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Wadeley, A., Clarke, E., Leverment, S. and Sengupta, R. (2018) 'Sleep in ankylosing spondylitis and non-radiographic axial spondyloarthritis: associations with disease activity, gender and mood', *Clinical Rheumatology*, 37 (4), pp. 1045-1052.

This is a post-peer-review, pre-copyedit version of an article published in 'Clinical Rheumatology'. The final authenticated version is available online at: http://doi.org/10.1007/s10067-018-3984-7.

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Sleep in Ankylosing Spondylitis and Non-radiographic Axial Spondyloarthritis: Associations with Disease Activity, Gender and Mood

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ABSTRACT

Introduction: The study aims were to assess the prevalence of good or poor sleep in a cohort of axial spondyloarthritis patients and to investigate its correlation with a range of objectively and subjectively measured variables in order to develop a model for distinguishing good from poor sleepers .

Methods: Five hundred ninety-eight patients with ankylosing spondylitis and 61 with nonradiographic axial spondyloarthritis completed the Jenkins Sleep Evaluation Questionnaire. Measures of disease activity, mobility, function, mood, fatigue, quality of life, work productivity, night-time pain and general health were gathered.

Results: Patients with ankylosing spondylitis or nonradiographic axial spondyloarthritis were initially compared. With the exception of waking up tired less often and having lower mobility and functioning, the two groups were similar so were combined for subsequent analysis. Twenty-nine percent of all patients were classified as good sleepers and 19% as poor sleepers. Poor sleepers had higher disease activity and fatigue scores and more night-time back pain than good sleepers. They reported poorer quality of life, general health, mood, and work-related measures. A model incorporating mood, gender, fatigue and objective and subjective judgements of disease activity correctly classified 87.3% of good and poor sleepers.

Conclusions: Poor sleep was strongly associated with poor mood, female gender, greater fatigue, greater disease activity (specifically, spinal pain and stiffness) and better mobility, however, the direction of causality between poor sleep and markers of active disease was undetermined. This study also highlights the need to standardise the measurement of sleep disturbance in axSpA to facilitate comparisons between patient groups and interventions.

KEYWORDS:

Ankylosing Spondylitis, Sleep, Fatigue, Gender, Quality of Life

INTRODUCTION

Axial Spondyloarthritis (axSpA) including ankylosing spondylitis (AS) and non-radiographic axial spondyloarthritis (nr-axSpA) are chronic inflammatory conditions which mainly affect the spine. The pain and stiffness associated with them are strongly implicated in poor sleep which, itself, has been identified as a major quality of life (QoL) concern for patients [1, 2] and contributor to work impairment and work hours lost [3]. Sleep disturbance has been reported in up to 80% of AS patients [4] yet the focus of published research in this area varies considerably. Sleep has been the primary outcome in a small number of studies [4, 5, 6], but is more often analysed as a secondary outcome [7, 8, 9]. This paper concerns variables that distinguish good from poor sleepers as its main focus and is the first of its kind to be based on a large, UK patient sample.

Outcome measures used to assess sleep in these studies include the Pittsburgh Sleep Quality Index (PSQI) [10], the Medical Outcomes Study sleep questionnaire (MOS) [11], the Jenkins Sleep Evaluation Questionnaire (JSEQ) [12] and the Uppsala Sleep Inventory (USI) [13]. The majority of studies involve subjective, self-report measures, but some include objective measures such as polysomnography [14]. Higher scores on the Bath Ankylosing Spondylitis and Functioning Indexes (BASDAI and BASFI), for disease activity and daily functioning respectively, are frequently associated with poorer sleep in such studies. Comorbid conditions, such as inflammatory bowel disease [15, 16], have also been measured and implicated in poor sleep in AS patients, as have anxiety and depression [17].

Age is a key variable with regard to sleep patterns in AS and the effects found are mixed. However, reliable associations between age and sleep are difficult to establish even in healthy populations [18], and are further complicated by inherent and circumstantial individual differences in sleep needs, patterns and preferences [19].

A further key variable is gender. Two studies [1, 2] showed that men and women with AS equally rate sleep improvement as a priority but did not show whether or how their actual sleep patterns differed. A further study of 70 Swedish AS patients showed that sleep disturbance was more prevalent amongst females: insufficient sleep was reported by 80.8% of females compared to 50.0% of males. In addition, more females reported significantly more difficulty with falling and staying asleep, pain at bedtime, and in the night, and fatigue [4].

Some studies concern the efficacy of interventions to improve sleep. These include exercise [20] or use of non-steroidal anti-inflammatory medication [3, 7, 21, 22, 23]. Anti-tumour necrosis factor (Anti-TNF) therapies, when assessed as a secondary outcome in large phase 3 studies, have been shown to improve sleep in longitudinal studies [3, 21, 22, 23].

The main aim in this study was to assess the extent to which variables identified in the aforementioned research literature could distinguish between axSpA patients who experience good or poor sleep. To achieve this, the demographic variables of age, gender and disease duration were recorded along with Bath Ankylosing Spondylitis measures of disease activity (BASDAI) [24], functioning (BASFI) [25] and metrology (BASMI) [26]. A secondary aim was to analyse total and sub-scale scores, as well as to take separate measures which tend to be duplicated within scales such as fatigue and back pain, in order to check their correspondence with each other. Other measures of comorbidities, mood

(anxiety/depression), QoL, medication use, general health and functioning at work were also taken. These variables were compared in relation to disease (nr-axSpA and AS) and good/poor sleep classification. Key variables thus identified were then combined to assess their unique contribution to distinguishing good or poor sleep.

MATERIALS AND METHODS

Patients. This is a cross-sectional, observational, single-centre study in UK patients with axSpA, which commenced in July 2010 and has been ongoing up to the present. AxSpA patients were classified according to the ASAS axSpA criteria. Patients subsequently also meeting modified New York Criteria were classified as having AS whilst all other patients were deemed to have nr-axSpA. Data have been collected over a 5-year period from patients attending the Royal National Hospital for Rheumatic Diseases (RNHRD), Bath, under the care of a single rheumatologist (RS). Although data were collected at each visit, for each patient over this 5-year period, the focus of the current analyses is on the latest patient-reported information on sleep status and related factors. The latest time point used for cross-sectional analysis fell between September 2013 and June 2015. Bristol UK local research ethics committee (LREC) for National Health Service research approved the study, and all patients provided informed, written consent. (The Bath Spondyloarthritis (SpA) Biobank; REC reference: 13/SW/0096.)

Measures. The sleep measure used was the Jenkins Sleep Evaluation Questionnaire (JSEQ) which has an internal consistency of alpha = .79 [12]. It consists of four items asking about trouble falling asleep, waking several times in the night, trouble staying asleep and waking up feeling tired and worn out. Patients respond on a six-point scale indicating frequency of these problems during the past month and can score between 4 and 24. Low JSEQ (good sleep) was defined as problems on 3 days or fewer (≤ 8 points) and high JSEQ (poor sleep) as problems on 15 days or more (≥ 20 points) in the past month. In the absence of normative data for the patient group, this division was decided upon because it clearly distinguished patients whose sleep was hardly ever disturbed from those who experienced sleep problems on at least 50% of nights.

Disease characteristics were measured using the BASDAI, BASFI and BASMI. Fatigue was measured using the Functional Assessment of Chronic Illness Therapy (FACIT) Fatigue Scale V4.0 [27] and quality of life using the Ankylosing Spondylitis Quality of Life questionnaire (ASQoL) [28]. Back pain (night) and back pain (any time) measures were taken on a 0 none - 10 most severe visual analogue scale (VAS). The presence of extra articular manifestations (EAMs) of axSpA (IBD, uveitis and psoriasis) were recorded.

Mood and general health state were measured using the EuroQol five dimensions questionnaire (EQ5D) [29] Anxiety/Depression item (none, moderate, extreme) and general health state VAS (0 worst imaginable - 100 best imaginable).

For patients in work, two questions from the Work Productivity and Activity Impairment Questionnaire Specific Health Problem (WPAI:SHP V1.0) were used [30]: Q2 (work hours missed) and Q5 (productivity at work VAS: 0 no effect – 10 completely prevented from working) in the past 7 days.

Statistical analysis. IBM Statistical Package for the Social Sciences version 22 (IBM SPSS v.22) was used for all analyses. Kolmogorov-Smirnov tests revealed non-normal distributions in continuous data samples so medians, interquartile ranges (IQR) and percentages were used as descriptive statistics. Non-parametric, two-tailed, Mann Whitney U tests were used on continuous scale data to detect differences between AS and nr-axSpA patients, and good and poor sleepers. Chi square analyses were used to test for associations in frequency data. Direct binary logistic regression was used to test for the independent contribution of factors likely to predict good or poor sleep group membership. These factors, specifically gender, mood and individual BASDAI scale items, were chosen because of their likely impact upon night-time sleep rather than daytime functioning and their statistical significance in preceding tests. Although BASMI was non-significant at that point it was incorporated into the final model because it is a more objective test of functioning and its effect might be moderated by other co-variables. Collinearity statistics indicated that none of these predictor variables were problematic: Tolerance ≥ .20, VIF (Variance Inflation Factor) ≤ 5.22. $p \leq .05$ wer applied to all statistical tests.

RESULTS

Patient demographics, disease characteristics and comorbidity. There were 659 patients in total, aged 18-84 years (median = 51, IQR = 41-61 years) at the time of testing and 24% were female. Table 1 contains summary statistics for all patients and by diagnostic group. Ninety-one percent were AS patients. As would be expected due to stage of disease, they were significantly older (median 53, IQR = 42-63 years) than nr-axSpA patients (median 37, IQR = 28-44 years) and reported more years since diagnosis (median = 20, IQR = 9-31 v. median = 3, IQR = 2-8.75 years) and since symptom onset (median = 30, IQR = 20-41 v. median = 9.50, IQR = 5-19 years). Diagnostic groups did not differ in age at diagnosis, symptom onset or delay in diagnosis ($p \geq .11$). Comorbid IBD and psoriasis were not associated with diagnostic group but uveitis was, rising from 27.9% in nr-axSpA to 42.8% in AS.

Frequency of patients with low, medium and high JSEQ scores. Low JSEQ scores indicate problems on three days or fewer, medium scores on 4-14 days and high scores on 15 days or more in the past month. For each JSEQ item, the approximate percentages of patients falling into each low : medium : high category were: 'trouble falling asleep', 61.0 : 20.1 : 18.9; 'waking several times in the night', 33.8 : 26.7 : 39.5; 'trouble staying asleep', 40.5 : 27.0 : 32.5; 'wake up feeling tired and worn out', 36.8 : 27.5 : 35.7.

Comparisons by diagnostic (AS and nr-AxSpA) group. In Table 1, BASDAI and JSEQ scores indicated that AS patients, when compared to nr-AxSpA patients, experienced less stiffness duration and upon waking ($p \leq .03$), were less likely to wake up tired ($p = .02$). AS patients had higher BASMI (spinal movement changes) scores ($p = .00001$) and BASFI scores ($p = .002$) than nr-axSpA patients. Table 1 otherwise indicates little difference between AS and nr-axSpA patients in BASDAI and JSEQ scores. For this reason, patients are grouped together for further analyses.

INSERT Table 1: Comparison of patients with AS or nr-axSpA.

Comparisons of good and poor sleepers. Table 2 contains data comparing good sleepers (low JSEQ, n = 173) and poor sleepers (high JSEQ, n = 112). Good and poor sleepers comprise 29% and 19% of all patients respectively. AS and nr-axSpA patients are combined due to

negligible differences in JSEQ evident in Table 1. Gender and sleep group were associated such that men predominated in the good sleep group (80.9%) but less so (64.2%) in the poor sleep group ($p < .003$). All BASDAI scales, BASFI, ASQoL, back pain and EQ5D: General health state comparisons indicated significantly worse outcomes for poor sleepers compared to good sleepers ($p < .00001$). EQ5D: Anxiety/Depression was lower ($p < .00001$) in good sleepers (21.2%) compared to in poor sleepers (65.5%). Amongst patients who worked, poor sleepers reported more work hours missed and poorer productivity at work ($p \leq .007$) than good sleepers.

None of the variables relating to age, diagnosis time or symptom onset differed between JSEQ groups. There were no differences in BASMI scores or frequency of co-morbid conditions ($p \geq .27$).

INSERT Table 2: Comparison of patients with high and low Jenkins Sleep Evaluation Questionnaire (JSEQ) scores.

Unique predictors of good or poor sleep. Direct logistic regression was performed to assess the unique impact of nine independent variables (gender, BASMI, six BASDAI sub-scales and mood) on the likelihood that patients would report poor sleep (high JSEQ) scores. The BASMI was chosen as an objective measure of functioning and the others because of their relevance to night-time sleep and immediately after waking. Other measures that differed between sleep groups (BASFI and WPAI:SHP items) were excluded because they measure daytime functioning. ASQoL, FACIT and EQ5D: general health were excluded because of some overlap with items in other scales. High correlations between BASDAI spinal pain and back pain VAS measures ($rho_{(630)} = .71$ to $.74$, $p < .00001$, two tailed) and between BASDAI fatigue and FACIT ($rho_{(697)} = .69$, $p < .00001$, two tailed) justified use of the BASDAI measures only.

The full model, containing all the predictors and shown in Table 3, was statistically significant, χ^2 (8, N = 272) = 206.41 $p < .00001$, indicating that it could be used to distinguish between patients who reported sleep disruption on three days or fewer compared to 15 or more days in the past month. The model as a whole explained between 54.8% (Cox and Snell R Square) and 74.0% (Nagelkerke R Square) of the variance in sleep status and correctly classified 87.3% of cases. Table 3 shows that seven of the nine independent variables made a unique and statistically significant contribution to the model. The strongest predictor was EQ5D: Anxiety/Depression. The odds ratio indicated that for patients who assessed themselves as moderately to extremely anxious and depressed, high JSEQ classification was 7.18 times more probable than for those did not feel anxious and depressed. High JSEQ classification was 3.13 times more probable for females than for males. The odds ratio for BASDAI fatigue indicated that for every additional scale point, high JSEQ classification was 2.17 times more probable than low JSEQ classification. The odds ratio for BASDAI stiffness duration after waking indicated that for every additional scale point, high JSEQ classification was 1.99 times more probable than low JSEQ classification. The odds ratio for BASDAI spinal pain indicated that for every additional scale point, high JSEQ classification was 1.58 times more probable than low JSEQ classification. Finally, two predictors had weak, negative relationships with sleep category. The odds ratios for BASMI were 0.73 and for BASDAI stiffness on waking were 0.59. Taking the inverse of these, for the sake of clarity, they indicate that for every additional BASMI scale point, low JSEQ

classification was 1.38 times more probable than high JSEQ classification and for every additional BASDAI stiffness scale point, low JSEQ classification was 1.70 times more probable than high classification.

INSERT Table 3: Logistic regression predicting the likelihood of high Jenkins Sleep Evaluation Questionnaire (JSEQ) scores.

DISCUSSION

This study is, to our knowledge, the largest study of sleep disturbance in AS (or axial SpA) patients in the UK. Poor sleepers reported greater disease activity on all BASDAI measures, greater fatigue, poorer daily functioning, more back pain, reduced quality of life, poorer general health and greater incidence of EQ5D: Anxiety/Depression when compared to good sleepers. For those in work, poor sleepers missed more work hours and felt less productive. These differences appear not to be confounded by age, bearing in mind that, while sleep requirements change with age, the subjective sensation of poor or good sleep does not, at least among these patients. In addition, years since diagnosis and symptom onset and comorbid conditions (IBD, uveitis and psoriasis) are not implicated.

Further testing for the unique contribution of key variables to predicting poor or good sleep group classification was carried out. Together, these variables correctly classified 87.3% of patients. The order of ORs, starting with the highest, was EQ5D: Anxiety/Depression, female gender, BASDAI fatigue, stiffness duration, spinal pain, BASMI and stiffness on waking. Higher BASDAI stiffness on waking and BASMI predicted low JSEQ classification (less disturbance) while higher scores on the other 5 variables predicted high JSEQ classification (more disturbance). Effect size benchmarks [31] indicate a large effect for EQ5D: Anxiety/Depression, medium effects for gender and BASDAI fatigue and small effects for BASMI and BASDAI stiffness duration, stiffness on waking and spinal pain.

With regard to mood, we have shown that, for axSpA patients who report moderate to severe anxiety and depression, high JSEQ classification was 7.18 times more probable than for those did not feel anxious and depressed. Other studies attempting to link mood problems with sleep patterns in AS, but measuring depression alone, have produced equivocal results Two recent studies have linked greater depression with poorer sleep quality [6, 17] and two have not [4, 14]. Discrepancies may be partly due to the measures used, for example, whether they were standardised on clinical groups or not or comprised a single question, as well as the presence of other interacting but uncontrolled variables such as gender and age. The single, composite anxiety/depression question used here asked about two different, although arguably related, aspects of mood. Nevertheless, it was the strongest predictor of sleep group in this study and so deserves further scrutiny, ideally using more sensitive measures which distinguish anxiety and depression.

The second most important predictor of sleep group was gender which accords with one other study focusing on this [4]. The current study showed that females comprised 19.1% of the good sleep group as compared to 35.7% of the poor sleep group. For females in our cohort, high JSEQ classification was 3.13 times more probable than it was for males. These figures must be taken in the context of a predominantly male patient group. Age and stage of disease are additional confounders. In one meta-analysis to establish norms for healthy individuals across the lifespan [18], it was concluded that stage I and II sleep increased and

REM sleep decreased with age. Changes were greater for women, although in a similar direction to those in men, and patterns changed when ill-health-related variables were included. In this study, Table 2 shows no differences in age-related variables between sleep groups, suggesting that subjective sleep disturbance remains more prevalent amongst females regardless of age and stage of disease. However, middle-aged individuals, who make up most of the current patient group, were not well-represented in the aforementioned meta-analysis, rendering meaningful comparisons difficult.

Findings linking higher BASDAI scores with poorer sleep are robust [4, 5, 6, 9, 14, 17] and in agreement with the current study, where it is shown that fatigue, spinal pain and stiffness are unique predictors of poor sleep. As an objective measure of disease activity, BASMI also made a significant contribution. The causal direction of all these effects however is undetermined.

On a note of caution, in the original JSEQ development paper, the items mean = 2.38* in a non-clinical group (n = 250) [12]. (*Figure adjusted to correspond to our 4-24 scale. The original paper used 0-20.) This is lower than for all patients in this study: mean (SD) = 3.31 (1.48), $t_{(643)} = 16.00$, $p < .0001$, two-tailed). It is also much lower than the poor sleep group: mean (SD) = 5.60 (0.39), $t = 87.51_{(111)}$, $p < .00001$, two-tailed, and higher than the good sleep group: mean (SD) = 1.54 (0.35), $t_{(172)} = -31.82$, $p < .00001$), two-tailed, in this study. However, the original study utilised only working males whose average age was limited to 25 to 49 years. These factors, and the presence of skewed data samples in the current study, make meaningful comparisons with the current patients difficult, nevertheless the clear distinction between good and poor sleepers in this study lends validity to the conclusions drawn.

Studies of sleep such as this one, in naturalistic settings and based on self-report, are inherently difficult to control. However, highly controlled, laboratory-based, polysomnography research may not adequately reflect everyday sleeping conditions. Sleep in domestic settings is likely to be social [32] and, therefore, vulnerable to disturbance by others [33]. Few studies record these things, with one exception - a Turkish study in which it was reported that 81.1% of n=55 had a co-sleeper [5]. Secondly, sleep is often affected by uncontrollable external influences [34]. Finally, there are individual differences in sleep patterns and preferences [19] which are rarely taken into account in any kind of study [33].

CONCLUSIONS

In conclusion, findings in this study suggest a strong link between poor sleep and mood, gender, disease activity and mobility in AS and nr-axSpA patients. This study is the first of its kind based in the UK. The varied locations of other studies (Egypt [14], Turkey [5, 6] and China [9, 17]) lend contextual and population validity to the findings. This study further highlights the need to standardise the measurement of sleep disturbance in axSpA to allow future comparisons between patient groups and interventions.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Bristol UK local research ethics committee (LREC) for National Health Service research approved the study, and all patients provided informed, written consent. (The Bath Spondyloarthritis (SpA) Biobank; REC reference: 13/SW/0096.)

AVAILABILITY OF DATA AND MATERIAL

The datasets generated and/or analysed during the current study are not publicly available due to the Data Protection Act but are available from the corresponding author on reasonable request.

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Table 1

Comparison of patients with AS or nr-axSpA. BASDAI stiffness scores are the mean of items 5 (stiffness on waking) and 6 (duration of stiffness). Scale values are medians (interquartile range) and frequency data are % unless otherwise stated.

Variables	Total n = 659	nr-AxSpA n = 61	AS n = 598	p
% Male	76	59	78	.002
Age (yrs)	51 (41-61)	37 (28-44)	53 (42-63)	<.00001
Years since diagnosis	19 (8-30)	3 (2-8.75)	20 (9-31)	<.00001
Age at diagnosis (yrs)	29 (23-37)	31 (25-35.50)	28 (23-37)	.60
Age at symptom onset (yrs)	21 (17-26)	23 (16.25-29)	21 (17-26)	.28
Years since symptom onset	28 (18-40)	9.50 (5-19)	30 (20-41)	<.00001
Delay in diagnosis (yrs)	6 (2.25-12.00)	4 (2-11)	6 (3-12)	.11
% Inflammatory bowel disease present	8.0	1.6	8.7	.09
% Uveitis present	41.4	27.9	42.8	.03
% Psoriasis present	16.2	8.2	17.1	.11
BASDAI Total (All scales 0-10)	3.67 (2.17-5.33)	4.17 (2.83-6.00)	3.67 (2.17-5.17)	.11
- BASDAI fatigue	5.00 (3.00-7.00)	5.00 (3.00-7.00)	5.00 (3.00-7.00)	.51
- BASDAI spinal pain	4.00 (2.00-7.00)	6.00 (3.00-7.00)	4.00 (2.00-7.00)	.09
- BASDAI arthralgia	3.00 (1.00-5.00)	3.00 (1.00-5.00)	3.00 (1.00-5.00)	.95
- BASDAI enthesitis	3.00 (1.00-6.00)	3.00 (1.00-6.00)	3.00 (1.00-6.00)	.74
- BASDAI stiffness	3.00 (1.50-5.00)	4.00 (2.00-6.00)	3.00 (1.50-5.00)	.02
- on waking	4.00 (2.00-6.00)	4.50 (3.00-7.00)	3.00 (2.00-6.00)	.02
- duration	3.00 (1.00-4.00)	3.00 (1.00-5.00)	2.00 (1.00-4.00)	.03
JSEQ Total (All scales 1-6)	3.25 (2.00-4.50)	3.12 (2.25-4.34)	3.25 (2.00-4.50)	.66
- JSEQ falling asleep	2.00 (1.00-4.00)	2.00 (1.00-4.00)	2.00 (1.00-4.00)	.93

- JSEQ wake several times	4.00 (2.00-6.00)	4.00 (2.00-5.00)	4.00 (2.00-6.00)	.61
- JSEQ staying asleep	3.00 (2.00-5.00)	3.00 (2.00-5.00)	3.00 (2.00-5.00)	.44
- JSEQ wake up tired	3.00 (2.00-5.00)	5.00 (2.00-6.00)	3.00 (2.00-5.00)	.02
FACIT (0-42)	20.00 (12.00-30.00)	20.00 (12.00-32.00)	20.00 (12.00-29.50)	.82
BASMI (0-10) †	3.00 (1.60-5.20)	1.00 (0.40-1.60)	3.20 (1.80-5.40)	<.00001
BASFI (1 easy-100 impossible)	36.00 (17.00-58.00)	21.00 (10.00-47.00)	37.00 (18.00-59.00)	.002
ASQoL (0-36)	6.00 (2.00-11.00)	5.00 (2.75-12.00)	7.00 (2.00-11.00)	.81
Back pain (night 0-10)	3.00 (1.00-5.00)	3.00 (2.00-6.00)	3.00 (1.00-5.00)	.38
Back pain (any time 0-10)	3.00 (2.00-6.00)	4.00 (2.00-7.00)	3.00 (2.00-6.00)	.02
WPAI:SHP V1.0 Q2 (Work hours missed in the past 7 days.) ††	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	.38
WPAI:SHP V1.0 Q5 (Work productivity, 0 no effect – 10 could not work.) †††	2.00 (0.00-4.00)	2.00 (1.00-4.00)	2.00 (0.00-4.00)	.57
EQ5D: General health state (0 worst-100 best imaginable.)	66.00 (50.00-80.00)	71.00 (50.00-80.00)	65.00 (50.00-80.00)	.11
% EQ5D: Anxiety Depression: moderate-extreme	41	34.5	41.5	.37

Note: BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; JSEQ: Jenkins Sleep Evaluation Questionnaire; FACIT: Functional Assessment of Chronic Illness Therapy; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; ASQoL: Ankylosing Spondylitis Quality of Life; WPAI:SHP: Work Productivity and Activity Impairment Questionnaire: Specific Health Problem; EQ5D: EuroQol 5 dimension health status questionnaire. † n = 284 (nr-axSpA n = 262, AS n = 22). †† n = 350 (nr-axSpA

n = 45, AS n = 305). ††† n = 372 (nr-axSpA n = 45, AS n = 327). p (two tailed) values refer to Mann-Whitney tests for AS vs nr-axSpA or chi square for frequency comparisons of two-level categorical variables (gender: male, female; % inflammatory bowel disease, uveitis, psoriasis: present or not; EQ5D Anxiety depression: none, moderate-extreme) with JSEQ low/high categories. There were small variations in other sample sizes due to incomplete data.

Table 2

Comparison of patients with high and low Jenkins Sleep Evaluation Questionnaire (JSEQ) scores. Low JSEQ indicates problems on three days or fewer and high JSE on 15 days or more in the past month. BASDAI stiffness scores combine items 5 (stiffness on waking) and 6 (duration of stiffness). Scale values are medians (interquartile range) and frequency data are % unless otherwise stated.

Variables	Total n = 285	Low JSEQ n = 173	High JSEQ n = 112	p
% Male	74.4	80.9	64.3	.003
Diagnosis AS/nr-AxSpA	92.3/7.7	93.1/6.9	91.1/8.9	.70
Age (yrs)	50 (39-61)	49 (37.5-61.5)	52 (41-61)	.74
Years since diagnosis	16 (8-28)	16 (7-27)	17 (8-29)	.57
Age at diagnosis (yrs)	28 (23-38)	27.50 (23-38)	30.00 (23-38)	.87
Age at symptom onset (yrs)	21 (17-26.25)	21 (17-26)	25 (15-38)	.44
Years since symptom onset	25.50 (15.75-38)	20 (17-27)	26 (16-38.5)	.80
Delay in diagnosis (yrs)	6 (2-12)	5 (2-11)	7 (2.75-13)	.27
% Inflammatory bowel disease present	5.6	5.8	5.4	1.00
% Uveitis present	40.0	38.2	42.9	.50
% Psoriasis present	15.1	14.5	16.1	.84
BASDAI Total (All scales: 0-10)	3.50 (1.83-5.66)	2.50 (1.33-3.66)	5.50 (4.00-6.83)	<.0001
- BASDAI fatigue	5.00 (2.00-7.00)	3.00 (2.00-5.00)	7.00 (5.00-8.00)	<.0001
- BASDAI spinal pain	5.00 (2.00-7.00)	3.00 (2.00-5.00)	7.00 (5.00-8.00)	<.0001
- BASDAI arthralgia	3.00 (1.00-5.00)	2.00 (0.00-4.00)	5.00 (2.00-7.00)	<.0001
- BASDAI enthesitis	3.00 (1.00-6.00)	2.00 (0.00-4.00)	5.00 (2.00-7.00)	<.0001
- BASDAI stiffness	3.00 (1.50-5.50)	2.00 (1.00-3.50)	5.00 (3.00-7.00)	<.0001

- on waking	3.00 (2.00-6.00)	2.00 (1.00-4.00)	5.00 (3.00-8.00)	<.0001
- duration	2.00 (1.00-4.00)	2.00 (1.00-3.00)	4.00 (2.00-6.00)	<.0001
FACIT (0-42)	17.00 (9.00-29.00)	11.50 (8.00-17.25)	30.00 (23.00-38.00)	<.0001
BASMI (0-10) †	3.00 (1.60-5.20)	3.00 (1.40-5.20)	2.70 (1.60-5.30)	.70
BASFI (1 easy - 100 impossible)	32.00 (15.00-57.25)	23.50 (10.00-41.00)	56.00 (32.50-76.00)	<.0001
ASQoL (0-36)	5.00 (1.00-11.00)	2.00 (0.00-6.00)	11.00 (8.00-15.00)	<.0001
Back pain (night 0-10)	3.00 (1.00-6.00)	2.00 (1.00-3.00)	6.00 (3.00-8.00)	<.0001
Back pain (any time 0-10)	3.00 (1.00-6.00)	2.00 (1.00-3.00)	6.00 (3.00-8.00)	<.0001
WPAI:SHP V1.0 Q2 (Work hours missed in the past 7 days.) ††	2.38 (0.00-0.00)	0.00 (0.00-0.00)	3.64 (0.00-2.25)	.007
WPAI:SHP V1.0 (Work productivity Q5, 0 no effect – 10 could not work.) †††	2.00 (0.00-4.00)	1.00 (0.00-2.00)	4.00 (2.00-6.00)	<.0001
EQ5D: General health state (0 worst-100 best imaginable.)	69.00 (50.00-80.00)	73.00 (57.75-85.00)	50.00 (39.75-70.00)	<.0001
% EQ5D: Anxiety Depression: moderate-extreme	38.6	21.2	65.5	<.0001

Note: BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; FACIT: Functional Assessment of Chronic Illness Therapy; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; ASQoL: Ankylosing Spondylitis Quality of Life; WPAI:SHP: Work Productivity and Activity Impairment Questionnaire: Specific Health Problem; EQ5D: EuroQol 5 dimension health status questionnaire† n = 205 (Low JESQ n = 133, High JESQ n = 72). †† n = 150 (Low JESQ n = 100, High JESQ n = 50). ††† n = 150 (Low JESQ n = 102, High JESQ n = 48). p (two tailed) values refer to Mann-Whitney tests for high vs low JSEQ or chi square for frequency comparisons of two-level categorical variables (gender: male, female; inflammatory

bowel disease, uveitis, psoriasis: present or not; EQ5D Anxiety depression: none, moderate-extreme) with JSEQ low/high categories. There were small variations in other sample sizes due to incomplete data.

Table 3

Logistic regression predicting the likelihood of high Jenkins Sleep Evaluation Questionnaire (JSEQ) scores. Low JSEQ indicates problems on three days or fewer and high JSEQ on 15 days or more in the past month.

Variables	B	Standard Error	OR	95% CI	p
Gender	1.20	0.51	3.13	1.16-8.43	.02
BASMI	-0.32	0.11	0.73	0.58-0.91	.005
BASDAI fatigue	0.78	0.14	2.17	1.64-2.87	<.00001
BASDAI spinal pain	0.46	0.14	1.58	1.19-2.09	.001
BASDAI arthralgia	0.07	0.11	1.08	0.88-1.32	.49
BASDAI enthesitis	-0.04	0.13	0.96	0.75-1.23	.77
BASDAI stiffness on waking	-0.54	0.19	0.59	0.40-0.85	.005
BASDAI stiffness duration	0.69	0.18	1.99	1.40-2.83	.0001
EQ5D: Anxiety Depression: none/moderate-extreme	1.97	0.48	7.18	2.81-18.33	.00004

Note: BASMI: Bath Ankylosing Spondylitis Metrology Index; BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; EQ5D: EuroQol 5 dimension health status questionnaire. N = 272.