

## **A scoping review of literature: What has been studied about mental health problems among individuals with ankylosing spondylitis?**

### **Abstract**

**Background:** Research on mental health problems in individuals with ankylosing spondylitis (AS) has rapidly expanded since 2013. However, the evidence in this field can appear fragmented due to the limited number of existing reviews that synthesize research findings.

**Aim:** To map the evidence regarding the prevalence, correlated factors, and interventions for mental health problems in the AS population.

**Methods:** This review followed Arksey and O'Malley's framework and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews. Six electronic databases were searched for studies published in English since January 2013. Study quality was assessed using the Mixed Methods Appraisal Tool, and data were narratively summarized and reported.

**Results:** Seventy articles were included in this review. The prevalence rates of depression, anxiety, and sleep disorders ranged from 3.1% to 66.0%, 2.7% to 78.0%, and 1.7% to 71.7%, respectively. Correlated factors included sociodemographic variables, disease-related aspects, physical symptoms and function, and psycho-behavioral factors. Interventions were categorized into physical exercise, therapeutic, and psychosocial approaches.

**Conclusions:** Mental health problems are prevalent among individuals with AS, and the correlated factors are multidimensional. Interventions aimed at physical function, disease activity, and cognitive functions have been identified as critical strategies for addressing mental health problems. Further research is needed to design and develop effective interventions targeting these correlated factors, particularly psycho-social interventions, to prevent future deterioration.

**Keywords:** Ankylosing spondylitis; Mental health; Scoping review

## Introduction

Ankylosing Spondylitis (AS) is a chronic inflammatory disease that primarily affects the axial skeleton and sacroiliac joint, resulting in progressive spinal fusion (Sun et al., 2023). Consequently, a significant proportion of individuals with AS experience impaired mobility and diminished daily functioning (Navarro-Compán et al., 2021; Zhu et al., 2019). The disease can also manifest with extra-articular involvement, affecting organs such as the eyes, lungs, heart, and kidneys, thereby increasing mortality and morbidity rates (Saad et al., 2022). The global prevalence of AS is estimated to range from 0.07% to 0.32%, with a higher prevalence in males compared to females (Chen et al., 2020; Nelson et al., 2023). Symptom onset typically occurs in the twenties, or thirties, with profound and long-lasting effects on the lives of those affected (Boel et al., 2022; Kishimoto et al., 2023).

Individuals with AS are particularly susceptible to mental health problems due to a variety of factors. Chronic pain and stiffness associated with AS have a detrimental impact on overall well-being, increasing the risk of depression and anxiety (Omar et al., 2023; Webers et al., 2019). Additionally, physical impairment can lead to social isolation, further exacerbating the risk of mental health problems (Li et al., 2024). A lack of social support intensifies feelings of isolation and stress, exacerbating mental health problems within this population (Rat et al., 2021; Wysocki et al., 2023). Moreover, **maladaptive coping strategies in response to AS symptoms are associated with an increased risk of developing mental health problems (Ben Tekaya et al., 2024).**

Research indicates a high prevalence of mental health problems among individuals with AS. A systematic review reported a pooled prevalence of depression at 35%, with estimates from individual study ranging from 3% to 66% (Zhang et al., 2019). Another study found a pooled prevalence of sleep disorders at 53%, with Egypt reporting the highest prevalence at 90% and Australia the lowest at 19.2%(Salari et al., 2023). A cross-sectional study in Syria revealed that 36.9 % of participants exhibited clinically significant symptoms of anxiety (Safiah et al., 2024). If left untreated, these mental

health problems can lead to a range of negative outcomes, including diminished quality of life, reduced treatment adherence, increased healthcare utilization, and even suicide (Kuriya et al., 2020; Ma et al., 2022; Wu et al., 2017).

Recognizing the burden and impact of mental health problems among individuals with AS, various interventions have been implemented to improve their mental health. These include anti-tumor necrosis factor treatment (In et al., 2016; Webers et al., 2020), exercise interventions (Lane et al., 2022), cognitive-behavioral therapy and patient education programs (Frye & Rawlins, 2023; Y. Q. Song et al., 2021). However, existing evidence regarding mental health problems in the AS population is fragmented and lacks comprehensive synthesis, impeding the identification of effective solutions to enhance mental health on a global scale.

To address this gap, a scoping review is well-suited to map the evidence related to three key aspects: (1) the mental health problems experienced by individuals living with AS, (2) the factors correlated with these mental health problems, and (3) the interventions involved improving mental health problems in this population. Such a review will provide a comprehensive overview of the mental health challenges faced by individuals with AS, thereby informing the development of targeted strategies and interventions to enhance their mental health outcomes.

## **Methods**

This scoping review was conducted following the framework outlined by Arksey & O'Malley (Arksey & O'Malley, 2005), which consists of five steps: (1) formulating the research questions; (2) identifying relevant studies; (3) selecting studies for inclusion; (4) extracting the data; and (5) synthesizing and reporting the results. **Additionally, the review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist (Tricco et al., 2018), as detailed in Additional File 1.**

### *Step 1: formulating the research questions*

As outlined in the introduction, this scoping review aimed to comprehensively examine the existing evidence related to mental health problems in individuals with AS. Specifically, the review sought to address the following three research questions: (1) What mental health problems are experienced by individuals diagnosed with AS across different global regions? (2) What factors are associated with the development of mental health problems among individuals living with AS? and (3) What types of interventions have been implemented to support and promote mental health in this population?

### *Step 2: identifying relevant studies*

An initial literature search was conducted in the PubMed database to familiarize the research team with the existing literature, refine the research objectives, and identify relevant keywords and medical subject headings. Subsequently, a comprehensive search was carried out across six databases: PubMed, Web of Science, Embase, Scopus, Cochrane Library, and PsycINFO. These databases were selected to ensure a robust and multidisciplinary coverage of the relevant literature (Gusenbauer & Haddaway, 2020). The search terms and strategies were tailored to each database to optimize the identification of pertinent studies (details provided in Additional File 2).

### *Step 3: selecting studies for inclusion*

The inclusion criteria for this scoping review were: (1) studies published in English, (2) studies focusing on individuals with AS as the study population, and (3) articles investigating the prevalence, correlated factors, or interventions related to mental health problems. Exclusion criteria included: (1) reviews, conference abstracts, editorials, and study protocols, (2) studies published before 2013, and (3) studies for

which the full-text articles could not be obtained by the research team.

The study selection process involved the following steps: (1) importing identified studies into EndNote 9 and removing duplicates, (2) two reviewers (MXX and HYL) independently screened the titles and abstracts to exclude irrelevant studies, (3) retrieving and reviewing the full text of the remaining studies based on the inclusion and exclusion criteria, (4) resolving any disagreements between the reviewers through discussion with a third reviewer (LY), and (5) visualizing the study selection process in a PRISMA-ScR flow diagram (Figure 1).

#### *Step 4: extracting the data*

The included studies were thoroughly reviewed to extract the following information: authors, publication year, country, study design, sample size, gender ratio, age, disease duration, outcomes and assessment tools, prevalence of mental health problems, correlated factors, interventions, relevant findings, and **Mixed Methods Appraisal Tool (MMAT) score**. This information was charted into a Microsoft Excel database by the first author and verified by the other authors.

The methodological quality of the included studies was evaluated by two independent raters (MXX and HYU) utilizing the MMAT 2018 Version (Hong et al., 2018). The MMAT assesses five distinct methodological categories, making it applicable to various study designs, and is recognized for its reliability, validity, and efficiency (Afaya et al., 2021; Henning & Smith, 2023).

#### *Step 5: synthesizing and reporting the results*

Following the data extraction, the information gathered from the studies was organized into four tables and one figure that present the descriptive data of the included studies (see Table 1, Appendix A, Appendix B, Additional File 3, and Figure 2). Due to the heterogeneity of the studies, data pooling was not feasible, and findings are reported

on a study-by-study basis. The research team compiled all data into the appropriate cells within the tables, collectively addressing any discrepancies. After identifying the correlates of mental health problems, we examined intervention programs involved improving mental health. This process involved extracting intervention content, outcomes, assessment tools, and effectiveness to synthesize the information into a cohesive representation.

## **Results**

### *Characteristics of included studies*

The initial search yielded a total of 2,424 records. After removing duplicates, 1,543 unique records underwent title and abstract screening. Of these, 156 were selected for full-text review, and ultimately, 79 studies met the inclusion criteria and were included in the review. Of the included studies, the majority were quantitative non-randomized studies (n=67), comprising 46 cross-sectional studies, 9 cohort studies, 7 pre-post tests, and 5 non-randomized controlled designs. Quantitative randomized controlled trials (n=11) represented the second most common publication type, while the review also included one qualitative study. In total, the 79 articles involved 29,998 individuals diagnosed with AS, with sample size for individual studies ranging from 1 to 5,825 AS participants. The majority of studies were conducted in Asia (71%) (Acar et al., 2023; Altindag et al., 2021; Arisoy et al., 2013; Aydin et al., 2015; Aydin et al., 2016; Batmaz et al., 2013; Cay et al., 2022; Chen et al., 2021; Coksevim et al., 2018; Demir et al., 2013; Demirci et al., 2016; Dhakad et al., 2015; Dundar et al., 2014; Emmungil et al., 2021; Ersozlu-Bozkirli et al., 2015; Fang et al., 2019; Gica et al., 2021; Gong et al., 2024; In et al., 2016; Jiang et al., 2018; Jiang et al., 2015; Karaca et al., 2022; Karatas et al., 2018; Karatekin et al., 2023; Kilic et al., 2014; Kisacik et al., 2016; Lan et al., 2023; Nam et al., 2021; Nie et al., 2018; Oksuz et al., 2021; Oksuz & Unal, 2023; Omar et al., 2023; Oskay et al., 2018; Oskay et al., 2017; Park et al., 2019; Park et al., 2014;

Qian et al., 2023; Qin, 2020; Safiah et al., 2024; Sariyildiz et al., 2013; Shen et al., 2014; C. C. Shen et al., 2016; T. C. Shen et al., 2016; Singh et al., 2023; B. W. Song et al., 2021; Song & Chen, 2021; Y. Q. Song et al., 2021; Uslu et al., 2022; Wu et al., 2024; Xu et al., 2016; Yigit et al., 2013; Yildirim et al., 2017; Yuce et al., 2023; Zhang et al., 2016; Zhou et al., 2021; Zou et al., 2016) , followed by North America (14%) (Dau et al., 2018; Dubreuil et al., 2024; Frye & Rawlins, 2023; Hwang et al., 2024; Hwang et al., 2020; Karmacharya et al., 2024; Katz et al., 2022; Liew et al., 2017; Park et al., 2014; Reveille et al., 2020; Wu et al., 2017) and Europe (11%) (Anyfanti et al., 2016; Hyphantis et al., 2013; Meesters, Bremander, et al., 2014; Meesters, Petersson, et al., 2014; Navarro-Compan et al., 2023; Piekutin et al., 2018; Primholdt et al., 2017; Webers et al., 2020; Webers et al., 2019). Studies from Africa (Abdul-Sattar & Abou El Magd, 2017; Hakkou et al., 2013) and Oceania (Tymms et al., 2022) accounted for 3% and 1% of the included studies, respectively (Figure 2-A).

### *Prevalence of mental health problems*

The reviewed studies reported a variety of mental health outcomes among individuals with AS (see Figure 2-B). Many articles focused on single mental health outcomes, including depression (N=21) (Cay et al., 2022; Dau et al., 2018; Demir et al., 2013; Ersozlu-Bozkirli et al., 2015; Fang et al., 2019; Hwang et al., 2020; Hyphantis et al., 2013; Karmacharya et al., 2024; Kisacik et al., 2016; Meesters, Bremander, et al., 2014; Nam et al., 2021; Oksuz et al., 2021; Oskay et al., 2018; Oskay et al., 2017; Piekutin et al., 2018; Primholdt et al., 2017; Y. Q. Song et al., 2021; Uslu et al., 2022; Webers et al., 2020; Webers et al., 2019; Wu et al., 2017), sleep disorders (N=8) (Altindag et al., 2021; Aydin et al., 2015; Batmaz et al., 2013; Chen et al., 2021; Demirci et al., 2016; In et al., 2016; Karatas et al., 2018; B. W. Song et al., 2021), psychological distress (N=6) (Abdul-Sattar & Abou El Magd, 2017; Dundar et al., 2014; Hwang et al., 2024; Lan et al., 2023; Navarro-Compan et al., 2023; Reveille et al., 2020), or post-traumatic stress disorder (N=1) (Liew et al., 2017). Dual outcomes were also common,

with 24 studies examining both anxiety and depression (Arisoy et al., 2013; Aydin et al., 2016; Dhakad et al., 2015; Emmungil et al., 2021; Frye & Rawlins, 2023; Gica et al., 2021; Gong et al., 2024; Howren et al., 2023; Karaca et al., 2022; Karatekin et al., 2023; Katz et al., 2022; Kilic et al., 2014; Park et al., 2019; Park et al., 2014; Qian et al., 2023; Sariyildiz et al., 2013; Shen et al., 2014; Singh et al., 2023; Wu et al., 2024; Xu et al., 2016; Yildirim et al., 2017; Zhang et al., 2016; Zhou et al., 2021; Zou et al., 2016). Other combinations included depression and sleep disorders (N=4) (Acar et al., 2023; Coksevim et al., 2018; Tymms et al., 2022; Yuce et al., 2023), depression and psychological distress (N=2) (Song & Chen, 2021; Yigit et al., 2013), sleep disorders and psychological distress (N=2) (Dubreuil et al., 2024; Qin, 2020). Additionally, some studies explored three or more mental health problems concurrently: anxiety, depression, and sleep disorders (N=6) (Hakkou et al., 2013; Jiang et al., 2018; Jiang et al., 2015; Nie et al., 2018; Oksuz & Unal, 2023; Safiah et al., 2024); anxiety, depression, and comorbid anxiety and depression (N=2) (Anyfanti et al., 2016; Meesters, Petersson, et al., 2014); sleep disorders and comorbid anxiety and depression (N=1) (T. C. Shen et al., 2016), and depression, bipolar disease, and schizophrenia (N=1) (Omar et al., 2023). One study reported a combination of anxiety, depression, sleep disorders, bipolar disorder, and schizophrenia (C. C. Shen et al., 2016).

As illustrated in Figure 2-C, depression was the most frequently reported mental health problem, while post-traumatic stress disorder was the least reported. The literature demonstrated a wide range of prevalence rates for depression, anxiety, and sleep disorders (Figure 2-D). For depression, the prevalence rates varied from 3.1% to 66.0% (Dhakad et al., 2015; C. C. Shen et al., 2016), with a median prevalence of approximately 28.9%. **The median prevalence of depression differed by continent, with Asia reporting 34.35%, Europe 18.0%, North America 26.20%, Oceania 4.8%, and Africa 55.5%.** Among these studies, four classified depression into mild, moderate, and severe categories (Emmungil et al., 2021; Fang et al., 2019; Jiang et al., 2018; Meesters, Bremander, et al., 2014), while one study focused solely on moderate and severe levels (Piekutin et al., 2018). The prevalence of mild depression varied from 8.6% to 44.1%

(Jiang et al., 2018; Meesters, Petersson, et al., 2014), with a median prevalence of 20.28%. For moderate and severe depression, the prevalence rates ranged from 4.4% to 30.5% and 0.5% to 26.8% (Meesters, Petersson, et al., 2014; Piekutin et al., 2018), with a median prevalence of 13.86% and 7.88%, respectively. The prevalence of anxiety ranged from 2.7% to 78.0% (Dhakad et al., 2015; C. C. Shen et al., 2016), with a median prevalence of 34.1%. **By continent, the median prevalence of anxiety was 35.0% in Asia, 34.05% in Europe, 10.2% in North America, and 60.0% in Africa.** Additionally, the prevalence of comorbid anxiety and depression was reported as 6.4%, 11.2%, and 13.6% (Anyfanti et al., 2016; Meesters, Petersson, et al., 2014; T. C. Shen et al., 2016). In terms of sleep disorders, the prevalence ranged from 1.7% to 71.7% (Altindag et al., 2021; C. C. Shen et al., 2016), with a median prevalence of 53.5%. **The median prevalence of sleep disorders by continent was 53.5% in Asia, 19.2% in Oceania, and 64.5% in Africa.** The prevalence of bipolar disorder was reported as 0.3% and 0.6%, while the prevalence of schizophrenia was reported as 0.3% and 0.8% (Omar et al., 2023; C. C. Shen et al., 2016). Psychological distress was reported with a prevalence of 44.4% (Abdul-Sattar & Abou El Magd, 2017), and one publication reported a prevalence of 18.0% for post-traumatic stress disorder (Liew et al., 2017). Additionally, a qualitative study revealed that depression significantly hindered the daily lives of individuals with AS (Primholdt et al., 2017). Other details are summarized in Appendix A.

### *Correlates of mental health problems*

The reviewed studies identified a wide range of variables that were significantly associated with mental health problems in individuals with AS. These can be categorized into sociodemographic, disease-related, physical symptoms and function, and psycho-behavioral factors. **The correlates of anxiety, depression, sleep disorders, psychological distress, and post-traumatic stress disorderas identified in the literature search are summarized in Table 1.**

### *Sociodemographic factors*

The relationship between sociodemographic factors and mental health outcomes revealed several significant trends. Higher educational achievement was consistently associated with lower reported levels of anxiety, depression, and psychological distress (Jiang et al., 2018; Lan et al., 2023; Yildirim et al., 2017). Similarly, being employed was linked to a decreased likelihood of anxiety and depression (Fang et al., 2019; Nam et al., 2021; Safiah et al., 2024). Conversely, factors such as smoking, unmarried status, and lower income were positively correlated with increased depression (Hwang et al., 2020; Nam et al., 2021; Safiah et al., 2024). **Age has a complex relationship with mental health; younger individuals tended to report lower levels of depression (Piekutin et al., 2018), but were more likely to experience sleep disorders (B. W. Song et al., 2021) and post-traumatic stress disorder (Liew et al., 2017).** The influence of gender on mental health outcomes was mixed. Some studies indicated males had a greater propensity for depression (Webers et al., 2019), while others found females were more susceptible to depression (Karmacharya et al., 2024) and sleep disorders (Chen et al., 2021). Additionally, occupational status affected mental health, as farmers exhibited higher levels of psychological distress compared to other occupational groups (Lan et al., 2023).

**Table1. Sociodemographic, disease-related, physical symptoms and function and psycho-behavioral correlates of mental health problems**

|                                  | Anxiety    |   | Depression |  | Sleep disorders |  | Psychological distress |  | Post-traumatic stress disorder |   |
|----------------------------------|------------|---|------------|--|-----------------|--|------------------------|--|--------------------------------|---|
|                                  | Correlates | Citations   | Correlates | Citations  | Correlates      | Citations  | Correlates             | Citations  | Correlates                     | Citations                               |
| Sociodemographic characteristics |            |   |            |  |                 |  |                        |  |                                |   |
| Age                              | N/A        | N/A   | √          | (Piekutin et al., 2018)  | √               | (B. W. Song et al., 2021)  | N/A                    | N/A  | √                              | (Liew et al., 2017)                     |
| Gender                           | N/A        | N/A   | √          | (Webers et al., 2019) (Karmacharya et al., 2024)   | √               | (Chen et al., 2021)  | N/A                    | N/A  | N/A                            | N/A                                     |
| Employment status                | √          | (Safiah et al., 2024)   | √          | (Fang et al., 2019; Nam et al., 2021; Safiah et al., 2024)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Smoking status                   | N/A        | N/A   | √          | (Hwang et al., 2020; Nam et al., 2021)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Marital status                   | N/A        | N/A   | √          | (Hwang et al., 2020; Nam et al., 2021)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Socioeconomic status             | N/A        | N/A   | √          | (Safiah et al., 2024)  | N/A             | N/A  | √                      | (Lan et al., 2023)   | N/A                            | N/A                                     |
| Educational level                | √          | (Jiang et al., 2018; Yildirim et al., 2017)   | √          | (Jiang et al., 2018; Yildirim et al., 2017)  | N/A             | N/A  | √                      | (Lan et al., 2023)   | N/A                            | N/A                                     |
| Disease characteristics          |            |   |            |  |                 |  |                        |  |                                |   |
| Disease characteristics          | N/A        | N/A   | N/A        | N/A  | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Diagnostic delay                 | N/A        | N/A   | N/A        | N/A  | √               | (Nie et al., 2018)   | N/A                    | N/A  | N/A                            | N/A                                     |
| Extra-spinal manifestation       | N/A        | N/A   | √          | (Safiah et al., 2024)  | √               | (Nie et al., 2018)   | N/A                    | N/A  | N/A                            | N/A                                     |
| Disease duration                 | √          | (Jiang et al., 2018; Qian et al., 2023)   | √          | (Piekutin et al., 2018; Qian et al., 2023; Safiah et al., 2024; Wu et al., 2024; Zhang et al., 2016)   | √               | (Chen et al., 2021; Nie et al., 2018)  | √                      | (Hwang et al., 2024)   | N/A                            | N/A                                     |
| Calcitonin                       | N/A        | N/A   | N/A        | N/A  | √               | (Chen et al., 2021)  | N/A                    | N/A  | N/A                            | N/A                                     |
| Family history                   | √          | (Safiah et al., 2024)   | N/A        | N/A  | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| BASDAI                           | √          | (Jiang et al., 2018; Jiang et al., 2015; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016; Zhou et al., 2021) | √          | (Fang et al., 2019; Hwang et al., 2020; Jiang et al., 2018; Jiang et al., 2015; Safiah et al., 2024; Uslu et al., 2022; Xu et al., 2016; Yuce et al., 2023; Zhang et al., 2016; Zhou et al., 2021) | √               | (Gong et al., 2024; Hwang et al., 2020)  | √                      | (Altindag et al., 2021; Aydin et al., 2015; Batmaz et al., 2013; Chen et al., 2021; In et al., 2016; Jiang et al., 2015; Karatas et al., 2018; Nie et al., 2018; B. W. Song et al., 2021; Tymms et al., 2022; Yuce et al., 2023) | √                              | (Hwang et al., 2024; Song & Chen, 2021) |
| Patient global assessment        | √          | (Gong et al., 2024)   | √          | (Gong et al., 2024; Hwang et al., 2020)  | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| ASDAS-ESR/ESR                    | √          | (Safiah et al., 2024; Zhang et al., 2016)   | √          | (Safiah et al., 2024; Yuce et al., 2023; Zhang et al., 2016)   | √               | (Chen et al., 2021; B. W. Song et al., 2021; Yuce et al., 2023)  | N/A                    | N/A  | N/A                            | N/A                                     |
| ASDAS-CRP/CRP                    | √          | (Arisoy et al., 2013; Zhang et al., 2016; Zhou et al., 2021)  | √          | (Arisoy et al., 2013; Karmacharya et al., 2024; Nam et al., 2021; Safiah et al., 2024; Wu et al., 2024; Yuce et al., 2023; Zhang et al., 2016; Zhou et al., 2021)                                  | √               | (Chen et al., 2021; B. W. Song et al., 2021; Yuce et al., 2023)  | √                      | (Hwang et al., 2024)   | N/A                            | N/A                                     |
| Physical symptoms and function   |            |   |            |  |                 |  |                        |  |                                |   |
| Pain                             | √          | (Jiang et al., 2018; Qian et al., 2023; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016)                     | √          | (Fang et al., 2019; Jiang et al., 2018; Qian et al., 2023; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016)   | √               | (Altindag et al., 2021; Batmaz et al., 2013; Hakkou et al., 2013; In et al., 2016; Karatas et al., 2018; Nie et al., 2018) | √                      | (Hwang et al., 2024; Lan et al., 2023)   | N/A                            | N/A                                     |
| Fatigue                          | √          | (Safiah et al., 2024)   | √          | (Safiah et al., 2024)  | √               | (Nie et al., 2018)   | N/A                    | N/A  | N/A                            | N/A                                     |
| Morning stiffness                | √          | (Jiang et al., 2018; Zhang et al., 2016)  | √          | (Jiang et al., 2018; Zhang et al., 2016)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Health assessment questionnaire  | √          | (Xu et al., 2016)   | N/A        | N/A  | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Joint function                   | √          | (Qian et al., 2023)   | √          | (Fang et al., 2019; Qian et al., 2023)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |
| Fingertip-to-floor distance      | N/A        | N/A   | √          | (Zhang et al., 2016)   | N/A             | N/A  | N/A                    | N/A  | N/A                            | N/A                                     |

|   |     |   |     |  |     |   |     |                          |     |     |
|---|-----|---|-----|--|-----|---|-----|--------------------------|-----|-----|
|   |     |   |     | (Fang et al., 2019; Hwang et al., 2020;  |     |   | √   | (Hwang et al.,           | N/A | N/A |
| BASFI                                       | √   | (Jiang et al., 2018; Jiang et al., 2015; Safiah et al., 2024; Zhang et al., 2016) | √   | Jiang et al., 2018; Jiang et al., 2015; Karmacharya et al., 2024; Safiah et al., 2024; Uslu et al., 2022; Yuce et al., 2023; Zhang et al., 2016) | √   | (Chen et al., 2021; In et al., 2016; Jiang et al., 2015; Karatas et al., 2018; Nie et al., 2018; Yuce et al., 2023) |     | 2024; Song & Chen, 2021) |     |     |
| BASMI                                       | N/A | N/A   | √   | (Zhang et al., 2016)   | √   | (Batmaz et al., 2013; Chen et al., 2021)  | N/A | N/A                      | N/A | N/A |
| Sexual function                             | N/A | N/A   | √   | (Demir et al., 2013; Sariyildiz et al., 2013)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Restless legs syndrome                      | N/A | N/A   | N/A | N/A  | √   | (Demirci et al., 2016)  | N/A | N/A                      | N/A | N/A |
| History of falling                          | N/A | N/A   | √   | (Fang et al., 2019)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Psycho-behavioral factors                   | N/A | N/A   | N/A | N/A  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Medication adherence                        | N/A | N/A   | √   | (Oksuz et al., 2021)   | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Kinesiophobia                               | N/A | N/A   | √   | (Oskay et al., 2017)   | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Perceived control                           | N/A | N/A   | √   | (Webers et al., 2019)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Acceptance of illness                       | N/A | N/A   | √   | (Piekutin et al., 2018)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| History of mental distress                  | √   | (Safiah et al., 2024)   | √   | (Hwang et al., 2020; Safiah et al., 2024)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Affective temperament                       | √   | (Yildirim et al., 2017)   | √   | (Yildirim et al., 2017)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Satisfaction with social role participation | N/A | N/A   | √   | (Webers et al., 2019)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Body image                                  | √   | (Shen et al., 2014)   | √   | (Fang et al., 2019; Shen et al., 2014)   | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Sense of coherence                          | N/A | N/A   | √   | (Piekutin et al., 2018)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| The use of social media                     | N/A | N/A   | √   | (Uslu et al., 2022)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| BAS-G                                       | √   | (Safiah et al., 2024)   | √   | (Safiah et al., 2024)  | √   | (Chen et al., 2021; Nie et al., 2018)   | √   | (Song & Chen,            | N/A | N/A |
| ASAS-HI                                     | N/A | N/A   | N/A | N/A  | √   | (Chen et al., 2021)   | N/A | N/A                      | N/A | N/A |
| Anxiety                                     | N/A | N/A   | √   | (Arisoy et al., 2013; Jiang et al., 2018)  | √   | (Nie et al., 2018)  | N/A | N/A                      | N/A | N/A |
| Depression                                  | √   | (Arisoy et al., 2013; Jiang et al., 2018)   | N/A | N/A  | √   | (Batmaz et al., 2013; Hakkou et al., 2013; B. W. Song et al., 2021; Yuce et al., 2023)                              | N/A | N/A                      | N/A | N/A |
| Sleep disorders                             | √   | (Jiang et al., 2018; Safiah et al., 2024)   | √   | (Jiang et al., 2018; Safiah et al., 2024)  | N/A | N/A   | N/A | N/A                      | N/A | N/A |
| Quality of life                             | √   | (Safiah et al., 2024; Xu et al., 2016; Yildirim et al., 2017)                     | √   | (Demir et al., 2013; Safiah et al., 2024; Song & Chen, 2021; Wu et al., 2024; Xu et al., 2016; Yuce et al., 2023)                                | √   | (Batmaz et al., 2013; Karatas et al., 2018; Yuce et al., 2023)  |     |                          |     |     |

Abbreviations: BASDAI, bath ankylosing spondylitis disease activity index; ASDAS-CRP, ankylosing spondylitis disease activity score-C-reactive protein; CRP, C-reactive protein; ASDAS-ESR, ankylosing spondylitis disease activity score-erythrocyte sedimentation rate; ESR, erythrocyte sedimentation rate; BASFI, bath ankylosing spondylitis functional index; BASMI, bath ankylosing spondylitis metrology index; BAS-G: bath ankylosing spondylitis patient global score; ASAS-HI, ankylosing spondylitis disease activity index health index; N/A: not applicable.

### *Disease-related factors*

Greater disease activity, as measured by metrics such as bath ankylosing spondylitis functional index, patient global assessment, AS disease activity score-C-reactive protein/C-reactive protein, AS disease activity score-erythrocyte sedimentation rate/ erythrocyte sedimentation rate, was linked to higher rates of depression (Fang et al., 2019; Gong et al., 2024; Hwang et al., 2020; Jiang et al., 2018; Jiang et al., 2015; Karmacharya et al., 2024; Nam et al., 2021; Safiah et al., 2024; Uslu et al., 2022; Wu et al., 2024; Xu et al., 2016; Yuce et al., 2023; Zhang et al., 2016; Zhou et al., 2021), anxiety (Gong et al., 2024; Jiang et al., 2018; Jiang et al., 2015; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016; Zhou et al., 2021), sleep disorders (Altindag et al., 2021; Aydin et al., 2015; Batmaz et al., 2013; Chen et al., 2021; In et al., 2016; Jiang et al., 2015; Karatas et al., 2018; Nie et al., 2018; B. W. Song et al., 2021; Tymms et al., 2022; Yuce et al., 2023), and psychological distress (Hwang et al., 2024; Song & Chen, 2021). Additionally, longer disease duration was also correlated with increased rates of depression (Piekutin et al., 2018; Qian et al., 2023; Safiah et al., 2024; Wu et al., 2024; Zhang et al., 2016), anxiety (Jiang et al., 2018; Qian et al., 2023), sleep disorders (Chen et al., 2021; Nie et al., 2018), and psychological distress (Hwang et al., 2024). Other disease characteristics, such as diagnostic delay, extra-spinal manifestation, Calcitonina, and family history, were also associated with elevated risk of depression (Safiah et al., 2024), anxiety (Safiah et al., 2024), or sleep disorders (Chen et al., 2021; Nie et al., 2018).

### *Physical symptoms and function*

Poorer physical functioning, as assessed by measures like bath ankylosing spondylitis functional index and the health assessment questionnaire, was significantly associated with depression (Fang et al., 2019; Gong et al., 2024; Hwang et al., 2020; Jiang et al., 2018; Jiang et al., 2015; Karmacharya et al., 2024; Nam et al., 2021; Safiah

et al., 2024; Uslu et al., 2022; Wu et al., 2024; Xu et al., 2016; Yuce et al., 2023; Zhang et al., 2016), anxiety (Gong et al., 2024; Jiang et al., 2018; Jiang et al., 2015; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016), sleep disorders (Chen et al., 2021; In et al., 2016; Jiang et al., 2015; Karatas et al., 2018; Nie et al., 2018; Yuce et al., 2023), and psychological distress (Hwang et al., 2024; Song & Chen, 2021). Specific physical function impairments, such as joint function, fingertip-to-floor distance, mobility impairment, sexual function, and restless legs syndrome, also exhibited links to depression (Demir et al., 2013; Fang et al., 2019; Qian et al., 2023; Sariyildiz et al., 2013; Zhang et al., 2016), anxiety (Qian et al., 2023), or sleep disorders (Batmaz et al., 2013; Chen et al., 2021; Demirci et al., 2016). Moreover, certain physical symptoms, including pain, fatigue, and morning stiffness, were positively correlated with depression (Fang et al., 2019; Jiang et al., 2018; Qian et al., 2023; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016), anxiety (Jiang et al., 2018; Qian et al., 2023; Safiah et al., 2024; Xu et al., 2016; Zhang et al., 2016), sleep disorders (Altindag et al., 2021; Batmaz et al., 2013; Hakkou et al., 2013; In et al., 2016; Karatas et al., 2018; Nie et al., 2018), and psychological distress (Hwang et al., 2024; Lan et al., 2023). Additionally, a history of falls was also associated with a higher likelihood of depression (Fang et al., 2019).

### *Psycho-behavioral factors*

Cognition distortions, such as kinesiophobia (Oskay et al., 2017), and poor illness acceptance (Piekutin et al., 2018), were positively correlated with depression. Conversely, factors like medication adherence (Oksuz et al., 2021), social role satisfaction, a strong sense of perceived control (Webers et al., 2019) and coherence (Piekutin et al., 2018) demonstrated negative associations with depression. Furthermore, the use of social media was associated with a reduced likelihood of depression (Uslu et al., 2022). History of mental illness, affective temperament, and body image concerns exhibited positive correlations with both depression (Fang et al., 2019; Hwang et al.,

2020; Safiah et al., 2024; Shen et al., 2014; Yildirim et al., 2017) and anxiety (Safiah et al., 2024; Shen et al., 2014; Yildirim et al., 2017).

The impact of AS on global well-being was associated with an increased likelihood of depression (Safiah et al., 2024), anxiety (Safiah et al., 2024), and sleep disorders (Chen et al., 2021; Nie et al., 2018). Additionally, poor quality of life was correlated with depression (Demir et al., 2013; Safiah et al., 2024; Song & Chen, 2021; Wu et al., 2024; Xu et al., 2016; Yuce et al., 2023), anxiety (Safiah et al., 2024; Xu et al., 2016; Yildirim et al., 2017), and sleep disorders (Batmaz et al., 2013; Karatas et al., 2018; Yuce et al., 2023). Notably, strong associations were observed among anxiety, depression, and sleep disorders in individuals with AS (Batmaz et al., 2013; Hakkou et al., 2013; Jiang et al., 2018; Nie et al., 2018; Safiah et al., 2024; B. W. Song et al., 2021; Yuce et al., 2023).

### *Interventions for mental health problems*

The review identified 23 studies that reported interventions improving mental health among individuals with AS, which can be broadly categorized into three main groups: physical exercise, therapeutic, and psychosocial interventions (Appendix B).

### *Physical exercise interventions*

Seven studies examined the effects of physical exercise interventions on mental health outcomes. Two pre-post-design studies demonstrated the efficacy of exercise programs, including Clinical Pilates (Oskay et al., 2018) and multidimensional exercise training (Kisacik et al., 2016), in reducing depression. Additionally, three randomized controlled trials (RCTs) reported beneficial effects of aquatic exercises, hospital-based calisthenic exercise, and the combination of aerobic exercise and Clinical Pilates on alleviating anxiety (Aydin et al., 2016), sleep disorders (Oksuz & Unal, 2023), and psychological distress (Dundar et al., 2014). Furthermore, two RCTs indicated that tele-

yoga significantly alleviated depression (Acar et al., 2023; Singh et al., 2023), anxiety (Singh et al., 2023), and sleep disorders (Acar et al., 2023) compared to control conditions.

### *Therapeutic interventions*

Several studies investigated the psychological benefits of pharmacological treatment for individuals with AS. Both a pre-post design and an RCT found that anti-tumor necrosis factor (anti-TNF) therapy significantly relieved depression (Arisoy et al., 2013), anxiety (Arisoy et al., 2013), and sleep disorders (Karatras et al., 2018). A non-randomized controlled trial (non-RCT) also demonstrated that participants receiving anti-TNF therapy had significantly lower Pittsburgh Sleep Quality Index scores compared to those treated with non-steroidal anti-inflammatory drugs (In et al., 2016). Additionally, both an RCT (Webers et al., 2020) and a pre-post study (Ersozlu-Bozkirli et al., 2015) provided evidence that infliximab significantly alleviated depression in the AS population. Other RCTs revealed that Golimumab (Reveille et al., 2020) and Upadacitinib (Navarro-Compan et al., 2023) yielded significant reductions in psychological distress. However, one study indicated that Bimekizumab treatment led to reductions in sleep disorders, but not psychological distress (Dubreuil et al., 2024). Moreover, two non-RCTs showed that combining anti-TNF therapy with exercise produced greater decrease in depression, anxiety, and psychological distress compared to anti-TNF therapy alone (Karaca et al., 2022; Yigit et al., 2013). Another study found that combining anti-TNF with global postural reduction exercise resulted in significantly greater reductions in both depression and sleep disorders compared to the anti-TNF therapy plus conventional exercise group and the conventional exercise group (Coksevrim et al., 2018). Additionally, two pre-post studies reported reductions in anxiety and depression following kyphosis correction, with one-year (Park et al., 2014) and two-year postoperative follow-ups (Park et al., 2019).

### *Psychosocial interventions*

An RCT demonstrated that a 12-week WeChat-based psychoeducation program significantly decreased depression among AS participants compared to a control group (Y. Q. Song et al., 2021). Another RCT revealed that an 8-week intervention involving traditional Chinese music therapy effectively reduced psychological distress and sleep disorders compared to both a routine treatment group and a painting group (Qin, 2020). Furthermore, a pre-post study indicated that 17 cognitive-behavioral therapy sessions focusing on coping and self-regulation skills significantly reduced anxiety and depression in individual with AS (Frye & Rawlins, 2023).

### *Quality assessment*

Upon conducting a critical appraisal of all included references, it was found that the quality ratings of the quantitative non-RCT studies were categorized as moderate (n=5) (Emmungil et al., 2021; Katz et al., 2022; Meesters, Petersson, et al., 2014; T. C. Shen et al., 2016; Tymms et al., 2022), moderately high (n=40) (Abdul-Sattar & Abou El Magd, 2017; Altindag et al., 2021; Anyfanti et al., 2016; Arisoy et al., 2013; Aydin et al., 2015; Cay et al., 2022; Chen et al., 2021; Dau et al., 2018; Demir et al., 2013; Frye & Rawlins, 2023; Gica et al., 2021; Gong et al., 2024; Howren et al., 2023; Hwang et al., 2024; Hyphantis et al., 2013; In et al., 2016; Jiang et al., 2015; Karaca et al., 2022; Karatas et al., 2018; Karatekin et al., 2023; Karmacharya et al., 2024; Kilic et al., 2014; Kisacik et al., 2016; Lan et al., 2023; Liew et al., 2017; Meesters, Bremander, et al., 2014; Oksuz et al., 2021; Omar et al., 2023; Oskay et al., 2018; Oskay et al., 2017; Park et al., 2019; Park et al., 2014; Qian et al., 2023; C. C. Shen et al., 2016; Uslu et al., 2022; Wu et al., 2017; Wu et al., 2024; Yildirim et al., 2017; Zhou et al., 2021; Zou et al., 2016), and high (n=22) (Batmaz et al., 2013; Coksevim et al., 2018; Demirci et al., 2016; Dhakad et al., 2015; Ersozlu-Bozkirli et al., 2015; Fang et al., 2019; Hakkou et al., 2013; Hwang et al., 2020; Jiang et al., 2018; Nam et al., 2021; Nie et al., 2018; Piekutin et al., 2018; Safiah et al., 2024; Sariyildiz et al., 2013; Shen et al., 2014; B. W.

Song et al., 2021; Song & Chen, 2021; Webers et al., 2019; Xu et al., 2016; Yigit et al., 2013; Yuce et al., 2023; Zhang et al., 2016). Furthermore, two RCT studies were classified as having moderately low quality (Dubreuil et al., 2024; Oksuz & Unal, 2023). The majority of the RCT studies were rated as moderate in quality (n=6) (Acar et al., 2023; Aydin et al., 2016; Qin, 2020; Reveille et al., 2020; Singh et al., 2023; Webers et al., 2020), while one study was assessed as moderately high quality (Navarro-Compan et al., 2023). Additionally, two RCTs were deemed to be of high quality (Dundar et al., 2014; Y. Q. Song et al., 2021). The quality of the qualitative study (n=1) was determined to be high (Primholdt et al., 2017). All details can be found in Additional File 3.

## **Discussion**

This scoping review provides a comprehensive global overview of mental health problems experienced by individuals with AS, along with associated factors and interventions implemented since 2013. The findings identify six specific mental health problems, 42 correlated factors, and 23 interventions involved promoting mental health.

### *Prevalence of Mental Health Problems*

The review indicates that depression, anxiety, and sleep disorders are highly prevalent among individuals with AS, with overall median prevalence rates of 28.9%, 34.1%, and 53.5%, respectively. These rates align with previous systematic reviews (Park et al., 2020; Salari et al., 2023; Zhang et al., 2019) and reveal notable geographical variations: lower prevalence in Europe, North America, and Oceania, and higher rates in Asia and Africa. These disparities can be attributed to cultural attitudes, economic conditions, and access to healthcare. In higher-income regions, greater awareness and acceptance of mental health problems facilitate better reporting and diagnosis, resulting in lower prevalence rates (Adebayo et al., 2024). Conversely, cultural stigma in Asia and Africa often prevents individuals from seeking help, leading to higher reported rates

(Ahad et al., 2023). Additionally, wealthier countries tend to have more resources for mental health care, while economic hardships in some Asian and African nations exacerbate stressors, further increasing prevalence (Cancarevic et al., 2021; Knifton & Inglis, 2020).

The association between AS and mental health problems may be explained by underlying pathological mechanisms. Inflammation plays a key role in AS (Xiong et al., 2022), with elevated pro-inflammatory cytokines linked to more severe symptoms of depression, anxiety, and sleep disorders (Santoft et al., 2020). Anti-tumor necrosis factor drugs, such as adalimumab and infliximab, have shown efficacy in alleviating these mental health problems (Baghdadi et al., 2023; Tektonidou et al., 2020; Uzzan & Azab, 2021).

### *Correlated factors*

Sociodemographic factors, including marital status, employment status, educational level, and socioeconomic status, significantly influence the risk of developing mental health problems (Fang et al., 2019; Hwang et al., 2020; Jiang et al., 2018; Nam et al., 2021; Safiah et al., 2024; Yildirim et al., 2017). These factors are associated with better-coping resources and overall psychosocial support, which can mitigate the risk of developing depression and anxiety (Nölke et al., 2015; Reich et al., 2023). Smoking has also been identified as a risk factor for depression (Hwang et al., 2020; Nam et al., 2021), potentially due to its role in accelerating AS progression and exacerbating disease severity (Farouk et al., 2021; Gaber et al., 2015). Age and gender were found to have varying effects on depression, sleep disorders, and post-traumatic stress disorder (Chen et al., 2021; Karmacharya et al., 2024; Piekutin et al., 2018; B. W. Song et al., 2021; Webers et al., 2019), underscoring the need for tailored psychotherapeutic strategies.

Disease-related factors, such as higher disease activity and extra-spinal manifestation were associated with depression, anxiety, and sleep disorders. These

associations may indicate severe immune system dysregulation, which stimulates pro-inflammatory cytokines and triggers mental health (Parkinson et al., 2020; Zuo & Li, 2023). Besides, impaired physical function, pain, fatigue, longer disease duration, and diagnostic delay likely contribute to feeling of frustration and social isolation, exacerbating mental health problems (Parkinson et al., 2020; Webers et al., 2019; Zhu et al., 2019). Clinicians should implement comprehensive programs aimed at preventing disease progression, mitigating the adverse effects of the disease, and enhancing the mental health of individuals with AS.

Moreover, poor medication adherence and acceptance of illness were crucial factors associated with depression in AS patients. These factors are linked with negative clinical outcomes, such as symptom exacerbation, which subsequently impact mental health (Oksuz et al., 2021; Piekutin et al., 2018). Additionally, reduced sense of control, decreased satisfaction with social role participation, kinesiophobia, and negative body image were identified as significant factors correlated with anxiety and depression. These factors can result in occupational and social difficulties, ultimately leading to social isolation and decreased self-identity, further compromising mental health (Courbalay et al., 2021; Holt-Lunstad, 2024). Furthermore, affective temperaments were linked with anxiety and depression, as individuals with these traits often demonstrate poorer emotional regulation and are therefore more prone to mental health problems (Gonda et al., 2020; Toyoshima et al., 2021). Interestingly, using social media platforms was considered a protective factor against mental health problems. This is attributed to searching for medical treatment information that can help AS people cope with or mitigate the impact of their condition (Uslu et al., 2022). Therefore, future research should prioritize addressing medication adherence, enhancing cognitive functioning, and cultivating positive coping strategies to mitigate the influence of these psychosocial factors on the mental health of individuals with AS.

The review highlights the bidirectional relationships between anxiety, depression, and sleep disorders in individuals with AS. Anxiety and depression often co-occur, with shared neurobiological mechanisms and maladaptive cognitive patterns contributing to

their development and exacerbation (Janiri et al., 2020). Sleep disorders are closely linked to anxiety and depression, as poor sleep quality can lead to increased daytime fatigue and pain perception, further amplifying anxiety and depression (Quan et al., 2024). Conversely, the cognitive and physiological effects of anxiety and depression can disrupt normal sleep patterns (Orchard et al., 2020). The combined impact of these conditions is associated with an individual's poorer quality of life (Dong et al., 2020), underscoring the need for comprehensive, multidisciplinary approaches to manage the complex mental health challenges faced by individuals with AS.

### *Interventions involved improve mental health*

Therapeutic interventions, such as tumor necrosis factor inhibitors and Janus kinase enzyme inhibitors, have been shown to effectively alleviate inflammation, improve joint function, reduce pain, and potentially delay disease progression (Tian et al., 2023; Zhu et al., 2019), leading to improved mental health outcomes. Besides, surgery, such as kyphosis correction, can improve mobility, reduce pain, and enhance functional abilities (Ramiro et al., 2023; Zhu et al., 2019). By addressing the physical limitations and discomfort associated with AS, surgery can have a positive impact on the mental health of patients (Park et al., 2019; Park et al., 2014). However, these approaches have limitations, including potential side effects, long-term safety concerns, and surgical risks (Joaquim et al., 2023; Li et al., 2021). Therefore, future research should focus on the development of additional non-pharmacological interventions to improve the mental health of individuals with AS.

Building on the previously discussed therapeutic interventions, physical exercise has emerged as a promising approach for enhancing mental health in individuals with AS. Various forms of exercise have been shown to improve physical functioning, which can alleviate the negative effects of impaired mobility on mental health (Hu et al., 2021). Moreover, exercise is known to have immunological benefits, potentially reducing inflammation and, consequently, the impact of disease activity and pain on mental well-

being (Yu et al., 2022). Psycho-behaviorally, engaging in physical activities can foster social interaction and a sense of control, which are vital for mental health improvement (Pascoe et al., 2020; Smith & Merwin, 2021). However, it is essential to recognize that individuals with severe mobility limitations may face challenges in participating in conventional exercise programs. This underscores the need for customized exercise regimens that accommodate varying levels of ability and pain.

This scoping review has also found that psychosocial interventions represent promising non-pharmacological interventions for enhancing the mental health of individuals with AS. Psychoeducation interventions can target identified correlated factors, such as poor illness acceptance (Akyirem et al., 2021), poor perceived control (Akyirem et al., 2022), body image disturbance (Sebri et al., 2021), and medication adherence (Budiono et al., 2021), and improve cognitive functions and positive coping strategies. Then, music therapy can help reduce the physical discomfort and negative experiences of diseases (Rebecchini, 2021), while improving identity and resilience (Golden et al., 2021), and ultimately decrease the risk of developing mental health problems. Cognitive-behavioral therapy can help individuals with AS develop adaptive coping strategies and thought patterns, which enhance emotion regulation and social functioning, ultimately leading to significant reductions in anxiety and depression (Frye & Rawlins, 2023). Importantly, psychosocial interventions can facilitate the establishment of support networks and provide psychological skills and strategies, thereby facilitating long-term maintenance of mental health (Ribic et al., 2022; Zavala et al., 2023). However, the limited number of studies examining psychosocial interventions for the AS population indicates a clear need for further research in this area to expand the evidence base and develop more tailored, accessible interventions.

### *Implications*

To effectively improve the mental health outcomes for individuals with AS, it is necessary to consider the prevalence, correlated factors, and interventions identified in

this review. Notably, conditions such as bipolar disorder, schizophrenia, and post-traumatic stress disorder require further exploration, as they significantly impact health and functioning. Given that 98.8% of the studies employed quantitative designs, there is a clear need for qualitative and mixed-methods research to gain deeper insights into the experiences of this population.

The predominance of studies conducted in Asia may limit the generalizability of findings to other cultural contexts. Future research should aim to investigate mental health problems across diverse populations to validate and expand upon these results. Nurse practitioners play a crucial role in delivering comprehensive care (Cai et al., 2022; Kumar et al., 2020), yet only three studies examined psychosocial interventions tailored to this population. This gap presents an opportunity for psychiatric nurses to develop innovative approaches, such as ecological momentary interventions, to enhance mental health outcomes for individuals with AS.

### *Strengths and limitations*

This review synthesizes multiple studies to provide a broad perspective on the mental health problems faced by individuals with AS, facilitating the identification of relevant factors and interventions. Notably, scoping reviews seldom assess the methodological quality of included studies; however, we undertook this additional step to strengthen our conclusions. Nevertheless, several limitations should be considered when interpreting the results. Firstly, the review was limited to studies published in English, potentially limiting the scope of our findings. Secondly, most studies included in this review were conducted in Asia, potentially restricting the applicability of the results to other populations or contexts. Thirdly, the variability in data sources, mental health assessment tools, and the small sample sizes of some included studies may hinder the generalizability of the findings. Additionally, most studies examining correlated factors employed a cross-sectional design and cannot establish causality relationships. Lastly, only approximately half of the interventional studies employed RCT design, and

only 2 out of the 11 RCTs were rated as high quality, limiting the ability to draw definitive conclusions regarding the efficacy of interventions involved improving the mental health of individuals with AS.

## **Conclusion**

This scoping review underscores the significant prevalence and diverse factors associated with mental health problems in individuals with AS. It highlights multiple intervention strategies that can address these challenges, including disease management and cognitive function improvement. Future research should focus on qualitative studies and the development of tailored psychosocial interventions to further improve mental health outcomes for this population.

Appendix A. Summary of studies with prevalence and correlates of mental health problems

| Study/country                                 | Study design         | Sample/gender/age/disease duration  | Outcomes/assessment tools  | Prevalence  | Correlates   | MMAT rating |
|---|----------------------|---|--|---|--|-------------|
| (T. C. Shen et al., 2016)<br>Taiwan           | Retrospective cohort | N=1785<br>Male=1155, Female=630<br>44.7±16.8 years<br>Not specified           | Depression, anxiety, and sleep disorder;<br>Clinical Modification of the Ninth Revision of the International Classification of Diseases.                       | 1)Sleep disorders: 17.0%;<br>2)Coexistent anxiety and depression: 6.44%.  | Not Mentioned.   | 3           |
| (Meesters, Petersson, et al., 2014)<br>Sweden | Cross-sectional      | N=571<br>Male=374, Female=197<br>54.5±13.9 years<br>20.2±13.5 years           | Depression and anxiety;<br>Hospital Anxiety and Depression Scale; (HADS-D≥8, HADS-A≥8).  | 1)Depression: 13.5 %, including 8.6% mild, 4.4% moderate, and 0.5% severe;<br>2)Anxiety: 34.0%, including 20.8% mild, 8.8% moderate, and 4.4% severe;<br>3)Coexistent anxiety and depression:11.2%. | Not Mentioned.   | 3           |
| (Demir et al., 2013)<br>Turkey                | Cross-sectional      | N=23<br>Female=23<br>39.3±6.3 years<br>103.4±59.6 months                      | Depression;<br>Beck Depression Inventory;<br>(BDI>13).   | 1)Depression: 45.5 %.   | 1)BDI score was correlated with desire ( $r=-0.543, p=0.009$ ) and orgasm domain ( $r=-0.477, p=0.025$ ), and the total scores of the Female Sexual Function Index ( $r=-0.427, p=0.048$ ), and vitality ( $r=-0.471, p=0.036$ ) and mental health ( $r=-0.483, p=0.027$ ) subscales of SF-36. | 4           |
| (Anyfanti et al., 2016)<br>Greece             | Cross-sectional      | N=44<br>Male=27, Female=17<br>Not specified<br>Not specified                  | Depression and anxiety;<br>Self-Rating Depression Scale;<br>Hamilton Anxiety Scale;<br>(SDS≥50, HAM-A≥17).   | 1)Depression: 18.2%;<br>2)Anxiety: 34.1%;<br>3)Coexistent anxiety and depression:13.6%.   | Not Mentioned.   | 4           |
| (Wu et al., 2017)<br>USA                      | Retrospective cohort | N=1878<br>Male=1238, Female=520<br>52.0±16.0 years<br>Not specified           | Depression;<br>Clinical Modification of the Ninth Revision of the International Classification of Diseases.  | 1)Depression: 27.6%.  | Not Mentioned.   | 4           |
| (Hyphantis et al., 2013)<br>Greece            | Cross-sectional      | N=55<br>Male=47, Female=8<br>42.9±10.9 years<br>15.3±11.5 years               | Depression;<br>Patient Health Questionnaire;<br>(PHQ-9≥10).  | 1)Depression: 14.8%.  | Not Mentioned.   | 4           |
| (Katz et al., 2022)<br>USA                    | Cross-sectional      | N=3413<br>Male=1860, Female=1553<br>45.2±12.7 years<br>Not specified          | Depression and anxiety;<br>Clinical Modification of the Ninth Revision of the International Classification of Diseases.  | 1)Depression: 15.5%;<br>2)Anxiety: 10.2%.   | Not Mentioned.   | 3           |
| (Dau et al., 2018)<br>USA                     | Prospective cohort   | N=706<br>Male=523, Female=183<br>Not specified<br>Not specified               | Depression;<br>Center for Epidemiologic Studies Depression Scale;<br>(CES-D>16).   | 1)Depression: 23.9%.  | Not Mentioned.   | 4           |
| (Zou et al., 2016)<br>China                   | Cross-sectional      | N=40<br>Male=28, Female=12<br>31.48±10.13 years<br>Not specified              | Depression and anxiety;<br>Self-rating Depression Scale;<br>Self-rating Anxiety Scale;<br>(SDS>53, SAS≥50)   | 1)Depression: 42.5%;<br>2)Anxiety: 35.0%.   | Not Mentioned.   | 4           |
| (C. C. Shen et al., 2016)<br>Taiwan           | Retrospective cohort | N=2331<br>Male=1512, Female=819<br>36.50 (27.25-48.18) years<br>Not specified | Depression, anxiety, sleep disorder, bipolar disease, and schizophrenia;<br>Clinical Modification of the Ninth Revision of the International Classification of | 1)Depression: 3.1 %;<br>2)Anxiety: 2.7%;<br>3)Sleep disorder: 1.7%;<br>4)Bipolar disease: 0.3%;<br>5)Schizophrenia: 0.3%.   | Not Mentioned.   | 4           |

|   |                               |   | Diseases.   |   |  |   |
|---|-------------------------------|---|---|---|--|---|
| (Kilic et al., 2014)<br>Turkey                | Cross-sectional               | N=174<br>Not specified<br>38.25 years<br>Not specified                            | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale; (HADS-D $\geq$ 7,<br>HADS-A $\geq$ 10).  | 1)Depression: 45.4 %;<br>2)Anxiety: 20.7%.  | Not Mentioned.   | 4 |
| (Karatekin et al., 2023)<br>Turkey            | Prospective cohort            | N=41<br>Male=30, Female=11<br>41.23 $\pm$ 10.37 years<br>12.07 $\pm$ 9.56 years   | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale; (HADS-D $\geq$ 7,<br>HADS-A $\geq$ 10).  | 1)Depression: 26.8 %;<br>2)Anxiety: 56.0%.  | Not Mentioned.   | 4 |
| (Howren et al., 2023)<br>Canada               | Cross-sectional               | N=50<br>Not specified<br>Not specified<br>Not specified                           | Depression and anxiety;<br>Patient Health Questionnaire;<br>Generalized Anxiety Disorder<br>7-item;<br>(PHQ-9 $\geq$ 10, GAD-7 $\geq$ 10).          | 1)Depression: 60.9%;<br>2)Anxiety: 48.8%.   | Not Mentioned.   | 4 |
| (Meesters, Bremander, et al., 2014)<br>Sweden | Prospective cohort            | N=1738<br>Male=1120, Female=318<br>54.5 $\pm$ 14.3 years<br>Not specified         | Depression;<br>Clinical Modification of the<br>Ninth Revision of the<br>International Classification of<br>Diseases.                                | 1)Depression: 10.0%.  | Not Mentioned.   | 4 |
| (Emmungil et al., 2021)<br>Turkey             | Cross-sectional               | N=53<br>Male=34, Female=19<br>42.0 years<br>9.0 years                             | Depression and anxiety;<br>Beck Depression Inventory;<br>Beck Anxiety Inventory.  | 1)Depression: 30.2 %, including<br>15.1% mild, 11.3% moderate, and<br>3.8% severe;<br>2)Anxiety: 41.5%, including<br>30.2% mild, 1.8% moderate, and<br>9.5% severe. | Not Mentioned.   | 3 |
| (Dhakad et al., 2015)<br>India                | Prospective case-control      | N=100<br>Male=100<br>34.42 $\pm$ 9.78 years<br>Not specified                      | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale.  | 1)Depression: 66.0%;<br>2)Anxiety: 78.0%.   | Not Mentioned.   | 5 |
| (Gica et al., 2021)<br>Turkey                 | Cross-sectional               | N=80<br>Male=42, Female=38<br>41.5 $\pm$ 8.8 years<br>7.0 (1-30) years            | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale.  | 1)Depression: 6.25%;<br>2)Anxiety: 16.3%.   | Not Mentioned.   | 4 |
| (Omar et al., 2023)<br>Israel                 | Retrospective cross-sectional | N=5825<br>Male=3669, Female=2156<br>49.42 $\pm$ 17.2 years<br>Not specified       | Depression, bipolar, and<br>schizophrenia;<br>Clinical Modification of the<br>Ninth Revision of the<br>International Classification of<br>Diseases. | 1)Depression: 13.0 %;<br>2)Bipolar disease: 0.6%;<br>3)Schizophrenia: 0.8%.   | Not Mentioned.   | 4 |
| (Abdul-Sattar & Abou El Magd, 2017)<br>Egypt  | Cross-sectional               | N=90<br>Male=85, Female=5<br>37.8 $\pm$ 9.7 years<br>12.1 $\pm$ 8.9 years         | Psychological distress;<br>12-item General Health<br>Questionnaire;<br>(GHQ-12 $\geq$ 3).   | 1)Psychological distress: 44.4%.  | Not Mentioned.   | 4 |
| (Cay et al., 2022)<br>Turkey                  | Cross-sectional               | N=913<br>Male=662, Female=251<br>44.0 $\pm$ 10.8 years<br>118.4 $\pm$ 92.3 months | Depression;<br>Clinical history or medical<br>records.  | 1)Depression: 3.8%;   | Not Mentioned.   | 4 |
| (Oksuz et al., 2021)<br>Turkey                | Cross-sectional               | N=119<br>Male=105, Female=14<br>35.80 $\pm$ 9.08 years<br>9.88 $\pm$ 6.34 years   | Depression;<br>Beck Depression Inventory;<br>(BDI $>$ 17).  | Not Mentioned.  | 1)BDI scores was correlated with<br>Morisky-Green-Levine medication<br>adherence score ( $r=0.356$ , $p<0.001$ ).  | 4 |
| (Song & Chen, 2021)<br>China                  | Cross-sectional               | N=125<br>Male=97, Female=28<br>29.8 $\pm$ 8.2 years<br>Not specified              | Depression and psychological<br>distress;<br>Beck Depression Inventory;<br>Short Form 36 Health Survey.   | Not Mentioned.  | 1)Psychological distress: BDI score<br>( $\beta=0.444$ , $p<0.001$ );<br>2)BDI score was correlated with<br>physical function ( $r=-0.471$ ,<br>$p<0.001$ ) and psychological distress<br>subscales of SF-36 ( $r=0.565$ , | 5 |

|                                     |                 |   |   |   |  |
|-------------------------------------|-----------------|---|---|---|--|
|                                     |                 |   |   |   | $p<0.001$ );<br>3)Psychological distress was correlated with BASDAI score ( $r=0.398$ , $p<0.001$ ), BASFI score ( $r=0.212$ , $p=0.018$ ), and BAS-G score ( $r=0.299$ , $p<0.001$ ).   |
| (Oskay et al., 2017)<br>Turkey      | Cross-sectional | N=161<br>Not specified<br>Not specified<br>Not specified                | Depression;<br>Beck Depression Inventory.   | Not Mentioned.  | 1)BDI score was correlated with the Tampa Scale for Kinesiophobia score ( $r=0.398$ , $p<0.001$ ). 4   |
| (Sariyildiz et al., 2013)<br>Turkey | Cross-sectional | N=70<br>Male=70<br>36.4±7.4 years<br>9.9±6.9 years                      | Depression and anxiety;<br>Hospital Anxiety and Depression Scale.   | Not Mentioned.  | 1)HADS-D score was correlated with erectile function ( $r=-0.254$ , $p<0.05$ ); 2)HADS-A score was correlated with erectile function ( $r=-0.267$ , $p<0.05$ ) and orgasmic function ( $r=-0.251$ , $p<0.05$ ). 5  |
| (Aydin et al., 2015)<br>Turkey      | Cross-sectional | N=55<br>Male=40, Female=15<br>43.0±10.0 years<br>15.0±9.8 years         | Sleep quality;<br>Pittsburgh Sleep Quality Index; (PSQI>5).   | Not Mentioned.  | 1)PSQI score was correlated with BASDAI score ( $r=-0.612$ , $p<0.001$ ). 4  |
| (Jiang et al., 2015)<br>China       | Cross-sectional | N=683<br>Male=549, Female=134<br>27.3±8.7 years<br>6.5±6.5 years        | Depression, anxiety, and sleep quality;<br>Self-rating Depression Scale;<br>Self-rating Anxiety Scale;<br>Pittsburgh Sleep Quality Index. | Not Mentioned.  | 1)SDS score was correlated with BASDAI score ( $r=0.263$ , $p<0.01$ ) and BASFI score ( $r=0.261$ , $p<0.01$ ); 2)SAS score was correlated with BASDAI score ( $r=0.361$ , $p<0.01$ ) and BASFI score ( $r=0.323$ , $p<0.01$ ); 3)PSQI score was correlated with BASDAI score ( $r=0.204$ , $p<0.01$ ) and BASFI score ( $r=0.212$ , $p<0.01$ ). 4   |
| (Lan et al., 2023)<br>Vietnam       | Cross-sectional | N=75<br>Male=51, Female=24<br>33 (26-37) years<br>2.5 (1.25-4.33) years | Psychological distress;<br>Short Form 36 Health Survey.   | Not Mentioned.  | 1)Mental health score: academic level ( $p=0.006$ ) and occupation ( $p=0.002$ ); 2)Mental health score was correlated with pain ( $r=-0.09$ , $p=0.011$ ). 4  |
| (Gong et al., 2024)<br>China        | Cross-sectional | N=337<br>Male=270, Female=67<br>38.61±11.06 years<br>Not specified      | Depression and anxiety;<br>Depression Anxiety Stress Scales-21  | Not Mentioned.  | 1)Depression score was correlated with Patient Global Assessment score ( $r=0.465$ , $p<0.001$ ); 2)Anxiety score was correlated with the Patient's Global Assessment score ( $r=0.476$ , $p<0.001$ ). 4   |
| (Hwang et al., 2024)<br>USA         | Cross-sectional | N=169<br>Male=116, Female=53<br>50.85±14.77 years<br>25.47±13.32 years  | Psychological distress;<br>Patient-Reported Outcomes Measurement Information System 29-Item Health Profile                                | Not Mentioned.  | 1)Mental health summary score was correlated with duration of disease ( $r=0.130$ , $p=0.021$ ), VAS score ( $r=0.322$ , $p<0.0001$ ), BASDAI score ( $r=-0.75$ , $p<0.01$ ), BASFI score ( $r=-0.66$ , $p<0.01$ ), ASDAS ( $r=-0.71$ , $p<0.01$ ), C-reactive protein ( $r=-0.29$ , $p<0.01$ ), pain NRS ( $r=-0.65$ , $p<0.01$ ), global NRS ( $r=-0.78$ , $p<0.01$ ), and physician VAS ( $r=-0.28$ , $p<0.01$ ). 4 |
| (Safiah et al., 2024)<br>Syria      | Cross-sectional | N=103<br>Male=82, Female=21<br>Not specified<br>Not specified           | Depression, anxiety, and sleep disorder;<br>Patient Health Questionnaire-9;<br>Generalized Anxiety Disorder-7;<br>Jenkins Sleep Scale,    | 1)Depression: 49.5%;<br>2)Anxiety: 36.9%;<br>3)Sleep disorder: 39.8%. | 1)Depression:lower economic status ( $\beta=-0.28$ , $p=0.003$ ), job layoff due to disease ( $\beta=0.24$ , $p=0.008$ ), peripheral involvement ( $\beta=0.27$ , $p=0.002$ ), hip pain ( $\beta=0.26$ , $p=0.003$ ), history of mental distress ( $\beta=0.20$ , $p=0.014$ ), 5   |

|                                   |                    |  |   |  |
|-----------------------------------|--------------------|--|---|--|
|                                   |                    |  | (PHQ-9 $\geq$ 10, GAD-7 $\geq$ 10, JSS $>$ 7).  | disease duration $>$ 10 years ( $\beta=0.21$ , $p=0.011$ ), ASDAS-ESR ( $\beta=0.31$ , $p=0.001$ ), ASDAS-CRP ( $\beta=0.24$ , $p=0.01$ ), BASDAI score ( $\beta=0.45$ , $p<0.001$ ), BASFI score ( $\beta=0.28$ , $p=0.004$ ), BASG ( $\beta=0.25$ , $p=0.01$ ), lower fatigue ( $\beta=-0.71$ , $p<0.001$ ), poorer quality of life ( $\beta=0.76$ , $p<0.001$ ), and high frequency of sleep disorder ( $\beta=0.60$ , $p<0.001$ ).<br>2)Anxiety:job layoff due to disease ( $\beta=0.31$ , $p=0.001$ ), hip pain ( $\beta=0.18$ , $p=0.04$ ), history of mental distress ( $\beta=0.23$ , $p=0.01$ ), positive family history of AS ( $\beta=0.18$ , $p=0.03$ ), ASDAS-ESR ( $\beta=0.26$ , $p=0.008$ ), BASDAI score ( $\beta=0.32$ , $p=0.001$ ), BASFI score ( $\beta=0.27$ , $p=0.005$ ), BASG ( $\beta=0.26$ , $p=0.007$ ), lower fatigue ( $\beta=-0.589$ , $p<0.001$ ), poorer quality of life ( $\beta=0.59$ , $p<0.001$ ), and high frequency of sleep disorder ( $\beta=0.38$ , $p<0.001$ ). |
| (Karmacharya et al., 2024)<br>USA | Prospective cohort | N=1270<br>Male=945, Female=325<br>44.6 $\pm$ 14.3 years<br>21.6 $\pm$ 14.0 years | Depression;<br>Center for Epidemiologic Studies Depression Scale;<br>(CES-D $\geq$ 16).   | 1)Depression: 31.42%.<br>1)Depression: female, ASAD-CRP, and BASFI score ( $p<0.05$ ).   |
| (Wu et al., 2024)<br>China        | Cross-sectional    | N=145<br>Male=123, Female=22<br>35 (16-69) years<br>6 (0.1-30) years             | Depression and anxiety;<br>The revised Self-rating Depression Scale;<br>The revised Self-rating Anxiety Scale;<br>(SDS $\geq$ 53, SAS $\geq$ 50). | 1)Depression: 22.07%;<br>2)Anxiety: 15.17%.<br>1)Depression: CRP ( $p=0.008$ ), ASDAS-CRP ( $p=0.013$ ), vitality of SF-36 ( $p=0.043$ ), and with uveitis or not ( $p=0.008$ );<br>2)SDS score was correlated with the duration of radiographic axial spondyloarthritis ( $r=-0.268$ , $p=0.044$ ).   |
| (Piekutin et al., 2018)<br>Poland | Cross-sectional    | N=82<br>Male=73, Female=9<br>42.0 $\pm$ 11.3 years<br>13.0 $\pm$ 7.8 years       | Depression;<br>Beck Depression Inventory;<br>(BDI $>$ 10).  | 1)Depression: 57.3%, including 30.5% moderate and 26.8% severe.<br>1)BDI score was correlated with age ( $r=0.648$ , $p<0.001$ ), duration of disease ( $r=0.479$ , $p<0.001$ ), acceptance of illness ( $r=-0.634$ , $p<0.001$ ), and sense of coherence ( $r=-0.857$ , $p<0.001$ ).  |
| (Zhang et al., 2016)<br>China     | Cross-sectional    | N=314<br>Male=234, Female=80<br>27.6 $\pm$ 8.3 years<br>6.1 $\pm$ 4.9 years      | Depression and anxiety;<br>Self-rating Depression Scale;<br>Self-rating Anxiety Scale;<br>(SDS $>$ 50, SAS $>$ 50).                               | 1)Depression: 35.4%;<br>2)Anxiety: 37.6%.<br>1)SDS score was correlated with duration of disease ( $r=0.130$ , $p=0.021$ ), morning stiffness ( $r=0.163$ , $p=0.004$ ), VAS score ( $r=0.322$ , $p<0.0001$ ), BASDAI score ( $r=0.437$ , $p<0.0001$ ), BASFI score ( $r=0.444$ , $p<0.0001$ ), BASMI ( $r=0.167$ , $p=0.003$ ), fingertip-to-floor distance ( $r=0.133$ , $p=0.018$ ), ESR ( $r=0.161$ , $p=0.004$ ), and CRP ( $r=-0.167$ , $p=0.003$ );<br>2)SAS score was correlated with age ( $r=0.146$ , $p=0.01$ ), morning stiffness ( $r=0.248$ , $p<0.0001$ ), VAS score ( $r=0.389$ , $p<0.0001$ ), BASDAI score ( $r=0.512$ , $p<0.0001$ ), BASFI score   |

|                                   |                               |  |  |  |  |  |
|-----------------------------------|-------------------------------|--|--|--|--|--|
|                                   |                               |  |  |  |  | ( $r=0.403, p<0.0001$ ), ESR ( $r=0.147, p=0.009$ ), and CRP ( $r=-0.132, p=0.02$ ). |
| (Altindag et al., 2021)<br>Turkey | Cross-sectional               | N=53<br>Male=39, Female=14<br>33.4±7.4 years<br>5.7±3.8 years                        | Sleep disorder;<br>Epworth Sleepiness Scale;<br>(ESS>11).  | 1) Sleep disorder: 71.7%.                  | 1)ESS score was correlated with 4<br>BASDAI score ( $r=0.380, p=0.005$ )<br>and VAS score ( $r=0.563, p<0.001$ ).  |  |
| (Demirci et al., 2016)<br>Turkey  | Cross-sectional case-control  | N=108<br>Male=76, Female=32<br>41.0 (32.0-50.0) years<br>74.0 (26.0-144.0) months    | Sleep disorder;<br>Pittsburgh Sleep Quality Index;<br>(PSQI>5).  | 1)Sleep disorder: 64.8%.                   | 1)PSQI score was correlated with 5<br>restless legs syndrome severity<br>( $r=0.582, p<0.001$ ).   |  |
| (Uslu et al., 2022)<br>Turkey     | Cross-sectional               | N=155<br>Male=87, Female=68<br>40.06±10.99 years<br>10.65±0.87 years                 | Depression;<br>Beck Depression Inventory.  | Not Mentioned.                             | 1)Depression: the use of social media 4<br>( $p<0.001$ );<br>2)BDI score was correlated with<br>BASDAI score ( $r=0.167, p=0.019$ )<br>and BASFI score ( $r=0.188, p=0.022$ ).   |  |
| (Yildirim et al., 2017)<br>Turkey | Cross-sectional               | N=51<br>Male=19, Female=32<br>38.7±10.4 years<br>12.2±7.7 years                      | Depression and anxiety;<br>Beck Depression Inventory;<br>Beck Anxiety Inventory.   | Not Mentioned.                             | 1)BDI score was correlated with 4<br>duration of education ( $r=-0.367, p<0.05$ ), depressive trait ( $r=0.454, p<0.05$ ), cyclothymic trait ( $r=0.506, p<0.05$ ), irritable trait ( $r=0.449, p<0.05$ ) and anxious trait ( $r=0.576, p<0.05$ );<br>2)BAI score was correlated with<br>duration of education ( $r=-0.522, p<0.05$ ), quality of life ( $r=0.343, p<0.05$ ), depressive trait ( $r=0.579, p<0.05$ ), and cyclothymic trait<br>( $r=0.582, p<0.05$ ).  |  |
| (Yuce et al., 2023)<br>Turkey     | Cross-sectional case-control  | N=100<br>Male=73, Female=27<br>41.96±9.11 years<br>13.2±9.1 years                    | Depression and sleep quality;<br>Beck Depression Inventory;<br>Pittsburgh Sleep Quality Index<br>(PSQI>5).   | 1)Sleep disorder: 57.0%.                   | 1)Sleep disorder: BASDAI score 5<br>( $\beta=0.536, p<0.001$ );<br>2)PSQI score was correlated with<br>BDI score ( $r=0.555, p<0.0001$ ),<br>BASDAI score ( $r=0.536, p<0.0001$ ),<br>BASFI score ( $r=0.485, p<0.0001$ ),<br>ESR ( $r=0.494, p<0.0001$ ), CRP<br>( $r=0.476, p<0.0001$ ) and quality of<br>life ( $r=0.598, p<0.0001$ );<br>3)Depression: BASFI score<br>( $\beta=0.404, p<0.001$ );<br>4)BDI score was correlated with<br>BASDAI score ( $r=0.551, p<0.0001$ ),<br>BASFI score ( $r=0.608, p<0.0001$ ),<br>ESR ( $r=0.519, p<0.0001$ ), CRP<br>( $r=0.482, p<0.0001$ ) and quality of<br>life ( $r=0.714, p<0.0001$ ). |  |
| (Nam et al., 2021)<br>Korea       | Cross-sectional               | N=211<br>Male=161, Female=50<br>50.8±10.7 years<br>17.1±9.9 years                    | Depression;<br>Center for Epidemiological<br>Studies Depression Scale;<br>(CES-D>16).  | 1)Depression: 18.0%.                       | 1)Depression: smoking ( $OR=2.85, p=0.035$ ),<br>being employed<br>( $OR=0.35, p=0.012$ ), living with a<br>partner ( $OR=0.36, p=0.024$ ), CRP<br>( $OR=2.32, p=0.001$ ).   |  |
| (Tymms et al., 2022)<br>Australia | Retrospective cross-sectional | N=495<br>Male=274, Female=220,<br>Missing=1<br>48.3±13.6 years<br>164.4±151.4 months | Depression and Sleep disorder;<br>Insomnia Severity Index (ISI);<br>Clinical Modification of the<br>Ninth Revision of the<br>International Classification of | 1)Depression: 4.8%;<br>2) Insomnia: 19.2%. | 1)Insomnia: BASDI>4 ( $OR=7.29, p=0.001$ ).  |  |

|                                      |                 |  | Diseases;<br>(ISI>14).  |   |  |
|--------------------------------------|-----------------|--|---|---|--|
| (Xu et al., 2016)<br>China           | Cross-sectional | N=103<br>Male=78, Women=25<br>32.9±10.7 years<br>Not specified         | Depression and anxiety;<br>Self-rating Depression Scale;<br>Self-rating Anxiety Scale;<br>(SAS≥50, SDS>53). | 1)Depression: 36.9%;<br>2)Anxiety: 18.4%. | 1)Depression: VAS pain ( $\beta=-27.32$ , $p=0.01$ ), energy/vitality ( $\beta=2.28$ , $p=0.003$ );<br>2)SDS score was correlated with BASDI score ( $r=0.43$ , $p<0.01$ ), VAS pain ( $r=0.51$ , $p<0.01$ ), mental components summary ( $r=-0.56$ , $p<0.01$ ), physical components summary ( $r=-0.48$ , $p<0.01$ ), physical functioning ( $r=-0.42$ , $p<0.01$ ), role limitations due to physical problems ( $r=-0.48$ , $p<0.01$ ), body pain ( $r=-0.36$ , $p<0.01$ ), general health perception ( $r=-0.29$ , $p=0.03$ ), vitality ( $r=-0.52$ , $p<0.01$ ), social functioning ( $r=-0.39$ , $p<0.01$ ), role limitations due to emotional problems ( $r=-0.48$ , $p<0.01$ ), mental health ( $r=-0.39$ , $p<0.01$ );<br>3)Anxiety: VAS pain ( $\beta=2.65$ , $p<0.001$ ), general health perception ( $\beta=-14.28$ , $p=0.01$ );<br>4)SAS score was correlated with BASDAI score ( $r=0.48$ , $p<0.01$ ), VAS pain ( $r=0.60$ , $p<0.01$ ), Health Assessment Questionnaire score ( $r=0.36$ , $p<0.01$ ), mental components summary ( $r=-0.39$ , $p<0.01$ ), physical components summary ( $r=-0.46$ , $p<0.01$ ), physical functioning ( $r=-0.37$ , $p<0.01$ ), role limitations due to physical problems ( $r=-0.39$ , $p<0.01$ ), body pain ( $r=-0.32$ , $p<0.01$ ), general health perception ( $r=-0.47$ , $p<0.01$ ), vitality ( $r=-0.45$ , $p<0.01$ ), role limitations due to emotional problems ( $r=-0.40$ , $p<0.01$ ), mental health ( $r=-0.31$ , $p=0.02$ ). |
| (Zhou et al., 2021)<br>China         | Cross-sectional | N=182<br>Male=163, Female=19<br>Not specified<br>Not specified         | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale; (HADS-D≥8,<br>HADS-A≥8).               | Not Mentioned.                            | 1)Depression and anxiety: BASDAI score and ASDAS-CRP ( $p<0.001$ ). 4  |
| (Webers et al., 2019)<br>Netherlands | Cross-sectional | N=245<br>Male=153, Female=92<br>51.2±12.3 years<br>23.6±13.3 years     | Depression;<br>Hospital Anxiety and<br>Depression Scale;<br>(HADS-D≥8).                                     | 1)Depression: 18.0%.                      | 1)Depression: male gender ( $\beta=0.197$ , $p=0.001$ ), perceived control ( $\beta=-0.507$ , $p<0.001$ ), and satisfaction with social role participation ( $\beta=-0.363$ , $p<0.001$ ). 5   |
| (B. W. Song et al., 2021)<br>Korea   | Cross-sectional | N=107<br>Male=88, Female=19<br>35.81±11.78 years<br>71.92±71.73 months | Sleep quality;<br>Pittsburgh Sleep Quality Index;<br>(PSQI>5).  | 1)Sleep disorder: 65.4%.                  | 1)Sleep disorder: age ( $p=0.008$ ), pain ( $p=0.016$ ), BDI scores ( $p<0.001$ ), BASDI score ( $p<0.001$ ), ESR ( $p=0.002$ ), CRP ( $p=0.002$ ). 5  |
| (Chen et al., 2021)<br>Taiwan        | Cross-sectional | N=104<br>Male=90, Female=14<br>45.98±12.16 years<br>19.18±11.18 years  | Sleep quality;<br>Pittsburgh sleep quality index<br>(PSQI).   | 1)Sleep disorder: 36.5%.                  | 1)Sleep disorder: male gender ( $OR=0.134$ , $p=0.013$ ), longer disease duration ( $OR=1.071$ , $p=0.009$ ), higher CRP level ( $OR=4.501$ , 4  |

|                               |                               |   |  |  |  |
|-------------------------------|-------------------------------|---|--|--|--|
|                               |                               |   |  |  | <i>p</i> <0.001), and higher serum calcitonin level ( <i>OR</i> =3.210, <i>p</i> =0.048);<br>2)PSQI score was correlated with disease duration ( <i>r</i> =0.196, <i>p</i> <0.05), BASDAI score ( <i>r</i> =0.390, <i>p</i> <0.01), calcitonin ( <i>r</i> =0.260, <i>p</i> =0.008), CRP ( <i>r</i> =0.204, <i>p</i> =0.04), ASDAS-ESR ( <i>r</i> =0.378, <i>p</i> <0.01), ASDAS-CRP ( <i>r</i> =0.394, <i>p</i> <0.01), BASFI score ( <i>r</i> =0.325, <i>p</i> <0.01), BAS-G ( <i>r</i> =0.306, <i>p</i> <0.01), BASMI ( <i>r</i> =0.210, <i>p</i> =0.037), ASAS-health index ( <i>r</i> =0.311, <i>p</i> <0.01).   |
| (Liew et al., 2017)<br>USA    | Retrospective cross-sectional | N=113<br>Male=107, Female=6<br>58.0±14.0 years<br>Not specified   | Post-traumatic Stress Disorder; Clinical Modification of the Ninth Revision of the International Classification of Diseases. | 1)Post-traumatic stress disorder: 17.7%                                  | 1)Post-traumatic stress disorder: 4 younger age ( <i>p</i> =0.04).   |
| (Fang et al., 2019)<br>Taiwan | Cross-sectional               | N=120<br>Male=91, Female=29<br>42.8±13.1 years<br>13.7±10.2 years | Depression; Beck Depression Inventory-II; (BDI-II>13).   | 1)Depression: 25%, including 13.3% mild, 7.5% moderate, and 4.2% severe. | 1)Depression: BASDAI score ( $\beta$ =-0.21, <i>p</i> =0.032), the impact of AS on work ( $\beta$ =-0.14, <i>p</i> =0.049), history of falling ( $\beta$ =0.14, <i>p</i> =0.032), BASDAI score ( $\beta$ =0.21, <i>p</i> =0.032), positive body image ( $\beta$ =-0.38, <i>p</i> <0.001);<br>2)BDI score was correlated with right sacroiliac joint severity ( <i>r</i> =0.26, <i>p</i> =0.004), left sacroiliac joint severity ( <i>r</i> =0.27, <i>p</i> =0.002), BASFI score ( <i>r</i> =0.62, <i>p</i> <0.001), BASDAI score ( <i>r</i> =0.62, <i>p</i> <0.01), pain ( <i>r</i> =0.24, <i>p</i> =0.009), body image ( <i>r</i> =-0.68, <i>p</i> <0.01).  |
| (Shen et al., 2014)<br>China  | Cross-sectional               | N=103<br>Male=78, Female=25<br>32.9±10.7 years<br>Not specified   | Depression and anxiety; Self-rating Depression Scale; Self-rating Anxiety Scale; (SDS>53, SAS≥50).                           | 1)Depression: 36.9%;<br>2)Anxiety: 18.4%.                                | 1)Depression: role function impairment ( $\beta$ =0.420, <i>p</i> =0.024), social function impairment ( $\beta$ =0.417, <i>p</i> <0.001), appearance-related concerns ( $\beta$ =0.464, <i>p</i> =0.020);<br>2)SDS score was correlated with appearance-related concerns ( <i>r</i> =-0.410, <i>p</i> <0.01), distress ( <i>r</i> =0.334, <i>p</i> <0.05), impairment in social function ( <i>r</i> =0.441, <i>p</i> <0.01), impairment in social life ( <i>r</i> =0.393, <i>p</i> <0.01), and impairment in role function ( <i>r</i> =0.411, <i>p</i> <0.01).<br>3)Anxiety: role function impairment ( $\beta$ =0.611, <i>p</i> =0.009), social function impairment ( $\beta$ =0.79, <i>p</i> =0.034);<br>4)SAS score was correlated with pre-occupation with appearance ( <i>r</i> =0.324, <i>p</i> <0.05), distress ( <i>r</i> =0.242, <i>p</i> <0.05), impairment in social function ( <i>r</i> =0.343, <i>p</i> <0.05), impairment in social life ( <i>r</i> =0.404, <i>p</i> <0.01), and impairment in role function ( <i>r</i> =0.385, <i>p</i> <0.01). |

|                                  |                    |  |   |  |  |
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| (Hakkou et al., 2013)<br>Morocco | Cross-sectional    | N=110<br>Male=75, Female=35<br>38.5±12.6 years<br>Not specified      | Depression, anxiety, and sleep disorder;<br>Hospital Anxiety and Depression Scale;<br>Hamilton Anxiety Scale;<br>(HADS-D≥8, HADS-A≥8).                              | 1)Depression: 55.5%;<br>2)Anxiety: 60.0%;<br>3)Sleep disorder: 64.5%.  | 1)Sleep disorder: pain ( $OR=1.019$ , $p=0.023$ ), depression ( $OR=1.304$ , $p<0.001$ ).  |
| (Batmaz et al., 2013)<br>Turkey  | Cross-sectional    | N=80<br>Male=75, Female=5<br>35.3±6.7 years<br>9.1±6.3 years         | Sleep quality;<br>Pittsburgh Sleep Quality Index; (PSQI>5).   | 1)Sleep disorder: 50.0%.   | 1)Sleep disorder: pain ( $\beta=0.441$ , $p=0.002$ );<br>2)PSQI score was correlated with BASMI ( $r=0.27$ , $p<0.05$ ), BASDAI score ( $r=0.29$ , $p<0.01$ ), pain ( $r=0.36$ , $p<0.01$ ), depression ( $r=0.36$ , $p<0.01$ ), quality of life ( $r=0.34$ , $p<0.01$ ).  |
| (Hwang et al., 2020)<br>USA      | Prospective cohort | N=991<br>Male=731, Female=260<br>42.3±13.6 years<br>17.1±12.9 years  | Depression;<br>Center for Epidemiological Studies Depression; (CES-D≥16).   | 1)Depression: 26.2%.   | 1)Depression: current smoking ( $p=0.0003$ ), unmarried marital status ( $p=0.0005$ ), higher BASFI scores ( $p<0.0001$ ), higher BASDAI scores ( $p<0.0001$ ), higher PGA scores ( $p<0.0001$ ), history of depression ( $p<0.0001$ ).  |
| (Jiang et al., 2018)<br>China    | Cross-sectional    | N=683<br>Male=549, Female=134<br>27.33±8.67 years<br>6.47±6.47 years | Depression, anxiety, and sleep quality;<br>Self-rating Depression Scale;<br>Self-rating anxiety scale;<br>Pittsburgh Sleep Quality Index; (SDS>50, SAS≥50, PSQI>7). | 1)Depression: 64.1%, including 44.1% mild, 15.6% moderate, and 4.1% severe;<br>2)Anxiety: 31.0%, including 22.9% mild, 6.6% moderate, and 1.8% severe;<br>3)Sleep disorder: 37.3%. | 1)Depression: SAS score ( $\beta=0.674$ , $p<0.001$ ), years of education ( $\beta=-0.123$ , $p<0.001$ ), sleep duration ( $\beta=0.087$ , $p=0.001$ );<br>2)SDS score was correlated with years of education ( $r=-0.202$ , $p<0.01$ ), morning stiffness ( $r=0.106$ , $p<0.01$ ), duration of morning stiffness ( $r=0.079$ , $p<0.05$ ), overall pain ( $r=0.187$ , $p<0.01$ ), back pain ( $r=0.166$ , $p<0.01$ ), BASFI score ( $r=0.261$ , $p<0.01$ ), BASDAI score ( $r=0.263$ , $p<0.01$ ), SAS ( $r=0.690$ , $p<0.01$ ), sleep disturbance ( $r=0.176$ , $p<0.01$ ), subjective sleep quality ( $r=0.272$ , $p<0.01$ ), daytime dysfunction ( $r=0.240$ , $p<0.01$ ), sleep latency ( $r=0.235$ , $p<0.01$ ), sleep duration ( $r=0.181$ , $p<0.01$ ), sleep efficacy ( $r=0.167$ , $p<0.01$ ), sleep medication ( $r=0.173$ , $p<0.01$ ), PSQI score ( $r=0.320$ , $p<0.01$ );<br>3)Anxiety: SDS score ( $\beta=0.598$ , $p<0.001$ ), pain ( $\beta=0.107$ , $p<0.001$ ), sleep disturbance ( $\beta=0.071$ , $p=0.022$ ), subjective sleep quality ( $\beta=0.099$ , $p=0.002$ ), daytime dysfunction ( $\beta=0.070$ , $p=0.029$ ); BASFI score ( $\beta=0.088$ , $p=0.002$ );<br>4)SAS score was correlated with years of education ( $r=-0.098$ , $p<0.05$ ), disease duration ( $r=0.077$ , $p<0.05$ ), morning stiffness ( $r=0.127$ , $p<0.01$ ), duration of morning stiffness ( $r=0.081$ , $p<0.05$ ), overall pain ( $r=0.312$ , $p<0.01$ ), back pain |

|                                  |                                 |   |  |   |  |
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|                                  |                                 |   |  |   | ( $r=0.267$ , $p<0.01$ ), BASFI score ( $r=0.323$ , $p<0.01$ ), BASDAI score ( $r=0.361$ , $p<0.01$ ), SDS score ( $r=0.690$ , $p<0.01$ ), sleep disturbance ( $r=0.307$ , $p<0.01$ ), subjective sleep quality ( $r=0.386$ , $p<0.01$ ), daytime dysfunction ( $r=0.365$ , $p<0.01$ ), sleep latency ( $r=0.282$ , $p<0.01$ ), sleep duration ( $r=0.157$ , $p<0.01$ ), sleep efficacy ( $r=0.158$ , $p<0.01$ ), sleep medication ( $r=0.161$ , $p<0.01$ ), PSQI score ( $r=0.406$ , $p<0.01$ ).  |
| (Nie et al., 2018)<br>China      | Cross-sectional                 | N=281<br>Male=191, Female=90<br>31.71±9.80 years<br>7.94±7.36 years   | Depression, anxiety, and sleep disorder;<br>Hospital Anxiety and Depression Scale;<br>Pittsburgh Sleep Quality Index;<br>(HADS-D≥8, HADS-A≥8, PSQI>5). | 1)Depression: 30.2%;<br>2)Anxiety: 48.0%;<br>3)Sleep disorder: 67.6%. | 1)Sleep disorder: fatigue ( $\beta=0.170$ , $p=0.002$ ), anxiety ( $\beta=0.151$ , $p=0.002$ ), nocturnal back pain ( $\beta=0.192$ , $p=0.001$ ), extra-spinal manifestation ( $\beta=0.120$ , $p=0.012$ ), duration of diagnostic delay ( $\beta=0.174$ , $p=0.001$ ), BAS-G ( $\beta=0.181$ , $p=0.003$ );<br>2)PSQI score was correlated with disease duration ( $r=0.223$ , $p<0.01$ ), duration of diagnostic delay ( $r=0.240$ , $p<0.01$ ), BASFI score ( $r=0.433$ , $p<0.01$ ), BASDAI score ( $r=0.452$ , $p<0.01$ ), fatigue ( $r=0.419$ , $p<0.01$ ), nocturnal back pain ( $r=0.456$ , $p<0.01$ ), total back pain ( $r=0.437$ , $p<0.01$ ), BAS-G ( $r=0.491$ , $p<0.01$ ). |
| (Qian et al., 2023)<br>China     | Prospective cohort              | N=40/22<br>(Joint ankylosis/Without joint ankylosis)<br>Joint ankylosis:<br>Male=16, Female=6<br>31.5 (26.0-33.0) years<br>7.5 (6.0-8.0) years<br>Without joint ankylosis:<br>Male=35, Female=5<br>51.0 (41.0-58.0) years<br>24.0 (16.0-24.0) years | Depression and anxiety;<br>Self-rating Depression Scale;<br>Self-rating Anxiety Scale;<br>(SDS>50, SAS≥50).  | Not Mentioned.  | Depression and anxiety: hip pain relief, joint function, disease duration, age at Total Hip Arthroplasty, and spine imaging lesions ( $p<0.001$ ).   |
| (Karatas et al., 2018)<br>Turkey | Non-randomized controlled trial | N=19/19<br>(Anti-TNF/Control)<br>Anti-TNF:<br>Men=14, Women=5<br>37.6±7.6 years<br>7(0.5-20) years<br>Control:<br>Men=15, Women=4<br>37.2±8.6 years<br>7(1.5-20) years  | Sleep disorder;<br>Pittsburgh Sleep Quality Index;<br>(PSQI>5).  | 1)Sleep disorder: 57.9%.  | 1)PSQI score was correlated with BASFI score ( $r=-0.558$ , $p=0.001$ ), BASDAI score ( $r=0.710$ , $p<0.001$ ), quality of life ( $r=0.743$ , $p<0.001$ ), and VAS score ( $r=0.715$ , $p<0.001$ ).   |
| (Aydin et al., 2016)<br>Turkey   | Randomized controlled trial     | N=18/19<br>(Hospital-based exercises/home-based exercises)<br>Hospital-based exercises:<br>Male=9, Female=9   | Depression and anxiety;<br>Hospital Anxiety and Depression Scale;<br>(HADS-D>7, HADS-A>8).   | 1)Depression: 48.5%;<br>2)Anxiety: 55.8%.                             | Not Mentioned.   |

|                                      |                                    |  |   |   |   |   |
|--------------------------------------|------------------------------------|--|---|---|---|---|
|                                      |                                    | 35.83±8.08 years<br>7.22±2.19 years<br>Home-based exercises:<br>Male=11, Female=8<br>33.52±7.72 years<br>7.10±2.79 years   |   |   |   |   |
| (Webers et al., 2020)<br>Netherlands | Randomized<br>controlled trial     | N=16/7<br>(Infliximab/Placebo)<br>Infliximab:<br>Male=11, Female=5<br>38.6±11.6 years<br>8.3±8.2 years<br>Placebo:<br>Male=7<br>44.9±5.8 years<br>11.5±7.4 years   | Depression;<br>Epidemiologic<br>Depression Scale; (CES-D>16).   | 1)Depression: 52.2%.                    | Not Mentioned.  | 3 |
| (In et al., 2016)<br>Turkey          | Non-randomized<br>controlled trial | N=28/31<br>(Anti-TNF/non-steroidal<br>inflammatory drugs)<br>anti-TNF:<br>Male=24, Female=4<br>38.9±8.3 years<br>9.2±6.1 years<br>Non-steroidal<br>inflammatory drugs:<br>Male=22, Female=9<br>39.2±9.3 years<br>6.9±5.6 years | Sleep disturbances;<br>Pittsburgh Sleep Quality Index;<br>(PSQI>5).<br>anti-  | Not Mentioned.                          | 1)PSQI score was correlated with<br>BASFI score ( $r=-0.444, p<0.001$ ),<br>BASDAI score ( $r=0.457, p<0.001$ ),<br>and VAS score ( $r=0.539, p<0.001$ ).                     | 4 |
| (Arisoy et al., 2013)<br>Turkey      | Pre-post test                      | N=9<br>Male=8, Female=1<br>39.4±10.1 years<br>10.6±7.6 years   | Depression and anxiety;<br>Hospital Anxiety and<br>Depression Scale;<br>Hamilton Depression Rating<br>Scale;<br>Hamilton Anxiety Rating Scale;<br>(HAM-D>17, HAM-A>10). | 1)Depression:33.3%;<br>2)Anxiety:22.2%. | 1)HAD-D score was correlated with<br>HAD-A score ( $r=0.864, p<0.001$ ),<br>and CRP ( $r=0.735, p<0.05$ );<br>2)HAD-A score was correlated with<br>CRP ( $r=0.695, p<0.05$ ). | 4 |

**Abbreviations:** BASDAI, bath ankylosing spondylitis disease activity index; ASDAS-CRP, ankylosing spondylitis disease activity score-C-reactive protein; CRP, C-reactive protein; ASDAS-ESR, ankylosing spondylitis disease activity score-erythrocyte sedimentation rate; ESR, erythrocyte sedimentation rate; BASFI, bath ankylosing spondylitis functional index; BASMI, bath ankylosing spondylitis metrology index; BAS-G: bath ankylosing spondylitis patient global score; ASAS-HI, ankylosing spondylitis disease activity index health index; HADS, hospital anxiety and depression scale; BDI, Beck depression inventory; SDS, self-rating depression scale; HAM, Hamilton anxiety scale; SF-36, 36-item short-form; PHQ-9, patient health questionnaire-9 items; CES-D, center for epidemiological survey, depression scale; SAS, self-rating anxiety scale; GAD-7, generalized anxiety disorder -7 items; GHQ-12, general health questionnaire-12 items; PSQI, Pittsburgh sleep quality index; VAS, visual analogue scale; NRS, numerical rating scale; JSS, Jenkins sleep scale; ESS, Epworth sleepiness scale; ISI, insomnia severity index; **MMAT, mixed methods appraisal tool.**

#### Appendix B. Summary of studies with interventions for improving mental health

| Study/country                  | Study design                   | Sample/gender/age/disease<br>duration  | Intervention   | Comparator | Outcomes/assessment<br>tools   | Findings  | MMAT rating |
|--------------------------------|--------------------------------|--|--|------------|--|---|-------------|
| (Dubreuil et al., 2024)<br>USA | Randomized controlled<br>trial | N=332<br>IG:<br>Male=160, Female=61<br>41.0±12.1 years<br>14.2±11.0 years<br>CG: | Bimekizumab 160 mg<br>administered every 4<br>weeks for a total<br>duration of 16 weeks. | Placebo    | Psychological distress;<br>Sleep disorders;<br>Short Form 36 Health<br>Survey;<br>Medical Outcomes Study<br>Sleep Scale-Revised. | 1)Bimekizumab<br>treatment led to<br>improvements in sleep at<br>Week 16;<br>2)No notable differences<br>in mean mental | 2           |

|                                   |                                 |  |  |   |   |  |   |
|-----------------------------------|---------------------------------|--|--|---|---|--|---|
|                                   |                                 | Male=80, Female=31<br>39.2±12.6 years<br>11.9±8.6 years  |  |   |   | component summary score of SF-36 between the two groups after 16 weeks of treatment.   |   |
| (Oskay et al., 2018)<br>Turkey    | Pre-post test                   | N=21<br>Male=8, Female=13<br>41.6±11.8 years<br>1-69 months  | Progressive Clinical Pilates training for 6 weeks  | Not applicable  | Depression;<br>Beck Depression Inventory.   | 1)Significant improvement was observed in depression (pre:9.33±6.03 vs post: 5.47±5.18, $p<0.001$ ).   | 4 |
| (Qin, 2020)<br>China              | Randomized controlled trial     | N=120<br>IG:<br>Male=50, Female=6<br>26.4±4.8 years<br>5.1±3.6 years<br>CG1:<br>Male=25, Female=7<br>26.3±5.3 years<br>4.5±3.2 years<br>CG2:<br>Male=23, Female=9<br>25.2±5.7 years<br>4.8±3.4 years | Traditional Chinese music intervention for 8 weeks   | Painting/Routine treatment                                | Psychological distress;<br>Sleep disorders;<br>Generic Quality of Life Inventory.                                       | 1)Significant improvement was observed in sleep (IG:16.59±1.99 vs CG1:14.22±2.2 vs CG2:11.63±2.41, $F=53.979$ , $p<0.001$ ) and psychological function (IG:69.02±4.62 vs CG1:60.98±6.39 vs CG2:41.29±7.13, $F=229.535$ , $p<0.001$ ) after 8 weeks of treatment. | 3 |
| (Oksuz & Unal, 2023)<br>Turkey    | Randomized controlled trial     | N=26<br>IG:<br>Male=7, Female=6<br>46.2±11.6 years<br>11.8±8.7 years<br>CG:<br>Male=11, Female=2<br>41.7±12.5 years<br>10.8±7.4 years  | Aerobic training plus clinical Pilates exercises for 8 weeks   | Aerobic training  | Depression;<br>Anxiety;<br>Sleep disorder;<br>Hospital Anxiety and Depression Scale;<br>Pittsburgh Sleep Quality Index. | 1)No notable differences in HADS and PSQI scores between the two groups after 8 weeks of treatment;<br>2)Significant improvement was observed in the IG for PSQI score (pre:6.2±1.5 vs post:4.6±1.9, $p=0.013$ ).  | 2 |
| (Dundar et al., 2014)<br>Turkey   | Randomized controlled trial     | N=69<br>IG:<br>Male=30, Female=5<br>42.3±11.3 years<br>13.7±12.5 years<br>CG:<br>Male=28, Female=6<br>43.1±11.7 years<br>14.1±12.2 years   | Aquatic exercise program consisted of 20 sessions, 5* per week for 4 weeks                             | Land-based exercise                                       | Psychological distress;<br>Short Form 36 Health Survey.   | 1)There was a statistically significant difference in the mental component summary of SF-36 after treatment (IG:0.27±0.11 vs CG:0.14±0.08, $p<0.001$ ) and 8 weeks follow-up (IG:0.24±0.15 vs CG:0.13±0.09, $p<0.001$ ).   | 5 |
| (Karaca et al., 2022)<br>Turkey   | Non-randomized controlled trial | N=48<br>IG:<br>Male=2, Female=10<br>38.8±9.5 years<br>2 (0-21) years<br>CG:<br>Male=15, Female=21<br>39.3±9.9 years<br>2 (0-30) years  | Group exercise sessions for 12 weeks (3 times a week) following the initiation of the anti-TNF therapy | Anti-TNF therapy  | Depression;<br>Anxiety;<br>Hospital Anxiety and Depression Scale.   | 1)Significant improvement was observed after 12 weeks between the CG and IG in the HADS-D score (IG:2.75±2.26 vs CG:5.78±4.70, $p<0.001$ ) and HADS-A score (IG:3.33±1.67 vs CG:7.72±4.70, $p<0.001$ ).  | 4 |
| (Coksevim et al., 2018)<br>Turkey | Non-randomized controlled trial | N=60<br>IG:<br>Male=16, Female=4<br>33.9±11.0 years  | Anti-TNF therapy plus global postural reduction exercise for 3 months                                  | Anti-TNF therapy plus conventional exercise /Conventional | Depression;<br>Sleep disorder;<br>Beck Depression Inventory;<br>Pittsburgh Sleep Quality                                | 1)Significant improvement was observed after 3 months between the three groups   | 5 |

|                                      |                                 |   |   |                                  |   |   |   |
|--------------------------------------|---------------------------------|---|---|----------------------------------|---|---|---|
|                                      |                                 | Not specified<br>CG1:<br>Male=14, Female=6<br>33.3±10.5 years<br>Not specified<br>CG2:<br>Male=12, Female=8<br>33.5±11.2 years<br>Not specified | exercise  |                                  | Index.  | in mean change of BDI score (IG:8.60±6.48 vs CG1: 4.90±5.94 vs CG2:0.20±5.51, $p<0.001$ ) and PSQI score (IG:6.35±2.60 vs CG1:4.55±3.68 vs CG2:1.00±3.76, $p<0.001$ ).  |   |
| (Reveille et al., 2020)<br>USA       | Randomized controlled trial     | N=208<br>IG:<br>Male=86, Female=19<br>38.4±10.1 years<br>5.6±6.6 years<br>CG:<br>Male=77, Female=16<br>39.2±10.8 years<br>5.5±5.9 years         | Intravenous Golimumab 2 mg/kg at weeks 0, 4, and 12 and every 8 weeks through week 28 | Placebo                          | Psychological distress; Short Form 36 Health Survey.  | 1)Significant between-group mean changes in the mental component summary of SF-36 were observed at week 8 (IG:5.6±9.3 vs CG:1.7±8.8, $p<0.01$ ) and week 16 (IG:6.5±9.1 vs CG:0.8±9.8, $p<0.001$ ).                                   | 3 |
| (Karatas et al., 2018)<br>Turkey     | Non-randomized controlled trial | N=38<br>IG:<br>Male=14, Female=5<br>37.6±7.6 years<br>7(0.5-20) years<br>CG:<br>Male=15, Female=4<br>37.2±8.6 years<br>7(1.5-20) years          | Anti-TNF therapy for 3 months   | None                             | Sleep disorder; Pittsburgh Sleep Quality Index.   | 1)Significant improvement in the IG was observed from baseline to 3 months in the PSQI score range (2-17 vs 0-16, $p=0.005$ ).  | 4 |
| (Aydin et al., 2016)<br>Turkey       | Randomized controlled trial     | N=37<br>IG:<br>Male=9, Female=9<br>35.83±8.08 years<br>7.22±2.19 years<br>CG:<br>Male=11, Female=8<br>33.52±7.72 years<br>7.10±2.79 years       | Hospital-based calisthenic exercises for 8 weeks                                      | Home-based calisthenic exercises | Depression; Anxiety; Hospital Anxiety and Depression Scale.                                 | 1)Hospital-based exercise group showed significant improvement in terms of the HADS-A scores (pre:8.22±4.90 vs post 6.50±3.45, $p=0.045$ ).   | 3 |
| (Yigit et al., 2013)<br>Turkey       | Non-randomized controlled trial | N=40<br>IG:<br>Male=15, Female=5<br>40.3±8.1 years<br>9.6±5.2 years<br>CG:<br>Male=17, Female=3<br>36.5±7.2 years<br>8.0±4.6 years              | Anti-TNF therapy plus a home-based exercise program for 10 weeks                      | Anti-TNF therapy                 | Depression; Psychological distress; Beck Depression Inventory; Short Form 36 Health Survey. | 1)Significant improvement was observed after 10 weeks between the CG and IG in BDI score change (IG: 2.55±3.38 vs CG:0.45±1.82, $p<0.01$ ) and mental health subscale score change of SF-36 (IG:-6.60±8.73 vs CG:-0±7.57, $p<0.05$ ). | 5 |
| (Webers et al., 2020)<br>Netherlands | Randomized controlled trials    | N=23<br>IG:<br>Male=11, Female=5<br>38.6±11.6 years<br>8.3±8.2 years<br>CG:<br>Male=7<br>44.9±5.8 years<br>11.5±7.4 years                       | Infusions of 5mg/kg Infliximab at weeks 0, 2, 6, 12, and 18                           | Placebo                          | Depression; Epidemiologic Studies Depression Scale.   | 1)Treatment: infliximab, 18-week;<br>2)Infliximab improves depressive symptoms in AS patients compared to placebo (IG:-6 vs. CG:+0.6, $p=0.02$ ).   | 3 |
| (Kisacik et al., 2016)               | Pre-post test                   | N=24  | Multidimensional  | Not applicable                   | Depression;   | 1)Significant changes in  | 4 |

|   |                                     |   |  |                                       |  |   |   |
|---|-------------------------------------|---|--|---------------------------------------|--|---|---|
| Turkey                                    |                                     | Female=24<br>39.9±10.0 years<br>5.1±4.5 years   | exercise program for<br>12 weeks                               |                                       | Beck Depression Inventory.   | BDI score were observed at week 3 (22.840±2.454 vs 9.260±2.454, $p<0.001$ ), week 6 (22.840±2.454 vs 7.840±2.454, $p<0.001$ ), week 9 (22.840±2.454 vs 6.530±2.594, $p<0.001$ ), and week 12 (22.840±2.454 vs 9.560±2.674, $p<0.001$ ). |   |
| (Park et al., 2019)<br>Korea              | Pre-post test                       | N=48<br>Male=43, Female=5<br>38.6 (29-57) years<br>21.2 (18-37) years   | Kyphosis Correction  | Not applicable                        | Depression;<br>Anxiety;<br>Hospital Anxiety and<br>Depression Scale. | 1)Significant improvements were observed in HADA-A score (preoperative:8.77±3.85 vs two-year follow-up:3.17±1.63, $p<0.001$ ) and HADA-D score (preoperative: 10.17±3.70 vs two-year follow-up: 2.90±1.63, $p<0.001$ ).                 | 4 |
| (In et al., 2016)<br>Turkey               | Non-randomized<br>controlled trials | N=59<br>IG:<br>Male=24, Female=4<br>38.9±8.3 years<br>9.2±6.1 years<br>CG:<br>Male=22, Female=9<br>39.2±9.3 years<br>6.9±5.6 years  | Anti-TNF therapy   | Non-steroidal anti-inflammatory drugs | Sleep disturbances;<br>Pittsburgh Sleep Quality<br>Index.            | 1)Significant improvement was observed between the CG and IG in PSQI score (IG:5.4±2.5 vs CG:9.8±3.0, $p<0.01$ ).   | 4 |
| (Park et al., 2014)<br>Korea              | Pre-post test                       | N=24<br>Male=20, Female=4<br>38 (30-67) years<br>Not specified  | Corrective osteotomy   | Not applicable                        | Depression;<br>Anxiety;<br>Hospital Anxiety and<br>Depression Scale. | 1)Significant improvements were observed in the range of HADA-A score (preoperative:3.0-10.5 vs two-year follow-up:1.0-6.0, $p<0.001$ ) and HADA-D score (preoperative: 2.0-9.5 vs two-year follow-up: 1.0-4.0, $p<0.001$ ).            | 4 |
| (Singh et al., 2023)<br>India             | Randomized controlled<br>trial      | N=109<br>IG:<br>Male=48, Female=9<br>34.4±9.4 years<br>Not specified<br>CG:<br>Male=43, Female=9<br>35.1±9.9 years<br>Not specified | Tele-yoga plus<br>standard medical care<br>for 3 months        | Standard medical<br>care              | Depression;<br>Anxiety;<br>Patient Health<br>Questionnaire-4.        | 1)Significant improvement was observed after 3 months between the CG and IG in PHQ-A score change (IG:0 to 2 vs CG:-1 to 1, $p=0.03$ ) and PHQ-D score change (IG:0 to 2 vs CG:0 to 1, $p=0.01$ ).                                      | 3 |
| (Ersozlu-Bozkirli et al., 2015)<br>Turkey | Pre-post test                       | N=29<br>Male=23, Female=6<br>34.3±10.3 years<br>48.6±74.7 months  | Intravenous Infliximab<br>5mg/kg at baseline,<br>weeks 2 and 6 | Not applicable                        | Depression;<br>Beck Depression Inventory.                            | 1)Significant change in BDI score was observed from baseline to week 12 (27.0±8.7 vs 10.3±8.4, $p<0.001$ ).   | 5 |

|  |                             |   |  |                            |   |  |   |
|--|-----------------------------|---|--|----------------------------|---|--|---|
| (Arısoy et al., 2013)<br>Turkey        | Pre-post test               | N=9<br>Male=8, Female=1<br>39.4±10.1 years<br>10.6±7.6 years  | Anti-TNF therapy for 6 weeks                                   | Not applicable             | Depression;<br>Anxiety;<br>Hamilton Depression Rating Scale;<br>Hamilton Anxiety Rating Scale.              | 1)Significant changes in HAM-D score were observed at week 2 (11.9±3.5 vs 3.4±2.8 $p<0.01$ ) and week 6 (11.9±3.5 vs 3.7±2.7, $p<0.01$ );<br>2)Significant changes in HAM-A score were observed at week 2 (10.2±3.5 vs 2.8±2.6 $p<0.01$ ) and week 6 (10.2±3.5 vs 3.7±2.7, $p<0.01$ ). | 4 |
| (Acar et al., 2023)<br>Turkey          | Randomized controlled trial | N=55<br>IG:<br>Male=15, Female=13<br>44.1±8.0 years<br>13.9±7.8 years<br>CG:<br>Male=16, Female=11<br>45.3±7.2 years<br>13.6±7.4 years    | Tele-yoga plus standard medical treatment for 8 weeks          | Standard medical treatment | Depression;<br>Sleep disorder;<br>Hospital Anxiety and Depression Scale;<br>Pittsburgh Sleep Quality Index. | 1)Tele-yoga showed significant improvements in sleep quality and depression compared with the control group, $p<0.05$ .  | 3 |
| (Y. Q. Song et al., 2021)<br>China     | Randomized controlled trial | N=118<br>IG:<br>Male=45, Female=14<br>30.8±8.8 years<br>3 years<br>CG:<br>Male=48, Female=11<br>29.1±7.6 years<br>3 years                 | 12-week WeChat-based educational intervention                  | Standard care              | Depression;<br>Beck Depression Inventory-II.  | 1)Significant improvement was observed after 12 weeks between the CG and IG in BDI score (IG:3 vs CG:5, $p=0.048$ ).   | 5 |
| (Navarro-Compan et al., 2023)<br>Spain | Randomized controlled trial | N=420<br>IG:<br>Male=153, Female=58<br>42.6±12.4 years<br>7.9±7.5 years<br>CG:<br>Male=158, Female=51<br>42.2±11.8 years<br>7.5±7.5 years | Once-daily oral Upadacitinib 15 mg for 14 weeks                | Placebo                    | Psychological distress;<br>Short Form 36 Health Survey.   | 1)Improvements from baseline with Upadacitinib 15 mg versus placebo were differentiated as early as week 4 for SF-36 mental component summary and these continued through week 14.   | 4 |
| (Frye & Rawlins, 2023)<br>USA          | Pre-post test               | N=1<br>Male=1<br>15 years<br>Not specified  | Cognitive behavioral therapy with 17 sessions during 13 months | Not applicable             | Depression;<br>Anxiety;<br>Patient Health Questionnaire-9;<br>Generalized Anxiety Disorder-7.               | 1)Significant change in PHQ-9 score was observed from baseline to session 17 (16 vs 1) and follow-up two years (16 vs 0);<br>2)Significant change in GAD-7 score was observed from baseline to session 17 (14 vs 0) and follow-up two years (14 vs 0).                                 | 4 |

**Abbreviations:** IG, intervention group; CG, control group; HADS, hospital anxiety and depression scale; BDI, Beck depression inventory; HAM-A, Hamilton anxiety scale; SF-36, 36-item short-form; PHQ-4, patient health questionnaire-4 items; GAD-7, generalized anxiety disorder -7 items; PSQI, Pittsburgh sleep quality index; HAM-D, Hamilton depression scale; PHQ-9, patient health questionnaire-9 items; **MMAT, mixed methods appraisal tool.**

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