WHR, higher BASDAI, and sleep disturbance are independent predictors of fatigue in AS patients. Furthermore, fatigued patients with AS have worse quality of life than non-fatigued patients with AS.

Social demographic factors are closely related to fatigue. Law et al. [1] indicated that female with AS had a significantly higher ESR and VAS for global fatigue compared with the male. However, no obvious correlation was found between gender and fatigue in our study, which may be attributed to differences in the population included, and 34.4% of women with AS were unemployed. A study of fatigue status in patients with rheumatoid arthritis (RA) showed that obesity was independently associated with fatigue [23]. One intervention for RA patients was to reduce daily sitting time, which confirmed that the WHR of RA patients tended to decrease and fatigue was relieved [24]. Eder et al. confirmed that obesity is linked with late-onset psoriasis and psoriatic arthritis (PsA) [25]. According to our study, we found that WHR has a significant correlation with fatigue in AS patients. Our previous report showed that AS patients who adhered to standard exercise had reduced disease activity and better quality of life, suggesting that we should encourage AS patients to stick to take appropriate exercise to keep weight and healthy [26].

Previous studies have demonstrated a correlation between disease activity and fatigue in AS patients [6, 27]. Alkan et al. [28] use Multidimensional Assessment of Fatigue (MAF) to evaluate 110 AS patients and 40 healthy controls, which showed that the MAF scores of all patients were significantly correlated with BASDAI. A cohort study also confirmed that BASDAI is an independent predictor of fatigue severity in AS patients [10]. In consistent with previous studies, we also found that BASDAI predicted fatigue in AS patients by FSS scale.

It has been confirmed that sleep disturbance is common in rheumatic diseases [29]. In RA patients, sleep disturbance was moderately correlated to fatigue [30]. In patients with PsA,

Table 5 Differences between quality of life in two groups grouped by fatigue

	All AS patients ($N = 150$)	AS with fatigue ($N = 73$)	AS without fatigue ($N = 77$)	P
SF-36				
PCS[a]	55.39 ± 23.09	47.57 ± 21.50	62.81 ± 22.20	*< 0.001*
MCS[a]	65.39 ± 22.49	57.83 ± 22.52	72.55 ± 20.12	*< 0.001*
PF[b]	80 (60.90)	75 (55.90)	85 (75.95)	*0.01*
RP[b]	50 (0, 100)	0 (0.50)	75 (0, 100)	*< 0.001*
BP[a]	54.43 ± 22.92	48.82 ± 21.76	59.74 ± 22.87	*0.003*
GH[a]	49.65 ± 21.92	42.77 ± 21.33	56.17 ± 20.54	*< 0.001*
VT[a]	59.67 ± 19.24	51.71 ± 17.72	67.21 ± 17.59	*< 0.001*
SF[b]	75 (59.38, 100)	75 (50, 87.5)	87.5 (62.5, 100)	*0.007*
RE[b]	100 (0, 100)	66.67 (0, 100)	100 (33.3, 100)	*0.002*
MH[a]	69.49 ± 18.05	63.67 ± 18.96	75.01 ± 15.33	*< 0.001*

Values presented as italicized data are considered statistically significant

SF-36 36-item short form health survey, *PCS* physical component summary, *MCS* mental component summary, *PF* physical functioning, *RP* role-physical, *BP* bodily pain, *GH* general health, *VT* vitality, *SF* social functioning, *RE* role emotional, *MH* metal health

[a] Values are presented as the mean ± SD and analyzed by independent samples *t* test

[b] Values are presented as the median (25th and 75th percentiles) and analyzed by Mann-Whitney

[c] Values are presented as the number (%) analyzed by chi-square tests

poor sleep is associated with fatigue [31]. Sleep disturbance is prevalent among AS patients [32]. A cross-sectional survey of 281 AS patients showed that 67.6% of the patients had sleep disturbance [33]. A study in Moroccan found a correlation between sleep disturbance and fatigue assessed by the fourth item of Hamilton Anxiety Scale [13]. Our study found that fatigued AS patients had more sleep disturbance than non-fatigued AS patients assessed by PSQI. Meanwhile, logistic regression analysis indicated that sleep disturbance had significant impacts on fatigue.

Measuring health-related quality of life (HR-QoL) is considered to be an essential part of the overall assessment of the health status in AS patients [34]. Previous studies have found that AS patients had significantly lower quality of life than healthy controls [35]. It should be noticed that fatigued AS patients score worse both in the domains of the PCS and MCS of SF-36, which indicated that the quality of life of fatigued AS patients decreased in many aspects. Schneeberger [11] demonstrated that fatigue could affect quality of life in AS patients. There have been reported that compared with non-fatigue patients, fatigue patients showed more significant anxiety, worse physical function, and lower quality of life [36]. We also found that compared with non-fatigued AS patients, fatigued AS patients showed more serious functional disability and anxiety, which all led to the decline of patients' quality of life.

As we all known, this study is the first to explore the fatigue status and its effects on the quality of life of AS patients in China. However, we still had several limitations. First, this study did not provide the details of medication used to treat AS, such as biological agents. Second, the AS patients were recruited from a single clinic of rheumatology, and sample sizes were not large enough; we still need more rigorous research to confirm the results. Third, because this study is a cross-sectional study, we cannot test the causal relationships between variables. In the future, studiers can expand the sample size from multiple centers and take effective intervention measures to reduce fatigue of AS patients and improve the quality of life in AS patients.

Conclusion

This is the first cross-sectional study to evaluate the predictors of fatigue and the effects of fatigue on HR-QoL among patients with AS in China. The survey indicated that WHR, BASDAI, and sleep disturbance were independent predictors of fatigue in AS patients, and the occurrence of fatigue significantly reduces the quality of life in AS patients physically and psychologically. Therefore, medical personnel should pay more attention to AS patients with fatigue and take effective measures to improve fatigue of AS patients.

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Compliance with ethical standards

All participants obtained informed consent in the study. This cross-sectional study was approved by the Ethics Committee of the Affiliated Hospital of Nantong University (2017-K003).

Disclosures None.

References

1. Law L, Beckman Rehnman J, Deminger A, Klingberg E, Jacobsson LTH, Forsblad-d'Elia H (2018) Factors related to health-related quality of life in ankylosing spondylitis, overall and stratified by sex. Arthritis Res Ther 20(1):284. https://doi.org/10.1186/s13075-018-1784-8
2. Hanson A, Brown MA (2017) Genetics and the causes of ankylosing spondylitis. Rheum Dis Clin N Am 43(3):401–414. https://doi.org/10.1016/j.rdc.2017.04.006
3. Fan D, Liu L, Ding N, Liu S, Hu Y, Cai G, Xia G, Xin L, Wang L, Xu S, Xu J, Zou Y, Pan F (2015) Male sexual dysfunction and ankylosing spondylitis: a systematic review and metaanalysis. J Rheumatol 42(2):252–257. https://doi.org/10.3899/jrheum.140416
4. Shen B, Zhang A, Liu J, Da Z, Xu X, Liu H, Li L, Gu Z (2014) Body image disturbance and quality of life in Chinese patients with ankylosing spondylitis. Psychol Psychother 87(3):324–337. https://doi.org/10.1111/papt.12016
5. Ulus Y, Akyol Y, Bilgici A, Kuru O (2019) Association of work instability with fatigue and emotional status in patients with ankylosing spondylitis: comparison with healthy controls. Clin Rheumatol 38(4):1017–1024. https://doi.org/10.1007/s10067-018-4366-x
6. Dean LE, Macfarlane GJ, Jones GT (2018) Five potentially modifiable factors predict poor quality of life in ankylosing spondylitis: results from the Scotland Registry for ankylosing spondylitis. J Rheumatol 45(1):62–69. https://doi.org/10.3899/jrheum.160411
7. Finsterer J, Mahjoub SZ (2014) Fatigue in healthy and diseased individuals. Am J Hosp Palliat Care 31(5):562–575. https://doi.org/10.1177/1049909113494748
8. Dernis-Labous E, Messow M, Dougados M (2003) Assessment of fatigue in the management of patients with ankylosing spondylitis. Rheumatology 42(12):1523–1528. https://doi.org/10.1093/rheumatology/keg421
9. Durmus D, Sarisoy G, Alayli G, Kesmen H, Cetin E, Bilgici A, Kuru O, Unal M (2015) Psychiatric symptoms in ankylosing spondylitis: their relationship with disease activity, functional capacity, pain and fatigue. Compr Psychiatry 62:170–177. https://doi.org/10.1016/j.comppsych.2015.07.016
10. Bedaiwi M, Sari I, Thavaneswaran A, Ayearst R, Haroon N, Inman RD (2015) Fatigue in ankylosing spondylitis and nonradiographic axial spondyloarthritis: analysis from a longitudinal observation cohort. J Rheumatol 42(12):2354–2360. https://doi.org/10.3899/jrheum.150463
11. Schneeberger EE, Marengo MF, Dal Pra F, Maldonado Cocco JA, Citera G (2015) Fatigue assessment and its impact in the quality of life of patients with ankylosing spondylitis. Clin Rheumatol 34(3):497–501. https://doi.org/10.1007/s10067-014-2682-3
12. Brophy S, Davies H, Dennis MS, Cooksey R, Husain MJ, Irvine E, Siebert S (2013) Fatigue in ankylosing spondylitis: treatment should focus on pain management. Semin Arthritis Rheum 42(4):361–367. https://doi.org/10.1016/j.semarthrit.2012.06.002
13. Aissaoui N, Rostom S, Hakkou J, Berrada Ghziouel K, Bahiri R, Abouqal R, Hajjaj-Hassouni N (2012) Fatigue in patients with ankylosing spondylitis: prevalence and relationships with disease-specific variables, psychological status, and sleep disturbance. Rheumatol Int 32(7):2117–2124. https://doi.org/10.1007/s00296-011-1928-5
14. Fitzgerald G, Gallagher P, O'Shea F (2019) Multimorbidity is common in axial spondyloarthropathy and is associated with worse disease outcomes: results from the ASRI cohort. J Rheumatol. https://doi.org/10.3899/jrheum.181415
15. Yilmaz O, Tutoglu A, Garip Y, Ozcan E, Bodur H (2013) 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 33(5):1159–1163. https://doi.org/10.1007/s00296-012-2510-5
16. Zochling J (2011) 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 Spondylarthropathies (HAQ-S). Arthritis Care Res 63(Suppl 11):S47–S58. https://doi.org/10.1002/acr.20575
17. Jiang Y, Yang M, Lv Q, Qi J, Lin Z, Liao Z, Zhang Y, Wu H, Song H, Zhan F, Liu S, Gao G, Hu S, Li Y, Shen L, Huang A, Wei Q, Cao S, Gu J (2018) Prevalence of psychological disorders, sleep disturbance and stressful life events and their relationships with disease parameters in Chinese patients with ankylosing spondylitis. Clin Rheumatol 37(2):407–414. https://doi.org/10.1007/s10067-017-3907-z
18. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ (1989) The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 28(2):193–213
19. Leung YY, Lee W, Lui NL, Rouse M, McKenna SP, Thumboo J (2017) Adaptation of Chinese and English versions of the ankylosing spondylitis quality of life (ASQoL) scale for use in Singapore. BMC Musculoskelet Disord 18(1):353. https://doi.org/10.1186/s12891-017-1715-x
20. Arisoy O, Bes C, Cifci C, Sercan M, Soy M (2013) The effect of TNF-alpha blockers on psychometric measures in ankylosing spondylitis patients: a preliminary observation. Rheumatol Int 33(7):1855–1864. https://doi.org/10.1007/s00296-013-2671-x
21. van Tubergen A, Coenen J, Landewe R, Spoorenberg A, Chorus A, Boonen A, van der Linden S, van der Heijde D (2002) Assessment of fatigue in patients with ankylosing spondylitis: a psychometric analysis. Arthritis Rheum 47(1):8–16. https://doi.org/10.1002/art1.10179
22. Dagfinrud H, Vollestad NK, Loge JH, Kvien TK, Mengshoel AM (2005) Fatigue in patients with ankylosing spondylitis: a comparison with the general population and associations with clinical and self-reported measures. Arthritis Rheum 53(1):5–11. https://doi.org/10.1002/art.20910
23. Katz P, Margaretten M, Trupin L, Schmajuk G, Yazdany J, Yelin E (2016) Role of sleep disturbance, depression, obesity, and physical inactivity in fatigue in rheumatoid arthritis. Arthritis Care Res 68(1):81–90. https://doi.org/10.1002/acr.22577
24. Thomsen T, Aadahl M, Beyer N, Hetland ML, Loppenthin K, Midtgaard J, Christensen R, Ostergaard M, Jennum PJ, Esbensen BA (2017) The efficacy of motivational counselling and SMS reminders on daily sitting time in patients with rheumatoid arthritis: a randomised controlled trial. Ann Rheum Dis 76(9):1603–1606. https://doi.org/10.1136/annrheumdis-2016-210953

25. Eder L, Abji F, Rosen CF, Chandran V, Gladman DD (2017) The association between obesity and clinical features of psoriatic arthritis: a case-control study. J Rheumatol 44(4):437–443. https://doi.org/10.3899/jrheum.160532
26. Sang Y, Dong C, Fu T, Zhao R, Ge X, Zhou W, Ji J, Gu Z (2018) Associated factors with adherence to standard exercise therapy and health-related quality of life in Chinese patients with ankylosing spondylitis. Mod Rheumatol:1–6. https://doi.org/10.1080/14397595.2018.1559966
27. Connolly D, Fitzpatrick C, O'Shea F (2019) Disease activity, occupational participation, and quality of life for individuals with and without severe fatigue in ankylosing spondylitis. Occup Ther Int 2019:3027280. https://doi.org/10.1155/2019/3027280
28. Alkan BM, Fidan F, Erten S, Aksekili H, Alemdar A, Eroglu E, Ardicoglu O, Tosun A (2013) Fatigue and correlation with disease-specific variables, spinal mobility measures, and health-related quality of life in ankylosing spondylitis. Mod Rheumatol 23(6):1101–1107. https://doi.org/10.1007/s10165-012-0800-0
29. Bagnato GL, Fiorenza A, Cordova F, Roberts WN, Moore C Jr, Greco D, Monaco C, Muscatello MR, Bruno A, Zoccali R, Bagnato G (2016) Clinical, autoimmune, and psychiatric parameters correlate with sleep disturbance in patients with systemic sclerosis and rheumatoid arthritis. Clin Exp Rheumatol 34(Suppl 100 (5)):49–55
30. Austad C, Kvien TK, Olsen IC, Uhlig T (2017) Sleep disturbance in patients with rheumatoid arthritis is related to fatigue, disease activity, and other patient-reported outcomes. Scand J Rheumatol 46(2):95–103. https://doi.org/10.3109/03009742.2016.1168482
31. Wong ITY, Chandran V, Li S, Gladman DD (2017) Sleep disturbance in psoriatic disease: prevalence and associated factors. J Rheumatol 44(9):1369–1374. https://doi.org/10.3899/jrheum.161330
32. Hakkou J, Rostom S, Mengat M, Aissaoui N, Bahiri R, Hajjaj-Hassouni N (2013) Sleep disturbance in Moroccan patients with ankylosing spondylitis: prevalence and relationships with disease-specific variables, psychological status and quality of life. Rheumatol Int 33(2):285–290. https://doi.org/10.1007/s00296-012-2376-6
33. Nie A, Wang C, Song Y, Xie X, Yang H, Chen H (2018) Prevalence and factors associated with disturbed sleep in outpatients with ankylosing spondylitis. Clin Rheumatol 37(8):2161–2168. https://doi.org/10.1007/s10067-018-4190-3
34. Yang X, Fan D, Xia Q, Wang M, Zhang X, Li X, Cai G, Wang L, Xin L, Xu S, Pan F (2016) The health-related quality of life of ankylosing spondylitis patients assessed by SF-36: a systematic review and meta-analysis. Qual Life Res 25(11):2711–2723. https://doi.org/10.1007/s11136-016-1345-z
35. Salaffi F, Carotti M, Gasparini S, Intorcia M, Grassi W (2009) The health-related quality of life in rheumatoid arthritis, ankylosing spondylitis, and psoriatic arthritis: a comparison with a selected sample of healthy people. Health Qual Life Outcomes 7:25. https://doi.org/10.1186/1477-7525-7-25
36. De Gucht V, Garcia FK, den Engelsman M, Maes S (2016) Differences in physical and psychosocial characteristics between CFS and fatigued non-CFS patients, a case-control study. Int J Behav Med 23(5):589–594. https://doi.org/10.1007/s12529-016-9544-0