ClinicoEconomics and Outcomes Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Analysis of Cost-Effectiveness of Biologic Therapies in Axial Spondyloarthritis Based on Real-World Data

Jamal Al-Saleh[1], Ahmed Abdelmoniem Negm[1,2], Ahlam Almarzooqi[3], Nasir Elamin Elhag Elsidig[1], Noura Zamani[1]

[1]Rheumatology Section, Dubai Hospital, Dubai Health, Dubai, United Arab Emirates; [2]Rheumatology Department, AL-Azhar University, Cairo, Egypt; [3]Rheumatology Department, Al Qassimi Hospital, Emirates Health Services, Sharjah, United Arab Emirates

Correspondence: Jamal Al-Saleh, Rheumatology Section, Dubai Hospital, Dubai Health, Dubai, United Arab Emirates, Email jaalsaleh@dubaihealth.ae

Purpose: To assess the cost-effectiveness of biologics in patients with axial spondyloarthritis (axSpA) in a real-world setting.

Patients and Methods: This is a non-interventional, registry-based, prospective cohort study included 203 consecutive patients with axSpA who attended the Rheumatology Department of a public hospital in the Emirate of Dubai between July 2018 and September 2020. Demographic and clinical data were collected and disease activity and treatment response were assessed. Patients were grouped according to the treatment received, distinguishing between biologics and non-biologics, and classified them based on their disease activity at baseline and 52 and 104 weeks. The direct and indirect costs associated with their management were collected. The incremental cost-effectiveness ratio (ICER) was calculated and the impact of patient-related factors on its value across subgroups was examined. A state-transition model was used to simulate disease progression across four health states over a lifetime (62 years), and Monte Carlo simulation was applied to address uncertainty.

Results: The total cost of managing the patients was AED 27,532,189, resulting in a gain of 293.7 quality-adjusted life years (QALYs) over a 2-year follow-up period. Biological therapies were associated with higher direct costs, accounting for 83.3% of the total costs of biologics. The overall ICER was AED 253,616 per QALY, influenced by higher medication acquisition costs. Patients with < 5 years of disease duration, female patients, those with radiographic-axSpA, co-existing fibromyalgia, and those receiving a combination of biologic treatments and conventional disease-modifying antirheumatic drugs showed a higher ICER than the median ICER of all biologic therapies.

Conclusion: Biologic therapies are cost-effective for patients with axSpA, especially those not achieving clinical targets. Patients' selection, and targeted cost-containment strategies, such as biosimilars and medication price reductions, can enhance clinical benefits and reduce societal costs.

Plain Language Summary: In this study, we evaluated the effects of biologics on healthcare costs and patient outcomes in patients with axial spondyloarthritis in Dubai. We followed 203 patients over 2 years and found that although biologics appeared to be more expensive, they helped patients live better lives by improving quality-adjusted life years. We used a Markov model to simulate a lifetime of treatment outcomes for an imagined group of 10,000 patients, which helped them predict chances of relapse and overall treatment benefits.

Some key findings include:

- Biologics offer a significant net benefit for patients who do not reach their treatment goals with standard therapies.
- Factors like a short duration of disease and female sex (along with other patient characteristics) play a role in how cost-effective the treatment is.
- This research is especially important because it fills a gap in information for the Middle East, helping healthcare leaders make better decisions about where to invest resources.

Key takeaways:

(1) Economic burden: The study highlights the substantial direct and indirect costs associated with the treatment of axial spondyloarthritis, emphasizing the significant impact of biologic therapies on the overall healthcare expenditures.

Received: 27 July 2025
Accepted: 6 December 2025
Published: 13 December 2025

(2) Cost-effectiveness: Biologics are a cost-effective treatment option for patients with axial spondyloarthritis, especially for those who fail to achieve clinical targets.
(3) Regional relevance: This study sheds light on the local healthcare scene, filling a gap caused by the lack of regional economic data and providing guidance for resource allocation and policy changes in the Middle East.

Keywords: average ankylosing spondylitis disease activity score, determinants, quality-adjusted life year, registry, treat-to-target

Introduction

Axial spondylarthritis (axSpA) is a chronic inflammatory condition that decreases patients' quality of life and poses a substantial economic burden on healthcare systems. AxSpA leads to severe disability in a considerable proportion of patients if left untreated.[1] In comparison to the general population, axSpA patients' quality of life (QoL), particularly their physical and mental QoL, is reduced, and it is comparable to the QoL of patients with other rheumatological illnesses.[2] In the Emirate of Dubai, the prevalence of seronegative spondylarthritis (SpA) has been reported to be 2.2%,[3] similar to values reported in a meta-analysis, 1.61% (95% CI 1.27–2.00) in Northern Arctic communities.[4] AxSpA induces substantial direct healthcare expenses and indirect costs due to reduced productivity and work disability impacting national healthcare systems and economies.[5,6]

The introduction of biologics has shifted the pattern of expenditure in the management of axSpA. In the pre-biologics era, indirect costs accounted for approximately 78% of the total spending on patients with axSpA in Europe.[7] This was attributed to lost productivity in the workplace and functional disability.[8] Additionally, the psychosocial effects of axSpA, which are often overlooked, further contribute to the indirect costs. Chronic pain, fatigue, functional limitations, and depression caused by axSpA can interfere with daily life activities and work performance.[9] However, since the adoption of the Assessment of SpondyloArthritis international Society (ASAS)/ European Alliance of Associations for Rheumatology recommendations for managing ankylosing spondylitis in 2006,[10] the direct cost of patient care for axSpA has exponentially increased over the years. Consequently, the indirect costs have been attenuated. A significant portion of the total costs is attributed to direct costs, primarily in the form of medications prescribed to patients with axSpA. The total costs per quality-adjusted life year (QALY) gained in patients with axSpA is estimated between EUR 118,000 to EUR 189,000, which exceeds the acceptability criteria in Europe.[11]

Disease activity influences the total costs of care for patients with axSpA, as high disease activity is often associated with more pronounced symptoms, a lower quality of life, and more significant radiographic progression in patients with axSpA.[12,13] In addition, these factors often contribute to increased utilization of healthcare resources and higher overall costs of care compared to those with an inactive disease.[14,15]

Data on the cost-effectiveness of interventions in patients with axSpA in the Middle East do not exist, as prior cost-effectiveness studies have been conducted in Western countries. Extrapolating these data can be misleading due to differences in local factors, such as healthcare infrastructure, treatment patterns, medication costs, and societal values, all of which can significantly influence the cost-effectiveness of interventions in patients with axSpA.

Given these gaps, a cost-effectiveness study on axSpA must be conducted in the United Arab Emirates (UAE) using real-world data to address several unmet needs, including 1) the current lack of economic data on chronic rheumatology conditions in the region hinders decision-makers from allocating resources based on available scientific evidence, and 2) the additional economic burden imposed on society because of the loss of productivity and disability in inadequately treated patients with axSpA, is unquantified and adds to the total cost of illness. Hence, exploring the cost-effectiveness of various treatment options in the UAE helps justify the use of more expensive treatments for better outcomes.

The primary objective of the study was to calculate the total expenditure for patients with axSpA and compare the cost-effectiveness of managing different disease states using biologic and non-biologic therapies. Also, we explored whether biologic therapies would be more cost-effective than non-biologic treatments in patients with axSpA, particularly among those with high disease activity.

Materials and Methods

Study Design

We conducted a non-interventional, registry-based, prospective cohort study at Dubai Hospital, a secondary care public hospital serving the urban regions of the Emirate of Dubai, between July 1, 2018 and September 8, 2020. Data were collected for 2 years to allow at least four assessments that are 6 months apart and to calculate the rate of relapse. We included all consecutive patients with axSpA attending the rheumatology clinic. The study was divided into two phases; in Phase 1, baseline visits were scheduled between July 2018 and September 2018 to recruit patients with axSpA. In Phase 2, we completed the recruitment phase by September 2018, and patients were followed until September 7, 2020.

Patient Selection

Patients were selected from a pool of individuals in the Dubai Arthritis Registry, an overview of the registry described in Supplementary Material Section 1, who attended the rheumatology department at Dubai Hospital and were diagnosed with SpA. By September 2018, 418 patients were diagnosed with SpA, of which we selected 262 patients with axial symptoms. The sample size re-estimation calculation is provided in Supplementary Material Section 2.

Inclusion and Exclusion Criteria

We included all patients who were aged over 18 years, were competent to provide written consent, and met the 2010 ASAS classification criteria for axial and peripheral SpA.[16] We excluded patients who did not meet the ASAS classification criteria for axSpA, those classified as having peripheral SpA in the registry, patients with a predominant peripheral SpA at baseline visits, patient with incomplete assessment at baseline, and patients who exceeded 6-month interval between follow-up visits.

In phase 1, the principal investigator and co-investigators conducted clinical interviews with all patients to verify the aforementioned criteria before recruiting them into the study. The flowchart illustrating the selection of patients with axSpA is shown in Section 3 of the Supplementary Material, Figure S1.

Data Collection

At baseline, we retrieved all relevant information on patients' demographics, clinical information related to the axSpA classification criteria, disease course before the baseline visit, medications, and comorbidities from electronic medical records (EMRs). We validated the collected data at the baseline visit and assessed disease activity. We collected the following data for all patients: 1) Patient's age as of December 31, 2018; 2) Sex; 3) Highest education level—illiterate; primary school, intermediate school, secondary school, college, university, and postgraduate; 4) Current working status—full-time, part-time, student, unemployed, retired, and their current job; 5) Date of presentation of the first persistent symptoms; 6) Disease duration—defined as the duration between the diagnosis of SpA and December 31, 2018; 7) Smoking status— current or past habit; 8) Medical insurance covering biological treatment; 9) Current or past musculoskeletal clinical features of axSpA. 10) Current or past extra-articular manifestations and associated diagnosis of axSpA; 11) Presence of fibromyalgia, diagnosed according to the 1990 American College of Rheumatology classification criteria; and 12) Charlson comorbidity index (CCI), which is a widely used clinical tool to predict 10-year mortality rate in patients with multiple comorbidities. CCI assesses 19 medical conditions, each assigned a weighted score based on its associated risk of mortality. Some of these conditions include cancer, diabetes, liver disease, kidney disease, and heart disease. The total score, which ranges from 0 to 37, is calculated by summing the individual weights of each comorbidity. A higher score reflects a more sever comorbidity, associated with a higher risk of mortality.[17] To facilitate the collection of real-world data from clinical practice, physicians were allowed to schedule follow-up visits according to their patient management plans, ensuring that the interval between these visits did not exceed 6 months. We collected the data at 52 and 104 weeks of follow-up.

Clinical Variables

We collected the following clinical variables at baseline and follow-up: Average ankylosing spondylitis disease activity score-C-reactive protein (ASDAS-CRP)[18] and number of visits to rheumatology and subspecialties clinics, namely

ophthalmology, dermatology, gastroenterology, and orthopedics. We recorded the number of emergency visits and hospital admissions due to disease flare-ups; number of physiotherapy sessions; laboratory test results, including C-reactive protein (CRP) levels, erythrocytes sedimentation rates, liver function test results, kidney function test results, annual total cholesterol and fasting blood sugar levels; and radiographic findings (radiograph, computed tomography, and magnetic resonance imaging), musculoskeletal ultrasound findings with and without injection, and various procedures to manage the patient's condition, such as colonoscopy, transesophageal echocardiogram, and pulmonary function test. We also collected patients' current treatment regimens, changes from previous medications and the reasons for these changes, and the duration of treatment, the number of sick leave days recommended by a rheumatologist because of axSpA activity or the patient's general well-being, and duration of light duties recommended by the rheumatologist. We used multiple imputation results for missing ASDAS for those who completed 104 weeks of follow-up. A brief description of the multiple imputation model is provided in Supplementary Material Section 5.1 Statistical Handling of Missing Data, Table S5.1.

Grouping

To evaluate the effectiveness and costs of various treatment strategies and medications, we conducted a cost-effectiveness analysis by categorizing patients based on disease activity and medication usage.

Disease Activity

Patients were categorized into four groups based on the disease activity score (ASDAS-CRP),[19] measured at baseline, 52, and 104 weeks. Disease activity levels were defined according to established ASDAS thresholds: inactive (ASDAS $<$ 1.3), low disease activity ($1.3 \leq$ ASDAS < 2.1), high disease activity ($2.1 \leq$ ASDAS < 3.5), and very high disease activity (ASDAS ≥ 3.5).

Medication Usage

Patients were categorized into one of the two subgroups according to the treatment plan: biologic therapy (intervention) and non-biologic therapy (comparative).

Biologic Therapy

This group included patients who received biologic monotherapy (including standard therapy, non-steroidal anti-inflammatory drugs [NSAIDs], and physical medicine) throughout the study and those who were treated with a combination of biologic therapy and conventional disease-modifying antirheumatic drugs (c-DMARDs) for at least 6 months.

Non-Biologic Therapy

This group comprised of patients on conventional disease-modifying antirheumatic drug (c-DMARD) monotherapy or combination therapy without biologic therapy throughout the study and those who only received NSAIDs and/or physical medicines, never being prescribed conventional DMARDs or biologics during the study period.

Economic Variables

We calculated the total cost associated with axSpA management, which is the sum of direct and indirect costs over the follow-up period. Direct costs included expenses related to hospital admissions, visits to rheumatology and subspecialty clinics, physiotherapy sessions, medications, laboratory tests, radiographic studies, and medical procedures. Indirect costs were defined as productivity losses, measured using sick leave days for absenteeism, duration of light duties in months, reduced hours for presenteeism, and early retirement before 60 years of age for long-term productivity loss. We estimated the indirect costs based on the 2022 UAE salary guide, mapping it against the individual's current post and the highest level of education.[20] We excluded costs related to diagnostic delays that can lead to increased healthcare resource use and associated costs in the years following diagnosis.[21] Additionally, we excluded productivity losses resulting from the disease's impact on daily functioning and work performance.[22]

We used an arbitrary cost-effectiveness threshold (CET) for the UAE, which was recently published following a consensus among health economists, clinicians, and payers.[23] The group agreed that the estimated CET is the product of 0.75 of UAE gross domestic product (GDP) per capita and a multiplier. The value of the multiplier is the product of (proportional/relative shortfall + 1) × (Incremental relative QALYs Gained +1) × (disease rarity + 1). The CET was calculated using a Microsoft Excel-based calculator, as published in the supplementary file of the same publication,[23] after adjusting for the estimated GDP per capita in 2023, which was $49,040.69.[24] We assumed that patients who achieved the target of inactive disease or low disease activity were considered to be in a healthy state and those with high and very high disease activity were considered to be in a diseased state.[25] We estimated the cost-effective threshold for axSpA to be AED 277,507 per QALY, which was considered as an acceptable CET.

Health Utility

At the time of the study, no validated health utility mapping for self-reported quality-of-life tools existed in the UAE, which limited the ability to conduct comprehensive cost-utility analyses in this population.[26] To address this limitation, we utilized a validated model to estimate health utility values from ASDAS using the EuroQol five-dimensional questionnaire with three levels of response as follows: no problems, some problems, and extreme problems (EQ-5D-3L). The model considers sex and patients' age at the time of measurement, using the EQ-5D-3L (UK tariff) calculator from ASDAS.[27] All the equations used in the calculation are outlined in the Supplementary Material, section 5.2.

Statistical Analysis

We used descriptive statistics to summarize patient demographics, clinical characteristics, and cost variables. Continuous variables were reported as medians [interquartile ranges], whereas categorical variables were presented as frequencies (percentages). Between-group comparisons were conducted using the *t*-tests or Mann–Whitney *U*-test for continuous variables and chi-square or Fisher's exact test for categorical variables, as appropriate.

We used a mixed-effects model to examine the longitudinal ASDAS (baseline, 52, and 104 weeks), including within-subject variability. We used a factorial plot to show the influence of various factors in our cohort on ASDAS during the study period, including sex, disease duration, co-existing fibromyalgia, radiographic classification (r-axSpA vs nr-axSpA) , use of baseline biologic therapy, history of change, or a change in biologic treatment during the study. We used Box-Cox transformation to convert the skewed distribution to calculate the lambda (λ) value and standard deviation to simulate the data.

Statistical analyses were performed using Minitab 18 Statistical Software (Minitab, Inc., State College, PA) and NCSS 2024 Statistical Software (2024). NCSS, LLC. Kaysville, Utah, USA, (ncss.com/software/ncss), with a significance level of $\alpha = 0.05$ for all statistical tests.

Sensitivity Analysis

We conducted a sensitivity analysis using factors that influence ASDAS in a mixed-effects model over a 2-year follow-up period to explore their effect on the deterministic incremental cost-effectiveness ratio (ICER). To evaluate the long-term cost-effectiveness of biologic versus non-biologic therapies in patients with axSpA, a Markov chain model was developed to simulate disease progression across four health states (inactive, low disease activity, high disease activity, very high disease activity) over a lifetime horizon. We captured the transition probabilities between states derived from prospective real-world evidence, incorporating treatment efficacy and discontinuation rates due to lack of efficacy or side effects. We assumed that all patients initially had an inactive disease at the beginning. The model incorporated different health states (eg, inactive, low disease activity, high disease activity, and very high disease activity) and evaluated the associated costs and QALYs gained for each state in biologic and non-biologic treatment groups. The probability of change in the disease state was assessed at the end of each cycle (2 years) from the previous state. The transition probability of changing disease state per cycle is shown in Section 3 of the Supplementary Material, Figure S2. We used the median values for cost and QALYs for each disease state as the deterministic values in our model. To calculate the probabilistic values, we utilized the BETA.INV function (with the RAND () function) in Microsoft Excel for estimating transition probability, and the GAMMA.INV function (also using the RAND () function ± 20% of the average) in

Microsoft Excel for estimating costs and QALY for lifetime expectancy of 80 years. We simulated the data for 10,000 iterations to explore the consistency of our results. We calculated the mean, standard deviation, and skewness for the four disease states in the two treatment groups, as well as the total cost and utility gained. Using the Box-Cox transformation, we converted the skewed distribution to calculate the lambda (λ) value and standard deviation.

Furthermore, a Monte Carlo simulation (10,000 iterations) was used to account for parameter uncertainty, and the results were reported as ICERs and probabilistic sensitivity analyses. Monte Carlo simulations were performed using the random number generation function in Microsoft Excel. We calculated the net momentary benefits to plot the cost-effectiveness curve of different disease states. We then compared the point estimates of deterministic and probabilistic variables to assess the robustness of our model. We repeated all sensitivity analyses for all biological agents in the study to compare the cost-effectiveness of each agent.

Lastly, we analyzed various alternative scenarios using different input values and evaluated the impact on ICER, including a 20% discount on biologic treatment, switching to biosimilars, switching to Janus kinase inhibitors, and de-escalation in those with sustained inactive disease for more than a year.[28]

Results

We identified 418 patients with SpA in our registry who have been followed up since January 1, 2018. We excluded 156 patients because they had peripheral SpA or did not meet the classification criteria for axSpA. Furthermore, we excluded 59 patients during the baseline phase—49 due to predominantly peripheral SpA features and 10 due to failure to attend their baseline visit. Thus, the axSpA group comprised 203 patients (Section 3 of the Supplementary Material, Figure S1).

Demographic and Clinical Characteristics

Of the 203 patients with axSpA, 111 (54.7%) were women. The median age of the patients was 42 years (interquartile range, 36–51 years), and the median disease duration was 5 years (interquartile range, 2–9 years). Table 1 summarizes the baseline demographic and clinical characteristics of the participants with axSpA, categorized by therapeutic subgroups. At baseline, 116 patients (57.1%) were receiving biologic treatment. After 104 weeks of follow-up, the number increased

Table 1 Summary of the Baseline Demographic and Clinical Characteristics of the Participants with Axial Spondylarthritis Categorized by Therapeutic Subgroups

Variable	All Patients (n = 203)	Biologic Therapy (n = 130)	Non-Biologic Therapy (n = 73)	P-value
Female, n (%)	111 (54.7)	67 (51.5)	44 (60.3)	0.20
Age, median (IQR) years	42 (36–51)	41 (35–49)	44 (37.3–51)	0.07
Smoking/Ex-smoker, n (%)	24 (11.8)	16 (12.3)	8 (10.9)	0.90
Does the insurance cover biologics, n (%)	118 (92.6)	124 (95.3)	64 (87.7)	0.20
Disease duration, median (IQR) years	5 (2–9)	6 (3–10)	4 (1.3–8)	0.10
r-axSpA, n (%)	118 (58.1)	71 (54.6)	47 (64.8)	0.10
Fibromyalgia, n (%)	39 (19.4)	30 (23.1)	9 (12.3)	0.07
ASDAS at baseline, median (IQR)	2.1 (1.4–2.8)	2.1 (1.4–3)	2.1 (1.4–2.5)	0.13
ASDAS at 52 weeks, median (IQR)	1.7 (1.2–2.1)	1.6 (1.2–2.1)	1.7 (1.23–2.23)	0.40
ASDAS at 104 weeks, median (IQR)	1.3 (1.0–1.7)	1.3 (1.0–1.7)	1.5 (1.2–1.6)	0.30
Δ ASDAS at 104 weeks vs baseline, median (IQR)	−0.63 (−1.36 to −0.01)	−0.7 (−1.5 to −0.1)	−0.5 (−1.3 to 0.13)	0.04*

Notes: *Statistically significant $p < 0.05$. The biologic and non-biologic treatment groups showed no significant differences, except for a notable decrease in ASDAS at 104 weeks in the biologic group.

Abbreviations: n, number; (%), percentage; IQR, interquartile range; r-axSpA, radiographic axial spondylarthritis; ASDAS, ankylosing spondylitis disease activity score.

to 130 patients (64%). Notably, 25 (12.3%) patients switched from one biologic therapy to another with different modes of action, mainly due to failure to achieve low or inactive disease activity, and 73 patients (36%) were on non-biological therapy throughout the study. In the non-biologic group, 47 patients (64.4%) were managed with NSAIDs and/or physical therapy alone, predominantly comprising of established axSpA cases that had discontinued biological treatment before the start of the study. The remaining 26 patients (35.6%) received c-DMARD, primarily for concurrent psoriatic rash or enthesitis despite their axial SpA diagnosis.

Base-Case Cost-Effectiveness Analysis

At baseline, 89 (43.8%) patients had high disease activity and 14 (6.9%) had very high disease activity. The median ASDAS was 2.4 (1.4–2.8). However, at the end of the study, 174 (85.7%) patients were either inactive or had low disease activity, with a median ASDAS of 1.3 (1–1.7). In Section 4 of the Supplementary Materials, Table S1 outlines disease activity states defined based on ASDAS at baseline, 52, and 104 weeks in all patients and therapeutic subgroups.

Upon examining the impact of patient-related factors on ASDAS, results showed that patients who were female, had co-existing fibromyalgia, who switched to biologics during the study, and had insurance that did not cover biologics demonstrated significantly higher ASDAS at the end of the study, compared with their counterparts shown in Section 3 of the Supplementary Material, Figure S3 (A-G).

The base-case analysis of the 203 patients with axSpA revealed a total management cost equal to AED 27,532,189, resulting in a gain of 293.7 QALYs over a 2-year follow-up period. The overall median cost per QALY was AED 93,743. Table 2 denotes direct and indirect costs in the two therapeutic subgroups, and Table 3 summarizes the direct and indirect

Table 2 Details of the Direct and Indirect Costs in the Two Therapeutic Subgroups

Cost Classification	Biologic Therapy			Non-Biologic Therapy			P-value
	Cost (AED)	Average cost per patient (AED)	% of Total costs	Cost (AED)	Average cost per patient (AED)	% of Total costs	
Direct cost	**19,854,559.60**	**152,727**	**83.3%**	**828,890**	**11,355**	**22.3%**	< 0.0001*
Rheumatology clinic	245,440.00	1888	1.0%	113,100.00	1549	3.0%	1
Other subspeciality clinics	77,220.50	594	0.3%	44,980.00	616	1.2%	1
Medication cost	18,075,044.00	139,039	75.9%	124,228.00	1702	3.3%	< 0.0001*
NSAIDs, physiotherapy, investigations, and procedures	1,336,911.50	10,284	5.6%	495,908.30	6793	13.4%	0.1
Disease-related ED, hospital admissions, and surgeries	119,943.60	923	0.5%	50,673.60	694	1.4%	1
Indirect cost	**3,967,405.00**	**30,519**	**16.7%**	**2,881,334.30**	**39,470**	**77.7%**	< 0.0001*
Cost of work absence	577,404.00	4442	2.4%	406,333.30	5566	11.0%	0.001*
Cost of light duties	1,830,000.00	14,077	7.7%	435,000.00	5959	11.7%	0.5
Number of retirements before the age of 60		2			3		
Cost of retirement	1,560,001.00	-	6.5%	2,040,001.00	-	55.0%	< 0.0001*
Total cost		**23,821,965**			**3,710,224**		

Notes: *Statistically significant $p < 0.05$. Direct costs constituted 83.3% of the total costs in the biologic group, whereas indirect costs comprised 77.7% of the total costs in the non-biologic group.
Abbreviations: NSAID, non-steroidal anti-inflammatory drug; n, number; (%), percentage; ED, Emergency department; AED, United Arab Emirates dirham.

Table 3 Direct and Indirect Costs per Treatment Subgroup and Disease Activity State

	Total Cost (AED)	% Direct Cost	% Indirect Cost
Biologic therapy for all disease states	**23,821,965**	**83.3%**	**16.7%**
Inactive	11,338,789	82.1%	17.9%
Low disease activity	8,979,685	83.1%	16.9%
High disease activity	3,362,263	87.6%	12.4%
Very high disease activity	141,228	100.0%	0.0%
Non-biologic therapy for all disease statuses	**3,710,224**	**22.3%**	**77.7%**
Inactive	1,880,422	8.7%	91.3%
Low disease activity	1,341,889	40.3%	59.7%
High disease activity	438,768	22.9%	77.1%
Very high disease activity	49,145	10.2%	89.8%

Notes: Total cost, % of direct, and % of indirect costs are highlighted in bold in biologics and non-biologics groups. Direct costs constituted 83.3% of the total costs in the biologic group, whereas indirect costs comprised 77.7% of the total costs in the non-biologic group.
Abbreviations: (%), percentage; AED, United Arab Emirates dirham.

costs per treatment subgroup and disease activity state. Biologic therapies were associated with higher direct costs, accounting for 83.3% of the total costs of biologics. This is primarily due to the drug cost per patient, which accounts for 75.9% of the total cost for biologics. However, the biologic treatment led to higher proportion of patients achieving inactive disease after 2 years compared to non-biological therapies (48.5% vs 24.7%, p-value < 0.001). Conversely, non-biologic therapies had relatively lower direct costs but significantly higher indirect costs than biologic therapy, due to the cost of work absence and retirement (11% and 55% of total non-biological costs, respectively).

The overall ICER was AED 253,616 per QALY, which was primarily influenced by the higher acquisition costs associated with biologic treatments. Assuming the calculated cost-effective threshold of AED 277,507 per QALY, the

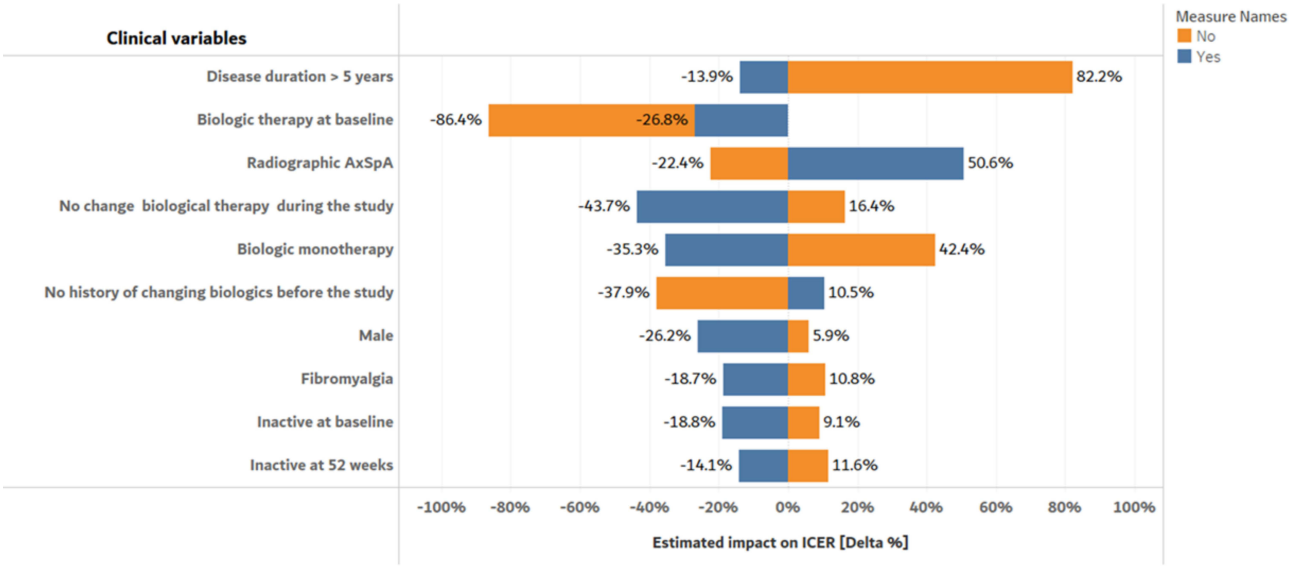

Figure 1 Tornado diagram showing the estimated impact of clinical parameters on the calculated incremental cost-effectiveness ratio (ICER).
Notes: *The calculation was done after adjusting for baseline EQ-5D-3L: EuroQol five-dimensional questionnaire with 3 levels of response. The Tornado chart illustrated that factors associated with higher ICERs compared to the median ICER for biologic treatment included disease duration <5 years, female sex, r-axSpA diagnosis, co-existing fibromyalgia, and combination therapy with biologics and c-DMARDs, while male sex and sustained inactive disease for 2 years were associated with lower ICERs.

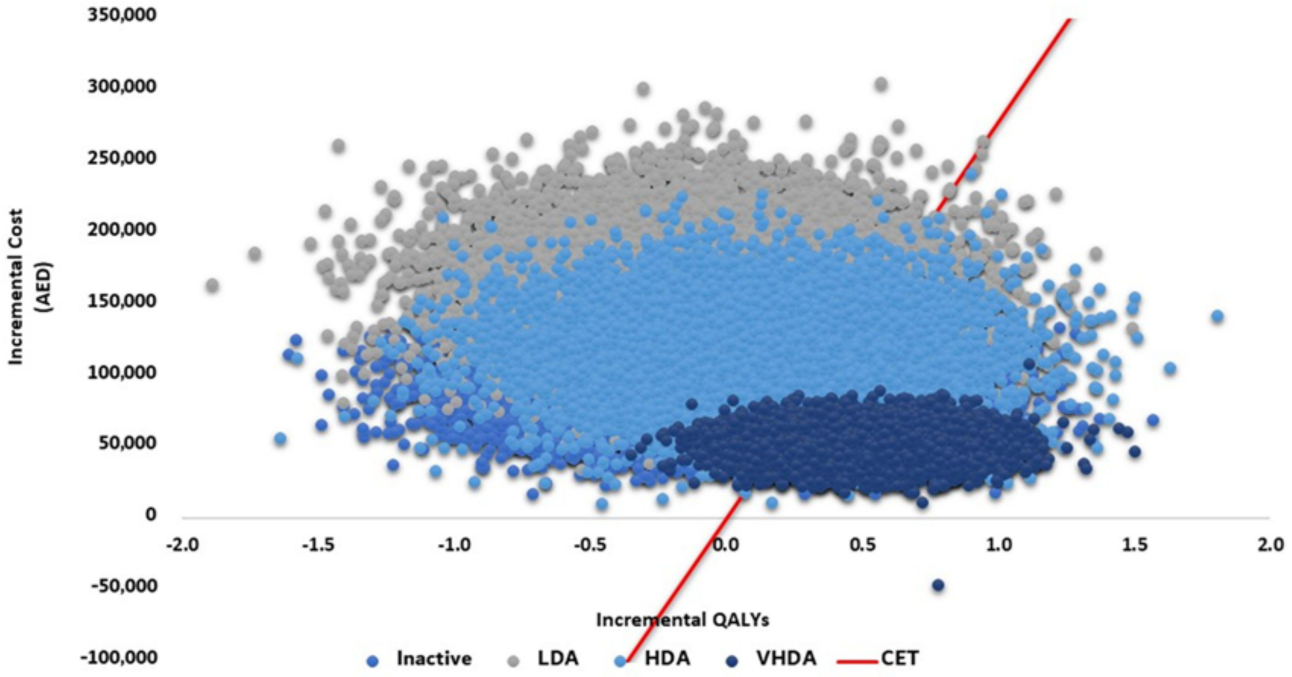

Figure 2 Incremental Cost-Effectiveness Ratio of biologics compared to non-biologics in different disease activity states of 10,000 patients with a lifetime horizon.
Abbreviations: LDA, low disease activity; HAD, high disease activity; VHDA, very high disease activity; %, percentage; AED, United Arab Emirates dirham; CET, cost-effectiveness threshold.

biologic therapy demonstrated a positive net monetary benefit of AED 23,891 per patient. The calculation is shown in Section 3 of the Supplementary Material, Figure S4.

Patients with a disease duration of less than 5 years, female patients, those with r-axSpA or co-existing fibromyalgia, and those receiving a combination of biologics and conventional disease-modifying antirheumatic drugs showed a higher ICER than the median ICER of all patients receiving biologics. In contrast, male patients and those with sustained inactive disease for 2 years exhibited a lower ICER. Figure 1 presents a tornado diagram illustrating the impact of various clinical parameters on the deterministic ICER.

Markov Chain Model and Monte Carlo Simulation

The lifetime simulation of the probabilities of changes in disease states stabilizes after 30 years in a Markov chain model. The deterministic variables used in the modeling, along with their lower and upper bounds, are detailed in Section 4 of the Supplementary Material, Table S2. The cost-effectiveness analysis revealed that 40% of all patients had an ICER below the CET. Figure 2 illustrates the scatter plots of costs versus QALYs gained in different disease activity states. The cost-effective acceptance curve indicated a 96% probability that biologic therapy is cost-effective at a willingness-to-pay threshold of AED 200,000 in patients with very high disease activity. In contrast, biologics were only 40% likely to be cost-effective in patients with high disease activity, given a willingness-to-pay threshold of AED 555,014 (CET × 2). Figure 3 shows the cost-effectiveness acceptance curve with disease states. Section 3 of the Supplementary Material, Figure S5 (A & B), illustrates the differences between various biologic and non-biologic treatments, as well as etanercept. Table 4 compares the point estimate of the cost per utility of the deterministic variables, Markov chain model, and Monte Carlo simulation.

We have explored several cost-containment strategies applicable to managing patients with axSpA. For example, medication price reductions by 20% lowered the ICER by 18%. Another impactful cost-saving factor was switching to biosimilars or JAK inhibitors, both of which provide significant cost benefits. A biologic de-escalation strategy, involving

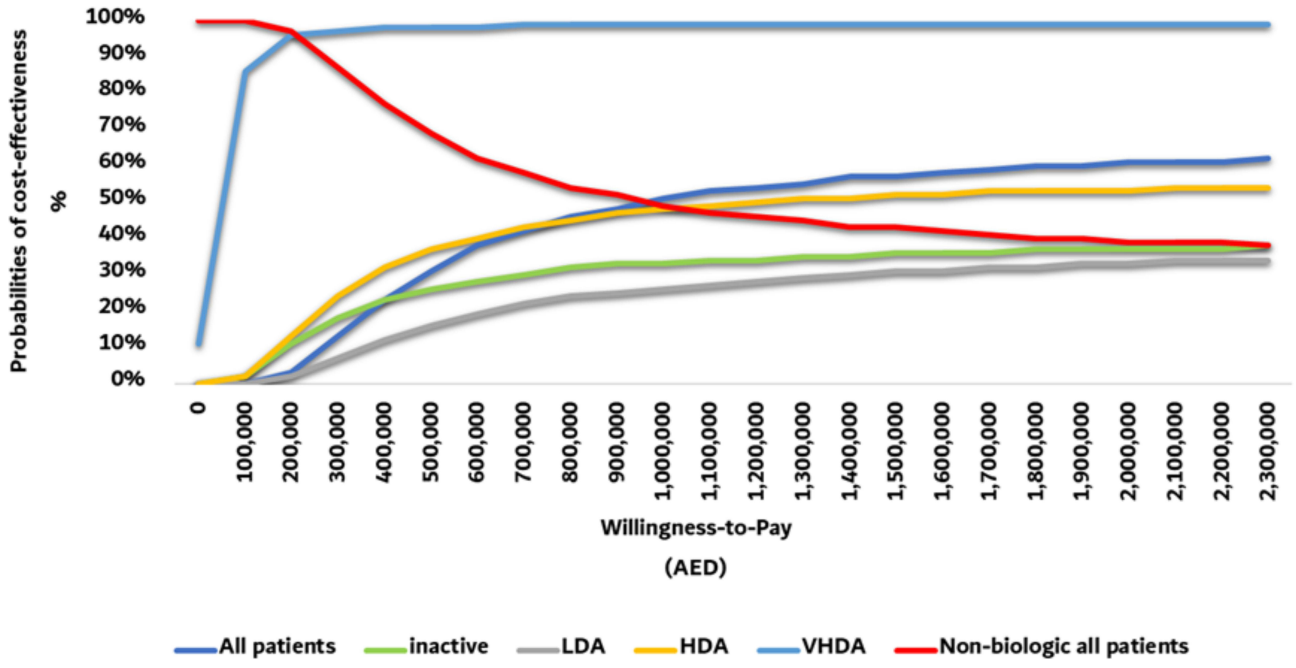

Figure 3 Cost-effectiveness acceptance curve for different disease states.
Abbreviations: LDA, low disease activity; HAD, high disease activity; VHDA, very high disease activity; %, percentage; AED, United Arab Emirates dirham.

reduced doses or longer intervals between scheduled doses, enables patients with sustained inactive disease to continue biologic treatment for 1 year or longer, resulting in a 17% decline in the ICER. Table 5 illustrates the impact of cost-containment strategies, trade-offs, and mitigation plans.

Table 4 Point Estimate of Cost per Utility Gained per Disease State and Treatment in the Base Case, Markov Chain Model, and Monte Carlo Simulations

Cost per Utility	Deterministic (AED)	Markov Simulation (AED)	Monte Carlo Simulation (AED)	Markov Simulation	Monte Carlo Simulation
Biologic therapy					
Inactive	64,218	63,687	63,520	99.2%	98.9%
Low disease Activity	129,898	129,872	128,738	100.0%	99.1%
HDA	118,101	117,252	113,776	99.3%	96.3%
VHDA	88,268	86,986	87,036	98.5%	98.6%
Non-biologic therapy					
Inactive	7058	7048	7024	99.9%	99.5%
Low disease Activity	7038	7002	6964	99.5%	99.0%
HDA	23,179	23,065	23,162	99.5%	99.9%
VHDA	163,817	163,405	159,939	99.7%	97.6%

(*Continued*)

Table 4 (Continued).

Cost per Utility	Deterministic (AED)	Markov Simulation (AED)	Monte Carlo Simulation (AED)	Markov Simulation	Monte Carlo Simulation
Biologic agents					
Adalimumab	142,455	136,890	137,944	96.1%	96.8%
Certolizumab pegol	132,479	130,240	127,582	98.3%	96.3%
Etanercept	63,064	62,643	61,410	99.3%	97.4%
Golimumab	158,063	151,650	152,452	95.9%	96.5%
Infliximab	118,095	113,222	110,284	95.9%	93.4%
Secukinumab	156,870	150,871	149,858	96.2%	95.5%

Notes: The median cost per utility from deterministic analysis, Markov chain modeling, and Monte Carlo simulation showed overall similarities among these values, suggesting the robustness of the estimates.
Abbreviations: LDA, low disease activity; HAD, high disease activity; VHDA, very high disease activity; %, percentage; AED, United Arab Emirates dirham.

Discussion

This study compared the cost-effectiveness of biologic versus non-biologic treatments in patients with axSpA residing in the UAE. Although biologic therapies incur higher upfront costs, they lead to better disease control. Overall, the ICER for biologics remained below the estimated CET, offering a positive net monetary benefit.

This study was conducted in a public hospital setting where most patients had medical insurance coverage for biologic treatments, and medications were procured at prices lower than the standard market rate. This setting has a considerable influence on the calculated ICER—reduced medication costs and insurance support helped lower the total direct costs associated with treatment. Consequently, biologics, despite having inherently higher base costs, appeared more cost-effective than non-biologics in this context as the additional costs were mitigated, resulting in a more favorable ICER compared to a setting lacking these financial benefits. Patients with axSpA without medical insurance tend to experience delayed diagnosis and suboptimal access to effective treatments. These factors can contribute to higher indirect costs, such as loss of productivity and disability, ultimately increasing the overall societal burden in the long run.[29]

In addition, most available ICER data in patients with axSpA are available from studies conducted outside the Middle East,[30,31] simulating the data from randomized controlled trials and registries; limited information is available from the Middle East. Indeed, the differences in healthcare systems, treatment guidelines, and associated costs, as well as willingness to pay across different regions, can significantly affect ICER outcomes for biologics.

A one-way sensitivity analysis identified several subgroups of patients with axSpA who had higher ICERs than the average value. These subgroups included patients with disease duration < 5 years, female individuals, those with r-axSpA, co-existing fibromyalgia, and those receiving a combination of biologics and c-DMARDs. These findings are consistent with those of previous studies that have identified similar trends.[32–35] Early axSpA is associated with higher direct costs due to diagnostic delays,[32] potential overtreatment, and high initial costs for intensive monitoring and therapy.[33] In addition, early axSpA is associated with significant pain and fatigue, which reduce work productivity and lead to substantial indirect costs related to productivity losses.[34,35] Female patients with axSpA experience worse health outcomes because they have a longer delay in diagnosis, higher disease activity, and significantly lesser responsiveness to biologic treatment compared to male patients.[36] In addition, the co-existence of fibromyalgia is often associated with considerably higher pain severity, higher disease activity, and worse quality of life in patients with axSpA than in those without fibromyalgia.[37] In contrast, our results revealed that patients who maintained sustained inactive disease for 2 years exhibited lower ICERs, compared with those with other disease activity states. This finding is in line with the recommendations that treat-to-target has favorable health economic outcomes.[38]

Table 5 Impact of Cost-Containment Strategies, Trade-Offs, and Mitigation Plans

Cost-Containment Strategies	ICER (AED)	ICER Reduction (AED)	% Reduction	Trade-Offs	Mitigations
Base case	253,617	0	0%	-	-
20% discount on treatment	208,031	45,586	18.0%	No trade-offs	Not needed
Switching to a biosimilar	186,533	67,085	26.5%	Efficacy and safety perception Immunogenicity considerations Patient confidence	Comprehensive patient education Close monitoring post-switch Shared decision-making Pharmacovigilance and registries
Switching to JAK inhibitors	207,640	45,977	18.1%	Different mechanisms of action Safety profile considerations Monitoring and management	Patient selection Safety and monitoring protocols Informed consent and education Periodic re-evaluation
De-escalation for those in inactive disease	210,880	42,737	16.9%	Risk of disease flare Uncertainty of long-term success Psychological impact	Gradual dose reduction Structured monitoring Patient agreement and counselling Ready plan for escalation

Notes: Implementation of cost-containment strategies resulted in a reduction of the ICER ranging from 16% to 26%.
Abbreviations: ICER, incremental cost-effectiveness ratio; %, percentage; AED, United Arab Emirates dirham; JAK, Janus kinases inhibitor.

In the Markov model, the simulations of the probabilities of health state transitions had stabilized over time, reaching a steady state after 30 years. This stability is due to the long-term behavior of a Markov process convergent to an equilibrium distribution. The base cases included patients with various levels of disease activity, enabling rheumatologists to increase or decrease the drug doses to attain or maintain the desired clinical targets. Additionally, some patients had previously not responded to biologic therapies and were switched to alternative biologics before enrolling in the study. All these factors influenced the reported ICER of individual biologic agents.

To the best of our knowledge, this is the first non-interventional, registry-based, prospective cohort study to evaluate the cost-effectiveness of available treatment strategies and individual biologics in patients with axSpA in the Middle East. It encompasses a spectrum of patients with different disease activity states, including those on regular and de-escalated treatment doses. Moreover, a lifetime horizon of 62 years (31 cycles) was used for the base-case analysis—an approach deemed suitable for chronic diseases, such as axSpA. The data were cross-validated with EMR and registry reports to ensure accuracy before calculating costs.

This study has some limitations that should be acknowledged. First, unlike clinical trials that include patients with severe disease activities, this study included patients with a spectrum of disease activity at baseline, which may have influenced the study outcomes. Second, calculating health utility based on ASDAS, age, and sex—an approach not yet validated in the UAE—might have introduced measurement variability. Although we identified non-compliance that led to treatment discontinuation, compliance validation during the study was not as accurate as it would be in a clinical trial setting, with patients classified as compliant if their adherence was between 75% and 100%, which was calculated retrospectively during the clinic visit. Being a single-center study presents notable limitations on generalizability. Factors such as Institutional treatment regimens and regional payment regulations may restrict the generalizability of our findings to larger healthcare systems or settings with diverse resource limitations. It is crucial to interpret the results in view of these limitations. Furthermore, the coronavirus disease pandemic may have underestimated the direct and indirect costs

in the last 6 months of the study, as limited accessibility to clinics and remote work concealed the need for work abstinence during the pandemic.

The growing evidence supports the cost-effectiveness and clinical benefits of biologics in patients with axSpA, their higher medication costs can be justified by their long-term clinical benefits for clinicians and policymakers.[39] This research is applicable to clinicians in outlining the variabilities in clinical response, especially among specific subgroups, indicating that treatment decisions should be closely aligned with patient-specific factors, including disease duration, sex, the presence of comorbid fibromyalgia, convenience, and insurance coverage. This personalized approach not only optimizes patient outcomes but also potentially enhances cost-effectiveness when integrated with precision de-escalation strategies, as proposed by the originator, or by switching to a biosimilar or JAK inhibitors without losing efficacy in patients who achieved clinical targets (non-medical switching). Furthermore, the loss of efficacy or safety concerns enables clinicians to switch biologics to JAK inhibitors, offering an additional cost-saving opportunity (medical-switching).[40]

This study provides compelling evidence for regional policymakers that investing in biologic treatment, despite their relatively high costs, yields long-term benefits, enhances clinical outcomes, and lowers indirect expenses related to work absenteeism and early retirement. Essentially, improving patient outcomes leads to a healthier workforce and decreased overall societal expenditures. Furthermore, the study explores additional means of enhancing cost-effectiveness through one approach or a combination of these strategies. Reducing medication prices, switching to biosimilars, and implementing precision de-escalation—where patients with sustained inactive disease are given a lower dose or a longer interval between doses—can lead to significant cost savings. More specifically, our findings suggest that policymakers should prioritize negotiation to reduce medication prices, promote biosimilar uptake, and support treatment strategies that optimize the timing and duration of biologic therapies. Supported by Markov and Monte Carlo models, the analysis demonstrates that with tailored cost-reduction approaches, healthcare spending can be sustained or reduced in the long term while preserving or enhancing patient care outcomes. In summary, the data underscore opportunities to align national healthcare policies with patient-centered outcomes. For public hospitals, formulary decisions and treatment protocols could be revised to prioritize direct access to biologics for axSpA patients who fail to achieve clinical targets, as delays in effective therapy correlate with higher long-term disability and costs. National insurance systems could adopt dynamic coverage policies that expand reimbursement for biologics during periods of clinically active disease, reducing financial burden on patients and society. To ensure sustainability, policymakers might enforce de-escalation of the originator or switching (to biosimilar transitions or JAK inhibitors) mandates for patients in sustained inactive disease or low disease activity, coupled with monitoring systems to track adherence. Finally, risk-sharing agreements between governments and manufacturers could lower upfront costs for public hospitals while ensuring equitable access. Such measures would require collaboration between regulatory bodies, insurers, and providers to balance the financial responsibility with improved axSpA outcomes.

Recommendations for future research should include—regional direction and global perspective. In the UAE, both public hospitals and private sector participation are essential in conducting similar studies to obtain a precise estimate of the costs associated with axSpA management. The findings will have significant clinical and health system implications for the region. There is also a need for longitudinal, multicenter studies that focus on homogeneous axSpA patient populations in real-world clinical settings. These studies will aid in the exploration of various cost-containment strategies, particularly for individuals who have achieved sustained inactive disease. The findings of these studies will provide valuable insights that would not only improve future management of these conditions but also show how different healthcare systems can optimize resource utilization.

Conclusion

Biologic therapies are cost-effective for patients with axSpA, especially those who are not achieving clinical targets. Targeted cost-containment strategies, such as biosimilar adoption and medication price reductions, can enhance value and yield long-term clinical benefits while reducing societal costs. Our findings underscore important aspects of cost-effective axSpA management in the Middle East and provide valuable insights for healthcare professionals and policymakers.

Future research should focus on longitudinal studies within the region and broader cost-related data collection to validate our findings and enhance generalizability.

Abbreviations

ADA, Adalimumab; AED, United Arab Emirates dirham; ASAS, Assessment of SpondyloArthritis International Society; ASDS-CRP, Average ankylosing spondylitis disease activity score-C-reactive protein; axSpA, axial Spondyloarthritis; c-DMARD, conventional disease-modifying antirheumatic drug; CER, Certolizumab; CET, cost-effectiveness threshold; DMARD, disease-modifying antirheumatic drug; EMR, electronic medical record; EQ-5D-3L, EuroQol five-dimensional questionnaire with 3 levels of response; ETA, Etanercept; GDP, gross domestic product; IFX, Infliximab; NMB, net monetary benefit; NSAID, non-steroidal anti-inflammatory drug; QALY, quality-assurance life years; SpA, spondylarthritis; UAE, United Arab Emirates.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article (and its Supplementary Information Files).

Ethical Approval and Informed Consent

This research adhered to the ethical guidelines outlined in the Declaration of Helsinki. The study was approved by the Institutional Review Board of the Dubai Scientific Research Ethics Committee (DSREC), supervised by the Dubai Health Authority (approval number: DSREC-07/2018_03). All patients involved in the study signed written informed consent.

Acknowledgments

We express our sincere gratitude to AbbVie for sponsoring this research. The support provided was instrumental in conducting this comprehensive study. We thank the revenue cycle management team in Dubai Hospital for providing all financial details related to hospital encounters and services.

Author Contributions

All authors made significant contributions to the work reported, whether in the conception, study design, execution, data acquisition, analysis and interpretation, or in all of these areas. They participated in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and are accountable for all aspects of the work.

Funding

The authors disclose that AbbVie Inc. funded this study as part of physician-initiated research, reference number: 7000961511. This funding arrangement was designed to support independent scientific inquiry, and AbbVie Inc. had no role in the study design, data collection, analysis, or interpretation of results or writing of the manuscript. The authors had full access to all the data and final responsibility for the decision to submit the manuscript for publication.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Neerinckx B, Lories RJ. Structural disease progression in axial spondyloarthritis: still a cause for concern? *Curr Rheumatol Rep*. 2017;19(3):14. doi:10.1007/s11926-017-0639-7
2. Cuervo F-M, Santos AM, Peláez-Ballestas I, et al. Comparison of quality of life in patients with musculoskeletal symptoms, those with other comorbidities, and healthy people, in a Colombian open population study. *Revista Colombiana de Reumatología*. 2020;27(3):166–176. doi:10.1016/j.rcreu.2020.04.002
3. Al Saleh J, Sayed ME, Monsef N, Darwish E. The prevalence and the determinants of musculoskeletal diseases in Emiratis attending primary health care clinics in Dubai. *Oman Med J*. 2016;31(2):117–123.

4. Stolwijk C, van Onna M, Boonen A, van Tubergen A. Global prevalence of spondyloarthritis: a systematic review and meta-regression analysis. *Arthritis Care Res*. 2016;68(9):1320–1331. doi:10.1002/acr.22831
5. Alonso S, Morante I, Alperi M, Queiro R. The ASAS health index: a new era for health impact assessment in spondyloarthritis. *J Rheumatol*. 2022;49(1):8–15. doi:10.3899/jrheum.200586
6. Wordsworth BP, Mowat AG. A review of 100 patients with ankylosing spondylitis with particular reference to socio-economic effects. *Br J Rheumatol*. 1986;25(2):175–180. doi:10.1093/rheumatology/25.2.175
7. Boonen A, van der Heijde D, Landewe R, et al. Direct costs of ankylosing spondylitis and its determinants: an analysis among three European countries. *Ann Rheum Dis*. 2003;62(8):732–740. doi:10.1136/ard.62.8.732
8. Reveille JD, Ximenes A, Ward MM, Deodhar A, Clegg D. Economic considerations of the treatment of ankylosing spondylitis. *Am J Med Sci*. 2012;343(5):371–374. doi:10.1097/MAJ.0b013e3182514093
9. Martindale J, Smith J, Sutton CJ, Grennan D, Goodacre L, Goodacre JA. Disease and psychological status in ankylosing spondylitis. *Rheumatology*. 2006;45(10):1288–1293. doi:10.1093/rheumatology/kel115
10. Zochling J, van der Heijde D, Burgos-Vargas R, et al. ASAS/EULAR recommendations for the management of ankylosing spondylitis. *Ann Rheum Dis*. 2006;65(4):442–452. doi:10.1136/ard.2005.041137
11. Boonen A, van der Heijde D, Severens JL, et al. Markov model into the cost-utility over five years of etanercept and infliximab compared with usual care in patients with active ankylosing spondylitis. *Ann Rheum Dis*. 2006;65(2):201–208. doi:10.1136/ard.2004.032565
12. Khampaen T, Kafaksom T, Dechapaphapitak N, Tongdee N, Chevaisrakul P. Correlations among quality of life, spinal mobility, and disease activity in early-treated axial spondyloarthritis: a single-center cross-sectional study. *BMC Rheumatol*. 2024;8(1):54. doi:10.1186/s41927-024-00426-2
13. Nossent JC, Sagen-Johnsen S, Bakland G. Disease activity and patient-reported health measures in relation to cytokine levels in ankylosing spondylitis. *Rheumatol Ther*. 2019;6(3):369–378. doi:10.1007/s40744-019-0161-7
14. Garrido-Cumbrera M, Collantes-Estevez E, Navarro-Compan V, et al. Patients with axial spondyloarthritis are great consumers of healthcare resources, especially young and women: results from the Spanish Atlas. *Rheumatol Ther*. 2023;10(3):729–739. doi:10.1007/s40744-023-00543-3
15. Garrido-Cumbrera M, Navarro-Compan V, Bundy C, et al. *Axial Spondyloarthritis: Patient-Reported Impact in Europe*. Cham (CH): Springer; 2022.
16. Rudwaleit M. New approaches to diagnosis and classification of axial and peripheral spondyloarthritis. *Curr Opin Rheumatol*. 2010;22(4):375–380. doi:10.1097/BOR.0b013e32833ac5cc
17. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373–383. doi:10.1016/0021-9681(87)90171-8
18. Nas K, Yildirim K, Cevik R, et al. Discrimination ability of ASDAS estimating disease activity status in patients with ankylosing spondylitis. *Int J Rheum Dis*. 2010;13(3):240–245. doi:10.1111/j.1756-185X.2010.01537.x
19. Lukas C, Landewe R, Sieper J, et al. Development of an ASAS-endorsed disease activity score (ASDAS) in patients with ankylosing spondylitis. *Ann Rheum Dis*. 2009;68(1):18–24. doi:10.1136/ard.2008.094870
20. Glover F. UAE salary guide 2022: how much should you be earning in Dubai and Abu Dhabi? 2022. Available from: https://www.thenationalnews.com/business/money/2022/01/06/uae-salary-guide-2022-how-much-should-you-be-earning/. Accessed November 20, 2024.
21. Berbel-Arcobe L, Aparicio M, Calvet J, et al. Association between diagnostic delay and economic and clinical burden in axial spondyloarthritis: a multicentre retrospective observational study. *Rheumatol Ther*. 2025;12(2):255–266. doi:10.1007/s40744-024-00742-6
22. Strand V, Singh JA. Patient burden of axial spondyloarthritis. *J Clin Rheumatol*. 2017;23(7):383–391. doi:10.1097/RHU.0000000000000589
23. Aldallal S, Farghaly M, Fahmy S, et al. Thresholds for the value judgement of health technologies in the United Arab Emirates: a consensus approach through voting sessions. *BMJ Open*. 2024;14(11):e090344. doi:10.1136/bmjopen-2024-090344
24. Data Commons is an initiative from Google. Explore diverse data, learn to use its tools through Python examples, and stay updated on the latest news and research. Available from: https://datacommons.org/place/country/ARE. Accessed March 22, 2025.
25. Smolen JS, Schols M, Braun J, et al. Treating axial spondyloarthritis and peripheral spondyloarthritis, especially psoriatic arthritis, to target: 2017 update of recommendations by an international task force. *Ann Rheum Dis*. 2018;77(1):3–17. doi:10.1136/annrheumdis-2017-211734
26. Al Sayah F, Roudijk B, El Sadig M, et al. A value set for EQ-5D-5L in the United Arab Emirates. *Value Health*. 2025;28(4):611–621. doi:10.1016/j.jval.2025.01.003
27. Hernandez Alava M, Wailoo A, Chrysanthou G, et al. Measuring quality of life of patients with axial spondyloarthritis for economic evaluation. *RMD Open*. 2022;8(1):e001955. doi:10.1136/rmdopen-2021-001955
28. Landewe RB, van der Heijde D, Dougados M, et al. Maintenance of clinical remission in early axial spondyloarthritis following certolizumab pegol dose reduction. *Ann Rheum Dis*. 2020;79(7):920–928. doi:10.1136/annrheumdis-2019-216839
29. Zhao SS, Pittam B, Harrison NL, Ahmed AE, Goodson NJ, Hughes DM. Diagnostic delay in axial spondyloarthritis: a systematic review and meta-analysis. *Rheumatology*. 2021;60(4):1620–1628. doi:10.1093/rheumatology/keaa807
30. Le QA, Kang JH, Lee S, Delevry D. Cost-effectiveness of treatment strategies with biologics in accordance with treatment guidelines for ankylosing spondylitis: a patient-level model. *J Manag Care Spec Pharm*. 2020;26(10):1219–1231. doi:10.18553/jmcp.2020.26.10.1219
31. Ara RM, Reynolds AV, Conway P. The cost-effectiveness of etanercept in patients with severe ankylosing spondylitis in the UK. *Rheumatology*. 2007;46(8):1338–1344. doi:10.1093/rheumatology/kem133
32. Rudwaleit M, Khan MA, Sieper J. The challenge of diagnosis and classification in early ankylosing spondylitis: do we need new criteria? *Arthritis Rheum*. 2005;52(4):1000–1008. doi:10.1002/art.20990
33. Boonen A, Webers C. Economic evaluations in axial spondyloarthritis. In: Mease P, Khan MA, editors. *Axial Spondyloarthritis*. Elsevier; 2019:259–279.
34. Boonen A, Sieper J, van der Heijde D, et al. The burden of non-radiographic axial spondyloarthritis. *Semin Arthritis Rheum*. 2015;44(5):556–562. doi:10.1016/j.semarthrit.2014.10.009
35. Corbett M, Soares M, Jhuti G, et al. Tumour necrosis factor-alpha inhibitors for ankylosing spondylitis and non-radiographic axial spondyloarthritis: a systematic review and economic evaluation. *Health Technol Assess*. 2016;20(9):1.
36. Rusman T, van Vollenhoven RF, van der Horst-Bruinsma IE. Gender differences in axial spondyloarthritis: women are not so lucky. *Curr Rheumatol Rep*. 2018;20(6):35.
37. Son SM, Kim DS, Lee JS. Fibromyalgia in axial spondyloarthritis: a meta-analysis. *J Clin Rheumatol*. 2022;28(1):e222–e227.
38. Webers C, Been M, van Tubergen A. Go or no-go for treat-to-target in axial spondyloarthritis? *Curr Opin Rheumatol*. 2023;35(4):243–248. doi:10.1097/BOR.0000000000000941

39. Dougados M. Treat to target in axial spondyloarthritis: from its concept to its implementation. *J Autoimmun*. 2020;110:102398. doi:10.1016/j.jaut.2019.102398
40. Ramiro S, Nikiphorou E, Sepriano A, et al. ASAS-EULAR recommendations for the management of axial spondyloarthritis: 2022 update. *Ann Rheum Dis*. 2023;82(1):19–34. doi:10.1136/ard-2022-223296