RMD Open
Rheumatic & Musculoskeletal Diseases

ORIGINAL RESEARCH

Improved physical functioning, sleep, work productivity and overall health-related quality of life with bimekizumab in patients with axial spondyloarthritis: results from two phase 3 studies

Maureen Dubreuil,[1] Victoria Navarro-Compán ,[2] Annelies Boonen ,[3,4] Karl Gaffney ,[5] Lianne S Gensler,[6] Christine de la Loge,[7] Thomas Vaux,[8] Carmen Fleurinck,[7] Ute Massow,[9] Vanessa Taieb,[10] Michael F Mørup,[11] Atul Deodhar,[12] Martin Rudwaleit [13]

To cite: Dubreuil M, Navarro-Compán V, Boonen A, *et al*. Improved physical functioning, sleep, work productivity and overall health-related quality of life with bimekizumab in patients with axial spondyloarthritis: results from two phase 3 studies. *RMD Open* 2024;**10**:e004202. doi:10.1136/rmdopen-2024-004202

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/rmdopen-2024-004202).

Received 8 February 2024
Accepted 8 May 2024

For numbered affiliations see end of article.

Correspondence to
Dr Maureen Dubreuil; mdubreui@bu.edu

ABSTRACT

Objective To assess the impact of bimekizumab on physical functioning, sleep, work productivity and overall health-related quality of life (HRQoL) in patients with non-radiographic (nr-) and radiographic (r-) axial spondyloarthritis (axSpA) in the phase 3 studies BE MOBILE 1 and 2.

Methods Patients were randomised to subcutaneous bimekizumab 160 mg or placebo every 4 weeks; from Week 16, all patients received bimekizumab 160 mg every 4 weeks. We report the following outcomes to Week 52: Bath Ankylosing Spondylitis Functional Index (BASFI), Medical Outcomes Study Sleep Scale Revised (MOS-Sleep-R) Index II, Work Productivity and Activity Impairment: axSpA (WPAI:axSpA), Short Form-36 Physical and Mental Component Summary (SF-36 PCS/MCS) and Ankylosing Spondylitis Quality of Life (ASQoL).

Results At Week 16, bimekizumab-randomised patients demonstrated significantly greater improvement from baseline versus placebo in BASFI, SF-36 PCS and ASQoL ($p<0.001$), and numerically greater improvements in MOS-Sleep-R Index II and WPAI:axSpA scores. Higher proportions of bimekizumab-randomised versus placebo-randomised patients at Week 16 achieved increasingly stringent thresholds for improvements in BASFI (0 to ≤4), and thresholds for meaningful improvements in SF-36 PCS (≥5-point increase from baseline) and ASQoL (≥4-point decrease from baseline). Responses were sustained or further improved to Week 52, where 60%–70% of bimekizumab-treated patients achieved BASFI ≤4 and meaningful improvements in SF-36 PCS and ASQoL, regardless of whether originally randomised to bimekizumab or placebo.

Conclusion Bimekizumab treatment led to early improvements in physical function, sleep, work productivity and overall HRQoL at Week 16 in patients across the full axSpA disease spectrum. Improvements were sustained to Week 52.

Trial registration numbers NCT03928704; NCT03928743.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Patients with axial spondyloarthritis (axSpA) experience impaired physical function, greater sleep disturbance, restrictions in paid and unpaid work productivity, and consequently diminished health-related quality of life.

⇒ Bimekizumab is a humanised monoclonal IgG1 antibody that selectively inhibits interleukin (IL)-17F in addition to IL-17A, which has demonstrated sustained efficacy and safety for up to 52 weeks in patients with axSpA.

WHAT THIS STUDY ADDS

⇒ At Week 16, bimekizumab demonstrated significantly greater improvement from baseline versus placebo in outcomes measuring physical function and health-related quality of life, with a greater proportion of bimekizumab-randomised patients also achieving thresholds for improvements in these outcomes. Numerically greater improvements in bimekizumab- versus placebo-randomised patients were also reported in outcomes measuring sleep disturbance and work productivity. These responses were sustained or further improved to Week 52.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Together with previously published efficacy and safety data, these results support the long-term efficacy of bimekizumab in improving clinical outcomes and alleviating the impact of axSpA on patients' lives.

INTRODUCTION

Axial spondyloarthritis (axSpA) is a chronic inflammatory rheumatic disease affecting the axial skeleton that encompasses patients with definitive structural damage of the sacroiliac

joints on pelvic radiographs (radiographic (r-)axSpA, ie, ankylosing spondylitis) and those without definitive radiographic damage (non-radiographic (nr-)axSpA).[1–3]

The disease is characterised by chronic back pain, morning stiffness, fatigue and a range of peripheral manifestations (arthritis, enthesitis, dactylitis) and extra-musculoskeletal manifestations (inflammatory bowel disease, psoriasis and uveitis) which greatly contribute to the overall disease burden.[2 4] Due to these signs and symptoms, patients with axSpA experience impaired physical function, poorer sleep quality, restrictions in paid and unpaid work productivity, and consequently diminished health-related quality of life (HRQoL).[2 4–6]

The primary treatment goal for axSpA is to maximise long-term HRQoL outcomes in patients, which can be achieved by targeting aspects of the disease that ultimately affect HRQoL.[7] Current medication classes for axSpA consist of non-steroidal anti-inflammatory drugs (NSAIDs) and biological and targeted synthetic disease-modifying antirheumatic drugs, specifically tumour necrosis factor inhibitors (TNFi), interleukin (IL)-17 inhibitors and, more recently, Janus kinase inhibitors (in certain countries).[8 9] However, treatment response rates can be suboptimal. For example, a real-world evidence study of over 500 patients receiving TNFis found that levels of pain and fatigue remained high after treatment, which was significantly associated with reduced HRQoL and work productivity.[10]

Bimekizumab is a humanised monoclonal IgG1 antibody that selectively inhibits IL-17F in addition to IL-17A, cytokines that have been implicated in the pathogenesis of axSpA.[11 12] Bimekizumab has demonstrated sustained efficacy and was well tolerated up to 52 weeks in patients with nr-axSpA and r-axSpA in the parallel phase 3 studies BE MOBILE 1 (NCT03928704) and BE MOBILE 2 (NCT03928743), and up to 5 years in patients with r-axSpA in the phase 2b trial BE AGILE (NCT02963506) and its open-label extension (NCT03355573).[13 14]

Here, we report the impact of treatment with bimekizumab on different aspects of patient functioning, including physical function, sleep disturbance, work productivity and overall HRQoL over one year in patients with nr-axSpA and r-axSpA in the BE MOBILE 1 and BE MOBILE 2 studies.

A graphical plain language summary of study results is provided in figure 1.

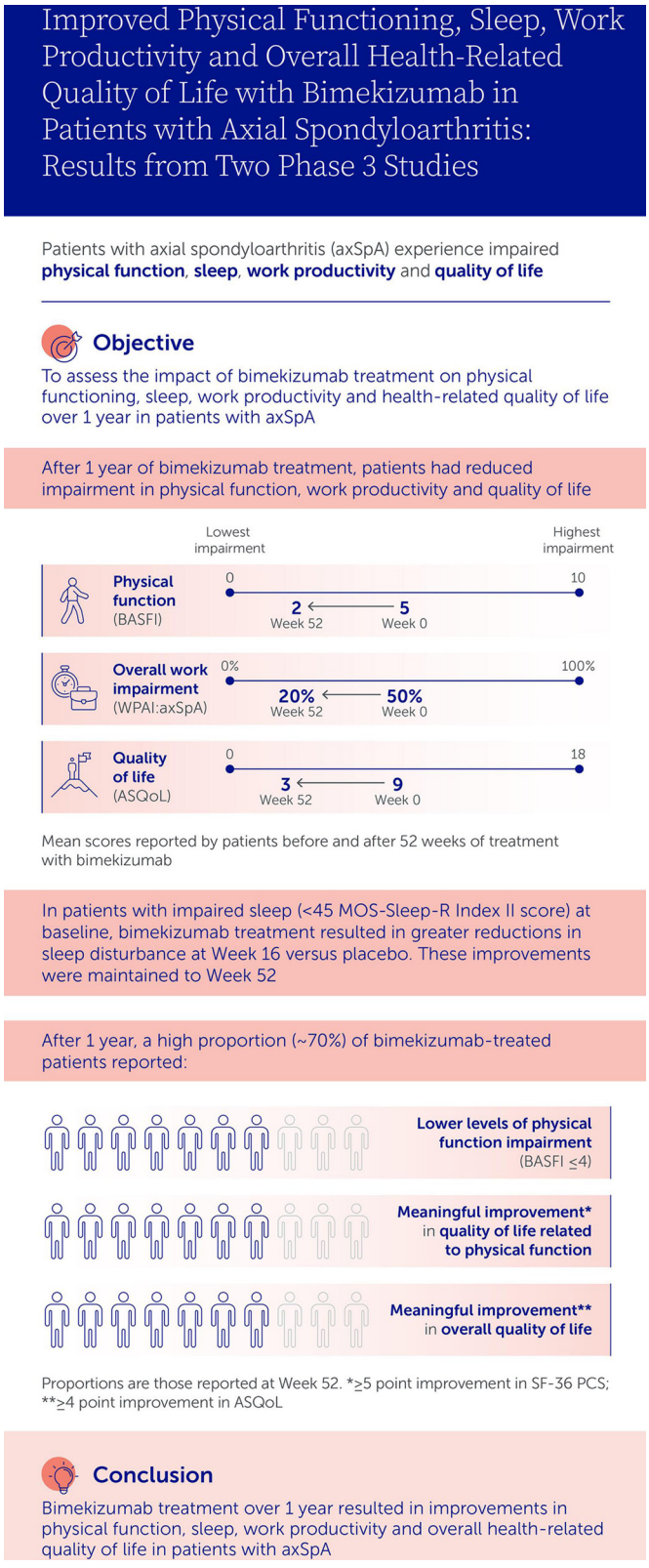

Figure 1 Graphical plain language summary. AS, ankylosing spondylitis; ASQoL, AS Quality of Life; BASFI, Bath AS Functional Index; MOS-Sleep R, Medical Outcomes Study Sleep Scale Revised; SF-36 PCS, Short Form-36 Physical Component Summary; WPAI:axSpA, Work Productivity and Activity Impairment: axSpA.

METHODS

Study design and patients

In both studies, patients were randomised to subcutaneous bimekizumab 160 mg or placebo every 4 weeks (Q4W); from Week 16 to 52, all patients received bimekizumab 160 mg every 4 weeks. The full study design and inclusion and exclusion criteria for BE

MOBILE 1 and BE MOBILE 2 have been described previously (online supplemental figure S1).[15]

Patients in BE MOBILE 1 had a clinical diagnosis of nr-axSpA and fulfilled Assessment of SpondyloArthritis international Society (ASAS) classification criteria.[15 16] At screening, patients were also required to display signs of objective inflammation, defined by active sacroiliitis on MRI fulfilling ASAS criteria and/or elevated C-reactive protein levels ≥6.0 mg/L.[15] In BE MOBILE 2, patients had a clinical diagnosis of r-axSpA and fulfilled the modified New York criteria.[15 17] All patients in BE MOBILE 2 also fulfilled the ASAS classification criteria. Patients in both studies were also required to have prior failure of ≥2 NSAIDs, or a history of intolerance or contraindication to NSAIDs. In addition, all patients had active nr-axSpA and r-axSpA at baseline (total Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score ≥4 and spinal pain (BASDAI Item 2) score ≥4).

Patients from both studies were excluded if they had received >1 TNFi, >2 additional biological response modifiers or any IL-17 response modifier.[15] In alignment with standard clinical trial safety procedures, patients were excluded if they demonstrated active suicidal ideation or positive suicide behaviour at baseline, as determined by the electronic Columbia-Suicide Severity Rating Scale.[18] Patients with moderately severe or severe major depression, as indicated by a score ≥15 using the Screening Patient Health Questionnaire-9, were also excluded.[19]

Outcomes

Patient-reported outcomes (PROs) assessing how patients with axSpA feel and function are increasingly being used in clinical trials, with several instruments recently being endorsed for use in axSpA by the ASAS Outcomes Measures in Rheumatology (OMERACT) working group.[20] In addition to traditional clinical outcomes, PROs can help provide a more comprehensive and patient-focused understanding of treatment efficacy.[21] Several established PRO instruments were used in BE MOBILE 1 and 2 to assess symptom severity and the life impact of bimekizumab, specifically on different aspects of patient functioning and overall HRQoL.[6]

Physical function

Physical function was assessed using the Bath Ankylosing Spondylitis Functional Index (BASFI), which assesses functional anatomical limitations and ability to perform everyday activities and has a range of 0–10, with lower scores indicating better physical function. This was assessed at baseline and Weeks 1, 2, 4, 8, 12, 16, 24, 36 and 52.

Sleep disturbance

Sleep disturbance was measured using the Medical Outcomes Study Sleep Scale Revised (MOS-Sleep-R). The Index II score is generated from nine items related to sleep problems. A T-score of 50 and SD of 10 reflect the United States (US) population mean, with a higher score reflecting less sleep disturbance.[22] At a patient level, scores within ±0.5 SD (ie, 45–55) can be considered average (compared with the US general population) for an individual respondent. At a group level, mean scores within ±0.3 SD (ie, 47–53) can be considered average (compared to the US general population).[23] MOS-Sleep-R Index II score was assessed at baseline and Weeks 8, 16, 24, 36 and 52.

Work productivity

Impact on work productivity was assessed using the Work Productivity and Activity Impairment: axSpA (WPAI:axSpA) questionnaire, specifically the subdomains of work time missed (ie, absenteeism), impairment while working (ie, presenteeism) and overall work impairment (the sum of absenteeism and presenteeism) which were all assessed in employed patients, and activity impairment attributable to axSpA which was assessed in all patients. These domains are expressed as a percentage (0–100%), where a higher percentage indicates greater impairment in work productivity.[24 25] Values were collected at baseline and Weeks 16, 24, 36 and 52.

Health-related quality of life

Overall HRQoL was assessed using the generic Short Form-36 (SF-36) questionnaire. The SF-36 Physical Component Summary (SF-36 PCS) and Mental Component Summary (SF-36 MCS) scores synthesise the impact of each SF-36 domain on physical and mental health, respectively. A T-score of 50 and SD of 10 reflects the US population mean.[26] At a patient level, scores within ±0.5 SD (ie, 45–55) can be considered average (compared to the US general population) for an individual respondent. At a group level, mean scores within ±0.3 SD (ie, 47–53) can be considered average (compared to the US general population).[26] SF-36 MCS and PCS scores were assessed at baseline and Weeks 8, 16, 24, 36 and 52.

A ≥5 point increase from baseline has been established as a meaningful improvement in SF-36 score and was used to define SF-36 PCS responders. This was selected as a pragmatic and conservative threshold to define responders, as it corresponds to a medium effect size (an effect size (the mean change divided by the baseline SD) of 0.5 in the general US population) and is larger (ie, more conservative) than the 3.8 and 4.6 reliable change index values proposed by the developer for the PCS and MCS, respectively.[26] Additionally, an increase in score of 2.5–5 points has been previously suggested as the minimum clinically important difference in SF-36 PCS and MCS for patients with rheumatoid arthritis.[27]

Disease-specific HRQoL was also assessed using a disease-specific instrument, the Ankylosing Spondylitis Quality of Life (ASQoL) questionnaire. ASQoL is an 18-item questionnaire assessing the impact of axSpA on patient HRQoL, where a score of '1' is given for each

item if a patient responds 'yes' and '0' if the response is 'no'. The ASQoL score is obtained by summing each score and ranges from 0 to 18, with higher scores indicating worse HRQoL.[28] This was assessed at baseline and Weeks 8, 12, 16, 24, 36 and 52. A reduction of 4 points or more has been established as a meaningful improvement in ASQoL.[29]

Statistical analyses

A full description of the statistical analyses used in BE MOBILE 1 and 2 has been reported previously.[15]

Here, we report mean scores and mean change from baseline in the above PROs in bimekizumab-randomised versus placebo-randomised patients to Week 52. Mean change from baseline in MOS-Sleep-R Index II and SF-36 MCS scores are also reported among patients with a baseline score <45 (considered below average compared with the average US population for an individual respondent). This analysis was conducted with data pooled across the two studies to allow for an adequate number of patients with impaired scores at baseline to be included.

In addition, we report to Week 52 the proportion of patients achieving low BASFI scores, using different cut-offs from most to least stringent (=0/≤1/≤2/≤3/≤4), the proportion of patients achieving established thresholds for a meaningful improvement in SF-36 PCS (≥5-point increase from baseline) and in ASQoL (≥4-point decrease from baseline), as well as the proportions of patients achieving ASQoL=0. The proportion of patients providing 'yes' (ie, impaired) responses to individual items of the ASQoL questionnaire is also reported at baseline and Weeks 4, 8, 12, 16, 24, 26 and 52 in patients randomised to bimekizumab who received bimekizumab continuously through 52 weeks.

Missing data were imputed with multiple imputation for all continuous outcomes except for WPAI:axSpA outcome data, which are reported as observed case due to the variability of employment throughout the study and the nature of the WPAI questionnaire not allowing for independent imputation. For outcomes which assessed the proportion of patients achieving established thresholds, missing data were treated as non-response. The proportion of patients affirming different items of the ASQoL questionnaire is reported as observed.

P values for differences between bimekizumab-randomised and placebo-randomised patients were calculated at Week 16 using an analysis of covariance model for change from baseline in BASFI, MOS-Sleep-R Index II, WPAI:axSpA, SF-36 and ASQoL scores. BASFI, SF-36 PCS and ASQoL were key secondary endpoints of the BE MOBILE studies. These endpoints were part of the hierarchical testing and were controlled for multiplicity. Changes from baseline in MOS-Sleep-R II index, WPAI:axSpA and SF-36 MCS scores were not key secondary endpoints of the BE MOBILE studies at Week 16, and so p values reported for these outcomes are considered nominal and are not controlled for multiplicity. Statistical comparisons were not carried out for proportions of patients achieving different thresholds of response, or the proportion of patients affirming individual items of the ASQoL questionnaire.

RESULTS

Baseline demographics and patient characteristics

In BE MOBILE 1 and BE MOBILE 2, 220/254 (86.6%) and 298/332 (89.8%) randomised patients completed treatment to Week 52, respectively. Baseline demographics and disease characteristics were generally comparable between treatment groups and reflected the wider axSpA population with active disease, wherein patients demonstrated high levels of disease activity, pain and stiffness (table 1).[30] A higher proportion of bimekizumab-randomised patients in BE MOBILE 2 had prior TNFi exposure (16.7%) compared with bimekizumab-randomised patients in BE MOBILE 1 (7.8%).

Baseline BASFI, SF-36 PCS and ASQoL scores indicated impaired physical function and HRQoL and were comparable between treatment groups and across studies. Mean baseline MOS-Sleep-Index II scores were slightly impaired.[22] SF-36 MCS scores across the two treatment arms indicated no decrement in mental health compared with US general population norms.[26]

Almost 75% of patients were employed at baseline, with similar proportions among bimekizumab versus placebo-randomised patients (nr-axSpA: 95/128 (74.2%), vs 93/126 (73.8%); r-axSpA: 161/221 (72.9%) vs 82/111 (73.9%)). Patients in both studies presented with around 50% mean impairments in the WPAI:axSpA subdomains of presenteeism, overall work impairment and activity impairment at baseline. Mean baseline absenteeism was lower at 10.9%–12.8% across treatment groups and studies.

Physical function

Bimekizumab-randomised patients achieved lower mean BASFI scores at Week 16 versus placebo-randomised patients, indicating less physical function impairment (figure 2). This corresponded to a greater mean change from baseline with bimekizumab versus placebo (nr-axSpA: −2.5 vs −1.0; r-axSpA: −2.2 vs −1.1 (both p<0.001)). The improvements were sustained from Week 16 to Week 52.

At baseline, most patients had a BASFI score >4, with a similar proportion among bimekizumab versus placebo-randomised patients (nr-axSpA: 76.6% vs 70.6%; r-axSpA: 75.6% vs 73.0%). By Week 16, a higher proportion of bimekizumab versus placebo-randomised patients achieved low BASFI score thresholds (figure 3). For example, over 40% of bimekizumab-randomised patients achieved BASFI ≤2 across both studies while only around 25% of

Table 1 Patient demographics and baseline characteristics

	BE MOBILE 1 (nr-axSpA)		BE MOBILE 2 (r-axSpA)	
	PBO n=126	BKZ 160 mg Q4W n=128	PBO n=111	BKZ 160 mg Q4W n=221
Sex, male, n (%)	65 (51.6)	73 (57.0)	80 (72.1)	160 (72.4)
Age, years, mean (SD)	39.4 (11.8)	39.5 (11.1)	39.2 (12.6)	41.0 (12.1)
Time since first symptoms of axSpA, years, mean (SD)	9.0 (9.0)	9.1 (8.7)	11.9 (8.6)	14.2 (11.0)
HLA-B27 positive, n (%)	94 (74.6)	103 (80.5)	93 (83.8)	191 (86.4)
BMI, kg/m^2, mean (SD)	27.7 (5.5)	27.2 (6.0)	27.1 (5.8)	26.8 (5.7)
Geographical region,* n (%)				
Asia†	13 (10.3)	15 (11.7)	21 (18.9)	40 (18.1)
Eastern Europe‡	71 (56.3)	73 (57.0)	55 (49.5)	108 (48.9)
Western Europe§	33 (26.2)	31 (24.2)	32 (28.8)	67 (30.3)
North America¶	9 (7.1)	9 (7.0)	3 (2.7)	6 (2.7)
Prior TNFi exposure,** n (%)	17 (13.5)	10 (7.8)	17 (15.3)	37 (16.7)
ASDAS, mean (SD)	3.7 (0.7)	3.7 (0.8)	3.7 (0.8)	3.7 (0.8)††
hs-CRP, mg/L, geometric mean (geometric CV, %)	5.0 (230.5)	4.6 (297.7)	6.7 (197.4)	6.5 (275.0)
BASDAI, mean (SD)	6.7 (1.3)	6.9 (1.2)	6.5 (1.3)	6.5 (1.3)
BASFI, mean (SD)	5.3 (2.3)	5.5 (2.2)	5.2 (2.0)	5.3 (2.2)
SF-36 PCS, mean (SD)	33.6 (8.7)	33.3 (8.3)	34.6 (8.7)	34.3 (8.4)††
SF-36 MCS, mean (SD)	51.9 (9.0)	51.3 (10.2)	51.9 (9.2)	50.8 (9.2)††
ASQoL, mean (SD)	9.4 (4.4)	9.5 (4.6)	8.5 (4.3)	9.0 (4.7)
MOS-Sleep-R Index II, mean (SD)	43.5 (9.3)	42.7 (8.7)	44.9 (9.0)	43.9 (9.5)
Employed, n (%)	93 (73.8)	95 (74.2)	82 (73.9)	161 (72.9)
WPAI:axSpA, mean (SD)				
% absenteeism	11.6 (26.7)‡‡	12.8 (25.0)§§	10.9 (26.9)¶¶	11.6 (23.7)***
% presenteeism	47.1 (20.9)†††	49.2 (25.1)‡‡‡	42.3 (23.4)§§§	46.1 (24.9)¶¶¶
% overall work impairment	49.1 (21.5)†††	52.2 (26.6)‡‡‡	43.9 (24.5)§§§	49.2 (25.6)¶¶¶
% activity impairment	54.4 (21.7)	57.3 (22.9)	54.1 (24.2)	53.1 (23.5)

Randomised set. Patients in BE MOBILE 1 met ASAS criteria and patients in BE MOBILE 2 met modified New York and ASAS criteria.
*Patients were categorised by the stratum to which they were randomised.
†Includes Turkey, Japan and China.
‡Includes Bulgaria, Czech Republic, Hungary and Poland.
§Includes Belgium, France, Germany, Netherlands, Spain and UK.
¶United States of America only.
**Defined as patients who were intolerant or experienced an inadequate response to previous TNFi treatment given at an approved dose for at least 12 weeks.
††n=220.
‡‡n=93.
§§n=95.
¶¶n=82.
***n=160.
†††n=84.
‡‡‡n=86.
§§§n=74.
¶¶¶n=149.
AS, ankylosing spondylitis; ASAS, Assessment of SpondyloArthritis international Society; ASDAS, Axial Spondyloarthritis Disease Activity Score; ASQoL, AS Quality of Life; axSpA, axial spondyloarthritis; BASDAI, Bath AS Disease Activity Index; BASFI, Bath AS Functional Index; BKZ, bimekizumab; BMI, body mass index; CV, coefficient of variation; HLA-B27, human leucocyte antigen-B27; MOS-Sleep R, Medical Outcomes Study Sleep Scale Revised; n, number; nr-axSpA, non-radiographic axSpA; PBO, placebo; Q4W, every four weeks; r-axSpA, radiographic axSpA; SD, standard deviation; SF-36 MCS, Short Form-36 Mental Component Summary; SF-36 PCS, Short Form-36 Physical Component Summary; TNFi, tumour necrosis factor inhibitor; WPAI:axSpA, Work Productivity and Activity Impairment axSpA.

placebo-randomised patients achieved the same threshold. The proportion of patients achieving low BASFI thresholds was maintained or improved to Week 52 with bimekizumab treatment, with around 45% of bimekizumab-randomised patients and patients switching from placebo to bimekizumab achieving BASFI ≤2 across both studies.

Sleep disturbance

In patients with nr-axSpA, at Week 16 bimekizumab-randomised patients achieved greater mean scores versus placebo-randomised patients, indicating reduced sleep disturbance (figure 2). This corresponded to a greater mean change from baseline with bimekizumab versus placebo (5.9 vs 3.1; nominal p=0.005). No clear separation between treatment groups was seen for r-axSpA patients at the same time point (5.6 vs 4.6; nominal p=0.417). The mean MOS-Sleep-R Index II score in all patients continued to improve to Week 52 in both studies, with the mean score of patients who switched from placebo

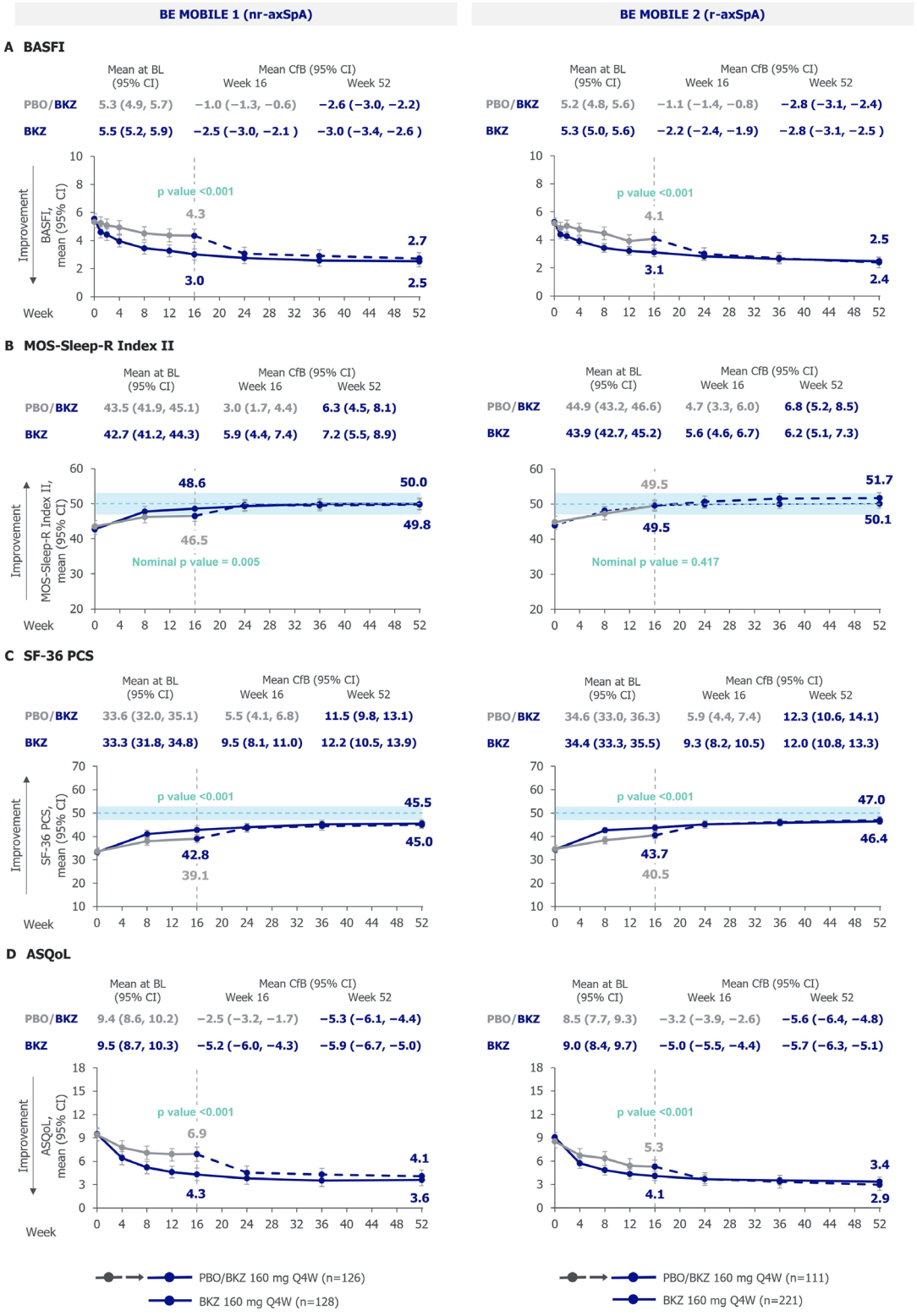

Figure 2 Mean BASFI, MOS-Sleep-R Index II, SF-36 PCS and ASQoL scores through Week 52. Randomised set. Missing values imputed using multiple imputation. Error bars represent 95% CI. P values calculated at Week 16 for BASFI, SF-36 PCS and ASQoL were part of a hierarchical gatekeeping strategy and used reference-based multiple imputation. P values without any multiplicity adjustment are indicated as nominal p values and should not be used as an indication of statistical significance. For SF-36 PCS and MOS-Sleep R Index II, group-level mean scores between 47 and 53 (represented by the blue shaded area) can be considered within the 'average' or 'normal' range for the US general population. Range of possible values for BASFI: 0–10; range of possible values for ASQoL: 0–18. ASQoL, Ankylosing Spondylitis Quality of Life; BASFI, Bath Ankylosing Spondylitis Functional Index; BKZ, bimekizumab; CfB, change from baseline; MOS-Sleep R, Medical Outcomes Study Sleep Scale Revised; n, number; nr-axSpA, non-radiographic axial spondyloarthritis; PBO, placebo; Q4W, every 4 weeks; r-axSpA, radiographic axial spondyloarthritis; SF-36 PCS, Short Form-36 Physical Component Summary; US, United States.

to bimekizumab approaching that of bimekizumab-randomised patients.

In a pooled analysis of patients with impaired MOS-Sleep-R Index II scores at baseline (<45) from BE MOBILE 1 and 2 (bimekizumab: n=204; placebo: n=131), bimekizumab-randomised patients achieved nominally greater mean change from baseline (95% confidence interval, CI) in MOS-Sleep-R Index II scores at Week 16 versus placebo-randomised patients (8.4 (7.3, 9.6) vs 6.4 (5.0, 7.7); nominal p=0.0332).

Work productivity

At Week 16, among patients who were employed at baseline, bimekizumab-randomised patients (nr-axSpA: n=95; r-axSpA: n=161) demonstrated greater improvements from baseline versus placebo-randomised patients (nr-axSpA: n=93; r-axSpA: n=82) in the WPAI:axSpA subdomain of presenteeism (nr-axSpA: –24.5% vs –14.1%, nominal p=0.003; r-axSpA: –20.8% vs –6.1%, nominal p<0.001; figure 4). Similar results were observed for overall work impairment (nr-axSpA: –26.5% vs –14.1%, nominal p=0.001; r-axSpA: –22.2% vs –6.7%, nominal p<0.001) and for activity impairment (nr-axSpA: –24.3% vs –9.7%; r-axSpA: –23.3% vs –14.4%; both nominal p<0.001; figure 4), in bimekizumab-randomised versus placebo-randomised patients at Week 16. Improvements in these WPAI:axSpA subdomains were sustained or further improved to Week 52 with bimekizumab treatment, and responses in patients who switched from placebo to bimekizumab approached that of bimekizumab-randomised patients.

Absenteeism was low at baseline in employed patients across both studies. At Week 16, absenteeism in bimekizumab-randomised versus placebo-randomised patients demonstrated a slight numerical improvement from baseline without clear separation from placebo (nr-axSpA: –1.4% versus +2.8%, nominal p=0.461; r-axSpA: –5.5% vs –1.2%, nominal p=0.151). These improvements were sustained or improved at Week 52.

Health-related quality of life

At Week 16, bimekizumab-randomised patients achieved higher mean SF-36 PCS and lower mean ASQoL scores versud placebo-randomised patients, indicating better HRQoL (figure 2). This corresponded to greater mean change from baseline with bimekizumab versus placebo in SF-36 PCS scores (nr-axSpA: 9.5 vs 5.5; r-axSpA: 9.3; vs 5.9; both p<0.001)) and ASQoL scores (nr-axSpA: –5.2 vs –2.5; r-axSpA: –5.0 vs –3.2; both p<0.001). Scores were comparable at Week 52. SF-36 MCS scores remained high throughout 52 weeks without notable differences in mean scores at Week 16 between placebo and bimekizumab-randomised patients (nr-axSpA: nominal p=0.08 and r-axSpA: nominal p=0.8 for differences in change from baseline; online supplemental figure S2).

As a substantial proportion of the population did not have an impaired SF-36 MCS score at baseline, a separate analysis was conducted which focused on patients

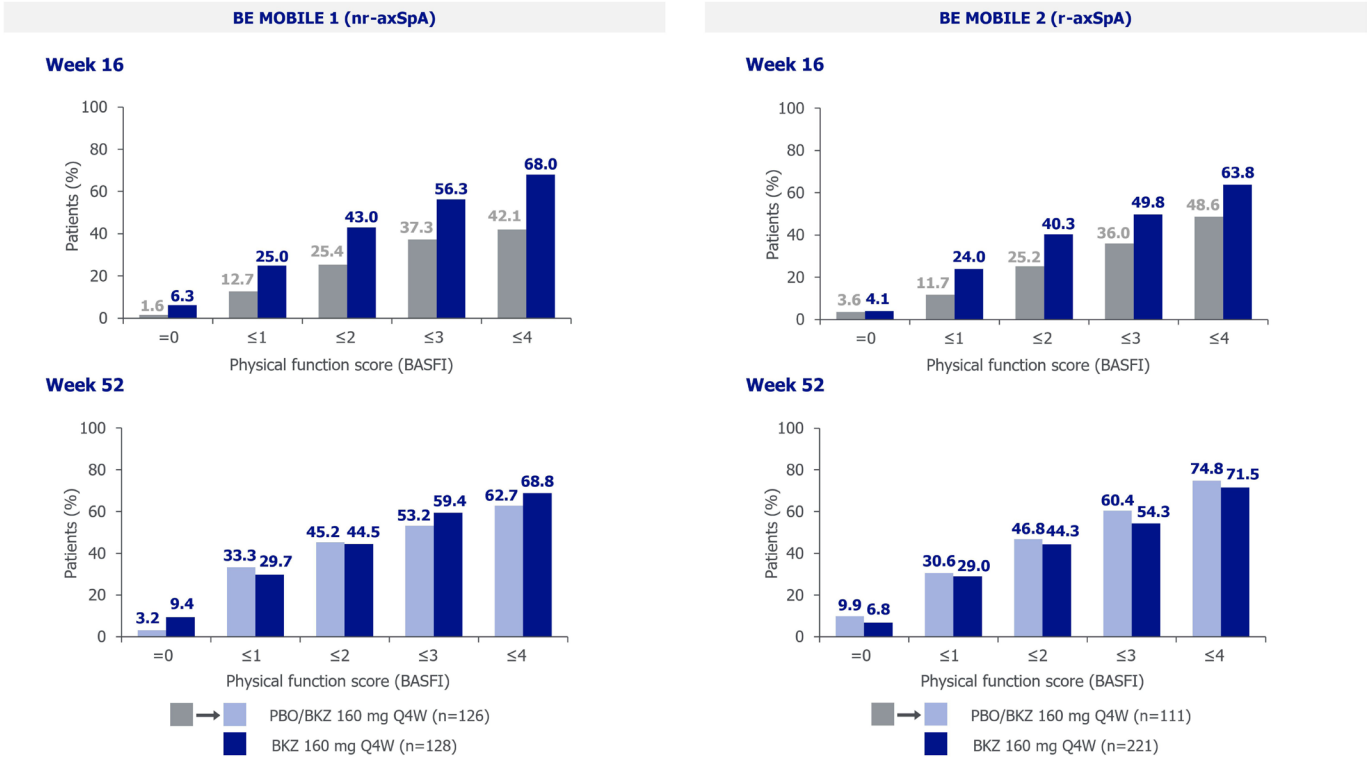

Figure 3 Proportion of patients achieving various thresholds (0 to ≤4) for low BASFI scores at Week 16 and Week 52. Randomised set. Missing data imputed using non-responder imputation. BASFI, Bath Ankylosing Spondylitis Functional Index; BKZ, bimekizumab; n, number; nr-axSpA, non-radiographic axial spondyloarthritis; PBO, placebo; Q4W, every 4 weeks; r-axSpA, radiographic axial spondyloarthritis.

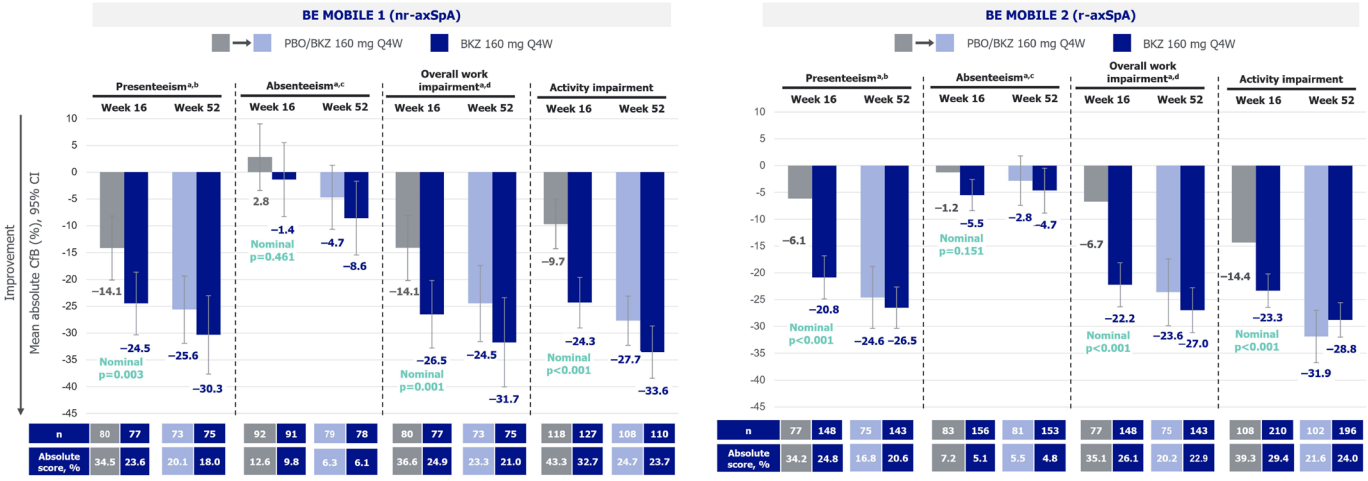

Figure 4 Change from baseline in work productivity (WPAI:axSpA) outcomes to Week 52. Randomised set. Data are reported as observed case. Error bars represent 95% CI. WPAI:axSpA item scores are expressed as a percentage, with a greater reduction indicating greater improvement. Week 16 nominal p values are calculated using ANCOVA with baseline WPAI:axSpA item score as covariate and treatment, region and either MRI/CRP classification at baseline (nr-axSpA) or prior TNF inhibitor exposure (r-axSpA) as fixed effects. Week 16 nominal p values were not adjusted for multiplicity and should not be used as an indication of statistical significance. [a]Absenteeism, presenteeism and overall work impairment were assessed only in patients who were employed at baseline; [b]Impairment while at paid work due to axSpA; [c]Work time missed due to axSpA; [d]Overall work impairment is a composite of absenteeism and presenteeism. ANCOVA, analysis of covariance; axSpA, axial spondyloarthritis; BKZ, bimekizumab; CfB, change from baseline; CRP, C-reactive protein; MRI, magnetic resonance imaging; nr-axSpA, non-radiographic axSpA; PBO, placebo; Q4W, every 4 weeks; r-axSpA, radiographic axSpA; TNF, tumour necrosis factor; WPAI:axSpA, Work Productivity and Activity Impairment: axSpA.

with scores <45 at baseline, pooled across BE MOBILE 1 and 2 (bimekizumab: n=51; placebo: n=83). This showed that bimekizumab-randomised patients with impaired SF-36 MCS at baseline achieved a nominally greater mean improvement (95% CI) in SF-36 MCS score versus placebo-randomised patients (9.1 (7.2, 11.0) vs 4.6 (2.0, 7.2); nominal p=0.0178).

The proportion of bimekizumab-randomised patients achieving a ≥5-point increase in SF-36 PCS at Week 16 was greater compared with placebo-randomised patients (nr-axSpA: 64.8% vs 41.3%; r-axSpA: 63.8% vs 49.5%; figure 5). The proportion of patients achieving this response was maintained or further improved with bimekizumab treatment, and at Week 52 proportions of patients achieving a ≥5-point increase in SF-36 PCS were comparable among bimekizumab-randomised patients versus patients switching from placebo to bimekizumab at Week 16 (nr-axSpA: 65.6% vs 64.3%; r-axSpA: 69.7% vs 68.5%).

A greater proportion of bimekizumab-randomised versus placebo-randomised patients across both studies also achieved an ≥4-point decrease in ASQoL from baseline at Week 16 (nr-axSpA: 67.6% vs 37.8%; r-axSpA: 66.1% vs 55.6%; figure 5). The proportion of patients achieving this level of response was sustained or further improved to Week 52 with bimekizumab treatment and was comparable among treatment groups at Week 52 (nr-axSpA: 64.9% vs 60.4%; r-axSpA: 69.8% vs 67.8%). Similar trends were observed in the proportions of patients achieving ASQoL=0 at Week 16 (nr-axSpA: 28.9% vs 10.3%; r-axSpA: 24.9% vs 16.2%) and Week 52 (nr-axSpA: 32.8% vs 26.2%; r-axSpA: 34.8% vs 41.4%).

Finally, among bimekizumab-randomised patients across both studies, over two-thirds of patients responded 'yes' at baseline to ASQoL items 4 ('I struggle to do jobs around the house'), 8 ('I keep stopping to rest'), 10 ('it takes a long time to get going in the morning'), 12 ('I get tired easily') and 14 ('the pain is always there'). At Week 52, the proportion of patients responding 'yes' reduced by over 50% for most ASQoL items (figure 6).

DISCUSSION

The primary treatment goal in axSpA is to maximise long-term HRQoL outcomes in patients by controlling inflammation and preserving function and social participation. Given this, assessing outcomes related to the impact of the disease on patients' lives, in addition to traditional clinical outcomes, provides a more comprehensive understanding of the efficacy of novel treatments, especially in the long term.[7]

This study assessed the long-term (1-year) impacts of subcutaneous bimekizumab on patient functioning and HRQoL outcomes across the full disease spectrum of axSpA. Improvements in physical functioning and overall HRQoL were substantially greater in bimekizumab-randomised patients versus placebo at Week 16, which were sustained or improved with bimekizumab treatment to Week 52. In addition, increasingly large proportions of bimekizumab-randomised versus placebo-randomised patients achieved

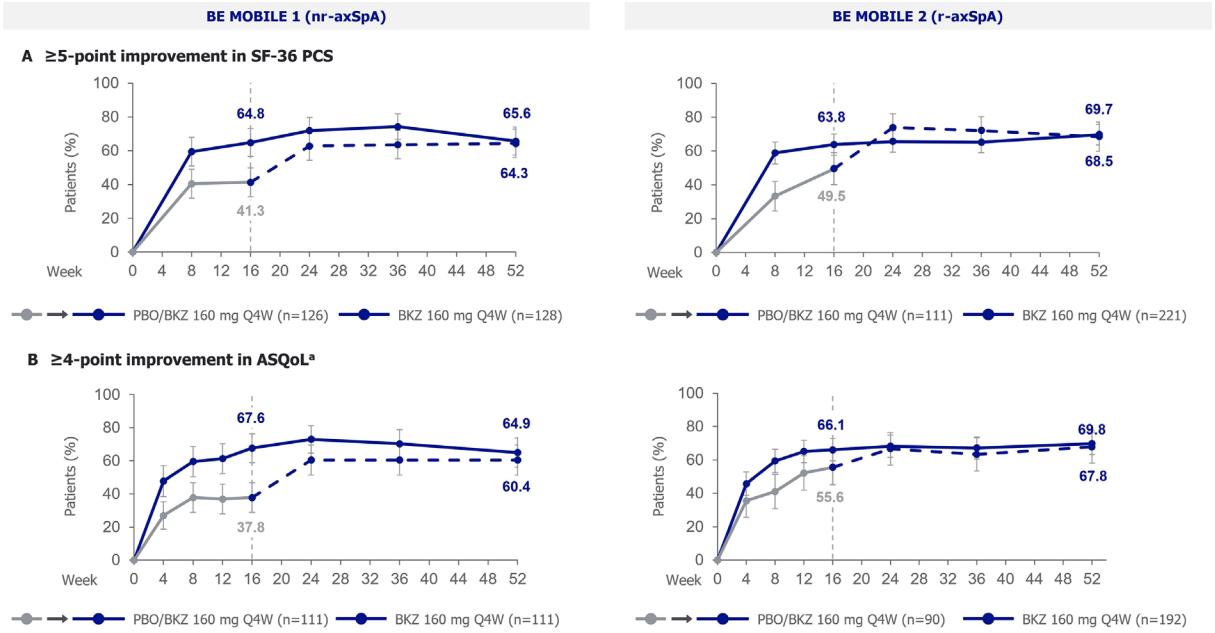

Figure 5 Proportion of patients achieving thresholds for meaningful improvement in SF-36 PCS and ASQoL through Week 52. Randomised set. Error bars represent 95% CI. [a]Among patients with ASQoL≥4. Missing data imputed using non-responder imputation. ASQoL, Ankylosing Spondylitis Quality of Life; BKZ, bimekizumab; CI, confidence interval; n, number; nr-axSpA, non-radiographic axial spondyloarthritis; PBO, placebo; Q4W, every 4 weeks; r-axSpA, radiographic axial spondyloarthritis; SF-36 PCS, Short Form-36 Physical Component Summary.

thresholds indicating low disease impact on physical function and clinically meaningful improvements in overall HRQoL from the start of bimekizumab treatment to Week 16, which were sustained to Week 52. Large reductions in the proportion of patients affirming different ASQoL items were also observed among patients treated with bimekizumab to Week 52. Even for ASQoL items with the largest proportion of patients agreeing at Week 52, the reduction in proportion was substantial compared with baseline. For example, ~40% of patients with nr-axSpA and r-axSpA agreed with item 12 ('I get tired easily') at Week 52 compared with >70% at baseline.

Less marked improvements were observed for sleep disturbance and mental component scores, as measured by the MOS-Sleep-Index II and SF-36 MCS, respectively. This may be as, on average, MOS-Sleep-Index II score was only slightly impaired and SF-36 MCS score was not impaired when compared with US general population norms at baseline, indicating that these patients generally had little sleep disturbance and were not impacted psychologically.[22 26] The latter is likely due to the study selection criteria, as patients with moderate to severe depression were excluded from the study. Due to this, post-hoc pooled analyses among patients with impaired MOS-Sleep-Index II and SF-36 MCS scores at baseline were conducted. These showed bimekizumab-randomised patients achieved greater improvements in MOS-Sleep-Index II and SF-36 MCS scores versus placebo-randomised patients at Week 16.

With regard to work productivity, patients who were employed at baseline achieved substantial and sustained improvements with bimekizumab treatment in the WPAI:axSpA subdomains of work presenteeism and overall work impairment. Limited improvements in absenteeism were observed, likely due to the low frequency of absenteeism at baseline, leaving limited room for improvement. However, it has been frequently described that absenteeism contributes less to self-reported productivity loss in employed patients with axSpA compared to presenteeism.[25 31]

Overall, these results suggest that inhibition of IL-17F in addition to IL-17A with bimekizumab is associated with substantial improvements in patients' daily functioning, including work productivity as well as overall improved HRQoL. This is on top of the previously demonstrated efficacy of bimekizumab in reducing inflammation and clinical signs and symptoms of axSpA.[15] These results are significant for patients with axSpA, for whom there have been some reports of impairment persisting in these domains despite receiving treatment. For example, a large observational study in Germany found a high prevalence of negative workplace experiences among axSpA patients, which was found to be associated with impaired BASFI scores. Notably, this was not improved with biological treatment.[32] However, this lack of improvement is not the case in all studies, with one systematic literature review finding overall work productivity to be improved to a greater extent for axSpA patients who received biological treatment than placebo.[33]

In addition, a cross-sectional questionnaire of patients with axSpA and psoriatic arthritis found that, despite biologic treatment, a high proportion of patients had abnormal sleep behaviour which was associated with

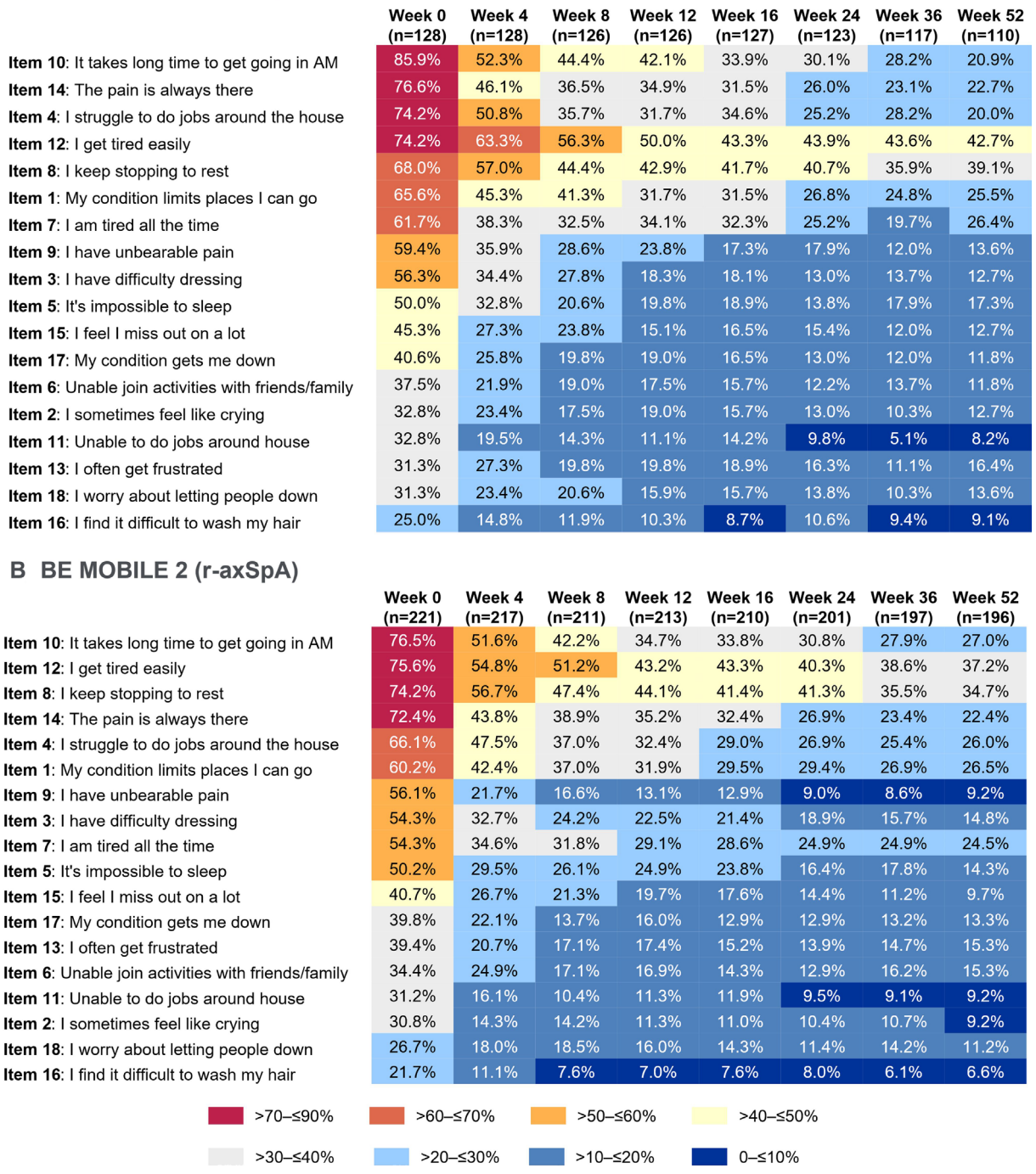

Figure 6 Proportion of bimekizumab-randomised patients responding 'yes' to individual ASQoL items. Randomised set, bimekizumab-randomised patients only. Data are reported as observed case. Items are ordered by decreasing percentage of patients reporting 'yes' at baseline. AM, morning; ASQoL, Ankylosing Spondylitis Quality of Life; BKZ, bimekizumab; n, number; nr-axSpA, non-radiographic axial spondyloarthritis; r-axSpA, radiographic axial spondyloarthritis.

impaired HRQoL and a higher rate of depressive symptoms. In fact, patients on biological therapy reported a shorter sleep duration than patients not receiving biological therapy.[34] Therefore, further research is needed to assess the effect of treatments on alleviating the impact of axSpA on patient physical function, sleep disturbance and work productivity, as this may remain an area of unmet need for patients.

Strengths and limitations

The parallel BE MOBILE 1 and BE MOBILE 2 studies had similar study designs which enabled the assessment of physical function, sleep, work productivity and HRQoL across the full disease spectrum of axSpA. The selected outcomes and study duration further enabled the assessment of the long-term (1-year) impact of bimekizumab treatment on outcomes that are most relevant to patients'

lives. This study presents specific findings, such as the individual items of ASQoL, which allows for better apprehension of the direct impact of treatment on specific features of the disease. Moreover, this study provides a deeper insight, beyond clinical response criteria, on the impact of axSpA on patient functioning and everyday life which may be of value to clinicians and to patients themselves.

While this study was able to use established meaningful within-patient improvement thresholds for SF-36 PCS and ASQoL,[26 29] equivalent thresholds have not been established for BASFI. In the absence of established responder thresholds for BASFI, the proportion of patients reaching different thresholds (described for the purpose of this study) for low BASFI scores, indicating less physical function impairment, is provided.

This study also assessed work productivity using WPAI:axSpA scores. Notably, BE MOBILE 1 and 2 occurred during the COVID-19 pandemic and involved patients from multiple countries. Therefore, WPAI outcomes, especially absenteeism, may have been confounded by pandemic-related job losses and country-specific job support measures. Additionally, the first question of the WPAI questionnaire does not allow patients to specify whether their employment status is due to the disease or other reasons (eg, employer-related or COVID-19-related job losses). Further, the 1-year study period may have been too short to observe improvements in work productivity scores for some patients, particularly for absenteeism, where workplace circumstances and support play a role in return to work.[32]

Although the recommended instrument for HRQoL in the ASAS-OMERACT core outcome set is the ASAS Health Index,[35 36] this study used ASQoL, a tool with similar content to the ASAS Health Index,[37] which was specifically developed for use in patients with ankylosing spondylitis and has since been validated in patients with nr-axSpA.[28 29] This allowed for the disease-specific impacts of axSpA on overall HRQoL to be measured in this current study.

Finally, the clinical trial study design may not have wholly reflected the real-world clinical setting; for example, patients were excluded from the BE MOBILE studies if they had moderate to severe depression, as per standard clinical trial safety procedures. It would be interesting to determine whether patients with depressive symptoms may derive further benefit from bimekizumab treatment due to expected improvements in axSpA symptoms related to sleep, work productivity and overall HRQoL. This highlights the need for further evidence in real-world settings which can evaluate the benefits of bimekizumab in these patients.

CONCLUSION

In conclusion, this analysis showed that inhibition of IL-17F in addition to IL-17A with bimekizumab to Week 16 resulted in greater improvements in physical function, sleep, work productivity and overall HRQoL versus placebo in patients across the full disease spectrum of axSpA. These responses were sustained or further improved beyond the double-blind period up to one year. Overall, these results demonstrate the value of bimekizumab in improving functioning, productivity and overall HRQoL in patients with axSpA, meeting a major treatment goal of the disease.

Together with previously published efficacy and safety data,[13] results from the BE MOBILE 1 and BE MOBILE 2 studies support the long-term efficacy of bimekizumab in improving clinical outcomes and alleviating the impact of axSpA on patients' lives. Results from open-label extension studies and real-world evidence reporting will be important to confirm these findings.

Author affiliations
[1]Department of Rheumatology, Boston University School of Medicine, Boston, Massachusetts, USA
[2]Department of Rheumatology, La Paz University Hospital, IdiPaz, Madrid, Spain
[3]Department of Internal Medicine, Division of Rheumatology, Maastricht University Medical Center, Maastricht, The Netherlands
[4]Care and Public Health Research Institute (Caphri), Maastricht University, Maastricht, The Netherlands
[5]Norfolk and Norwich University Hospital NHS Trust, Norfolk, UK
[6]Department of Medicine/Rheumatology, University of California San Francisco, San Francisco, California, USA
[7]UCB Pharma, Brussels, Belgium
[8]UCB Pharma, Slough, UK
[9]UCB Pharma, Monheim am Rhein, Germany
[10]UCB Pharma, Colombes, France
[11]UCB Pharma, Copenhagen, Denmark
[12]Division of Arthritis & Rheumatic Diseases, Oregon Health & Science University, Portland, Oregon, USA
[13]University of Bielefeld, Klinikum Bielefeld, Bielefeld, Germany

Acknowledgements The authors thank the patients and their caregivers in addition to all the investigators and their teams who contributed to these studies. The authors also acknowledge Natasha de Peyrecave, DPhil, UCB Pharma, Brussels, Belgium for substantial contributions to this publication, Celia Menckeberg, PhD, UCB Pharma, Breda, The Netherlands for publication coordination and editorial assistance, and Chloe Foulds, MBiol, and Kaity McCafferty, BSc, Costello Medical, UK for medical writing and editorial assistance. These studies were funded by UCB Pharma.

Contributors Substantial contributions to study conception and design: MD, VN-C, AB, KG, LSG, CdIL, TV, CF, UM, VT, MFM, AD and MR; substantial contributions to analysis and interpretation of the data: MD, VN-C, AB, KG, LSG, CdIL, TV, CF, UM, VT, MFM, AD and MR; drafting the article or reviewing it critically for important intellectual content: MD, VN-C, AB, KG, LSG, CdIL, TV, CF, UM, VT, MFM, AD and MR; final approval of the version of the article to be published: MD, VN-C, AB, KG, LSG, CdIL, TV, CF, UM, VT, MFM, AD and MR. CdIL is the guarantor for this paper.

Funding This article was based on the original studies BE MOBILE 1 (NCT03928704) and BE MOBILE 2 (NCT03928743) which were sponsored by UCB Pharma. Support for third-party writing assistance for this article, provided by Chloe Foulds, MBiol, and Kaity McCafferty, BSc, Costello Medical, UK, was funded by UCB Pharma in accordance with Good Publication Practice 2022 guidelines (https://www.ismpp.org/gpp-2022).

Competing interests MD: Educational grant from Pfizer paid to institution; consulting fees (eg, advisory boards) from Amgen and UCB Pharma; VN-C: Speakers bureau for AbbVie, Eli Lilly, Fresenius Kabi, Janssen, MSD, Novartis, Pfizer and UCB Pharma; consultant for AbbVie, Eli Lilly, Galapagos, MoonLake, MSD, Novartis, Pfizer and UCB Pharma; grant/research support from AbbVie and Novartis; AB: Research grants from AbbVie; speakers honoraria and consultation fees from AbbVie, Galapagos, Pfizer, Novartis and UCB Pharma; KG: Speakers bureau for AbbVie, Eli Lilly, Novartis and UCB Pharma; consultant for AbbVie, Eli

Lilly, Novartis and UCB Pharma; grant/research support from AbbVie, Gilead, Eli Lilly, Novartis and UCB Pharma; LSG: Grants from Novartis and UCB Pharma paid to institution; consulting fees from AbbVie, Acelyrin, Eli Lilly, Fresenius Kabi, Janssen, Novartis, Pfizer and UCB Pharma; CdlL: Consultant to UCB Pharma; TV, UM and MFM: Employees of UCB Pharma; CF and VT: Employees and shareholders of UCB Pharma; AD: Speakers bureau for Janssen, Novartis, and Pfizer; consultant for AbbVie, BMS, Eli Lilly, Janssen, MoonLake, Novartis, Pfizer and UCB Pharma; grant/research support from AbbVie, BMS, Celgene, Eli Lilly, MoonLake, Novartis, Pfizer and UCB Pharma; MR: Speakers bureau for AbbVie, Boehringer Ingelheim, Chugai, Eli Lilly, Janssen, Novartis, Pfizer and UCB Pharma; consultant of AbbVie, Eli Lilly, Novartis and UCB Pharma.

Patient consent for publication Not applicable.

Ethics approval The BE MOBILE 1 and BE MOBILE 2 studies were conducted in accordance with the Declaration of Helsinki and the International Conference on Harmonisation Guidance for Good Clinical Practice. Ethical approvals were obtained from the relevant institutional review boards at participating sites. All patients provided written informed consent in accordance with local requirements.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Underlying data from this manuscript may be requested by qualified researchers 6 months after product approval in the USA and/or Europe, or global development is discontinued, and 18 months after study completion. Investigators may request access to anonymised individual patient-level data and redacted trial documents which may include analysis-ready datasets, trial protocols, annotated case report forms, statistical analysis plans, dataset specifications and clinical study reports. Prior to the use of the data, proposals need to be approved by an independent review panel at www.Vivli.org and a signed data sharing agreement will need to be executed. All documents are available in English only, for a prespecified time, typically 12 months, on a password-protected portal.

ORCID iDs
Victoria Navarro-Compán http://orcid.org/0000-0002-4527-852X
Annelies Boonen http://orcid.org/0000-0003-0682-9533
Karl Gaffney http://orcid.org/0000-0002-7863-9176
Martin Rudwaleit http://orcid.org/0000-0001-5445-548X

REFERENCES

1 Boel A, Molto A, van der Heijde D, *et al*. Do patients with axial spondyloarthritis with radiographic sacroiliitis fulfil both the modified New York criteria and the ASAS axial spondyloarthritis criteria? Results from eight cohorts. *Ann Rheum Dis* 2019;78:1545–9.
2 Navarro-Compán V, Sepriano A, El-Zorkany B, *et al*. Axial spondyloarthritis. *Ann Rheum Dis* 2021;80:1511–21.
3 van der Heijde D, Molto A, Ramiro S, *et al*. Goodbye to the term 'ankylosing spondylitis', hello 'axial spondyloarthritis': time to embrace the ASAS-defined nomenclature. *Ann Rheum Dis* 2024;83:547–9.
4 Strand V, Singh JA. Patient burden of axial spondyloarthritis. *J Clin Rheumatol* 2017;23:383–91.
5 Yi E, Ahuja A, Rajput T, *et al*. Clinical, economic, and humanistic burden associated with delayed diagnosis of axial spondyloarthritis: a systematic review. *Rheumatol Ther* 2020;7:65–87.
6 van Tubergen A, Black PM, Coteur G. Are patient-reported outcome instruments for ankylosing spondylitis fit for purpose for the axial spondyloarthritis patient? A qualitative and psychometric analysis. *Rheumatology (Oxford)* 2015;54:1842–51.
7 Ramiro S, Nikiphorou E, Sepriano A, *et al*. ASAS-EULAR recommendations for the management of axial spondyloarthritis: 2022 update. *Ann Rheum Dis* 2023;82:19–34.
8 Noureldin B, Barkham N. The current standard of care and the unmet needs for axial spondyloarthritis. *Rheumatology (Oxford)* 2018;57:vi10–7.
9 Toussirot E. The use of Janus kinase inhibitors in axial spondyloarthritis: current insights. *Pharmaceuticals (Basel)* 2022;15:270.
10 Strand V, Deodhar A, Alten R, *et al*. Pain and fatigue in patients with ankylosing spondylitis treated with tumor necrosis factor inhibitors: multinational real-world findings. *J Clin Rheumatol* 2021;27:e446–55.
11 Braun J, Kiltz U, Baraliakos X. Emerging therapies for the treatment of spondyloarthritides with focus on axial spondyloarthritis. *Expert Opin Biol Ther* 2023;23:195–206.
12 Shah M, Maroof A, Gikas P, *et al*. Dual neutralisation of IL-17F and IL-17A with Bimekizumab blocks inflammation-driven osteogenic differentiation of human periosteal cells. *RMD Open* 2020;6:e001306.
13 Baraliakos X, Deodhar A, van der Heijde D, *et al*. Bimekizumab treatment in patients with active axial spondyloarthritis: 52-week efficacy and safety from the randomised parallel phase 3 BE MOBILE 1 and BE MOBILE 2 studies. *Ann Rheum Dis* 2024;83:199–213.
14 Deodhar A, Navarro-Compán V, Poddubnyy D, *et al*. Long-term safety and efficacy of Bimekizumab in patients with active Ankylosing Spondylitis: 5-year results from a phase 2B study and its open-label extension [abstract]. *Arthritis Rheumatology* 2023;75:0519.
15 van der Heijde D, Deodhar A, Baraliakos X, *et al*. Efficacy and safety of bimekizumab in axial spondyloarthritis: results of two parallel phase 3 randomised controlled trials. *Ann Rheum Dis* 2023;82:515–26.
16 Lambert RGW, Bakker PAC, van der Heijde D, *et al*. Defining active sacroiliitis on MRI for classification of axial spondyloarthritis: update by the ASAS MRI working group. *Ann Rheum Dis* 2016;75:1958–63.
17 van der LindenS, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. *Arthritis Rheumatol* 1984;27:361–8.
18 Posner K, Brown GK, Stanley B, *et al*. The Columbia-suicide severity rating scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry* 2011;168:1266–77.
19 Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 2001;16:606–13.
20 Navarro-Compán V, Boel A, Boonen A, *et al*. Instrument selection for the ASAS core outcome set for axial spondyloarthritis. *Ann Rheum Dis* 2023;82:763–72.
21 Revicki DA, Rentz AM, Luo MP, *et al*. Psychometric characteristics of the short form 36 health survey and functional assessment of chronic illness therapy-fatigue subscale for patients with ankylosing spondylitis. *Health Qual Life Outcomes* 2011;9:36.
22 Yarlas A, White MK, St Pierre DG, *et al*. The development and validation of a revised version of the medical outcomes study sleep scale (MOS Sleep-R). *J Patient Rep Outcomes* 2021;5:40.
23 Maruish ME. *User's Guide for the MOS Sleep Scale–Revised*. Lincoln, RI: QualityMetric Incorporated, 2012.
24 Reilly MC, Zbrozek AS, Dukes EM. The validity and reproducibility of a work productivity and activity impairment instrument. *Pharmacoeconomics* 1993;4:353–65.
25 Reilly MC, Gooch KL, Wong RL, *et al*. Validity, reliability and responsiveness of the work productivity and activity impairment questionnaire in ankylosing spondylitis. *Rheumatology (Oxford)* 2010;49:812–9.
26 Maruish ME. *User's Manual for the SF-36v2 Health Survey*. 3rd edn. Lincoln, RI: QualityMetric Incorporated, 2011.
27 Lubeck DP. Patient-reported outcomes and their role in the assessment of rheumatoid arthritis. *Pharmacoeconomics* 2004;22:27–38.
28 Doward LC, Spoorenberg A, Cook SA, *et al*. Development of the ASQoL: a quality of life instrument specific to ankylosing spondylitis. *Ann Rheum Dis* 2003;62:20–6.
29 Hoepken B, Serrano D, Harris K, *et al*. Validation of the ankylosing spondylitis quality of life assessment tool in patients with non-radiographic axial spondyloarthritis. *Qual Life Res* 2021;30:945–54.
30 Poddubnyy D, Sieper J, Akar S, *et al*. Characteristics of patients with axial spondyloarthritis by geographic regions: PROOF multicountry observational study baseline results. *Rheumatology (Oxford)* 2022;61:3299–308.
31 Maksymowych WP, Gooch KL, Wong RL, *et al*. Impact of age, sex, physical function, health-related quality of life, and treatment with adalimumab on work status and work productivity of patients with ankylosing spondylitis. *J Rheumatol* 2010;37:385–92.

32 Kiltz U, Hoeper K, Hammel L, *et al*. Work participation in patients with axial spondyloarthritis: high prevalence of negative workplace experiences and long-term work impairment. *RMD Open* 2023;9:e002663.
33 Rudwaleit M, Mørup MF, Humphries B, *et al*. Work productivity in patients with axial spondyloarthritis initiating biological or targeted synthetic disease-modifying antirheumatic drugs: a systematic literature review and meta-analysis. *RMD Open* 2023;9:e003468.
34 Frede N, Rieger E, Lorenzetti R, *et al*. Sleep behaviour differs in women and men with psoriatic arthritis and axial spondyloarthritis with impact on quality of life and depressive symptoms. *RMD Open* 2023;9:e002912.
35 Kiltz U, van der Heijde D, Boonen A, *et al*. Development of a health index in patients with ankylosing spondylitis (ASAS HI): final result of a global initiative based on the ICF guided by ASAS. *Ann Rheum Dis* 2015;74:830–5.
36 Navarro-Compán V, Boel A, Boonen A, *et al*. The ASAS-OMERACT core domain set for axial spondyloarthritis. *Semin Arthritis Rheum* 2021;51:1342–9.
37 Pike J, Dong Y, Piercy J, *et al*. Cross-walk of the assessment of spondyloarthritis international society health index and ankylosing spondylitis quality of life scores in ankylosing spondylitis and non-radiographic axial spondyloarthritis patients. *Rheumatol Ther* 2021;8:849–62.