



Artificial Intelligence as a Partner in Ankylosing Spondylitis Care: Evaluating ChatGPT's Role and Performance

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Abstract

Aim: Artificial Intelligence may have significant potential to assist clinicians in decision-making and diagnosis, especially in units dependent on up-to-date guidelines such as rheumatology. This study aims to evaluate the effectiveness of ChatGPT in providing clinicians with evidence-based information about ankylosing spondylitis (AS).

Material and Method: Frequently asked questions (FAQs) about AS were developed by reviewing commonly accessed patient-oriented websites, social media platforms, and official hospital pages. Questions were designed based on scientific guidelines, particularly the American College of Rheumatology (ACR) and Assessment of SpondyloArthritis international Society (ASAS)-European League Against Rheumatism (EULAR) axial spondyloarthritis guidelines. ChatGPT's responses were evaluated on a 1-to-4 scale. Each question was posed twice to assess reproducibility, with consistency defined by identical scores across both attempts.

Results: ChatGPT demonstrated an overall accuracy of 81.9% in its responses to 72 FAQs. The highest accuracy (91.7%) was observed in responses related to the prevention of AS. Of the 36 questions based on ACR and ASAS-EULAR guidelines, ChatGPT provided accurate answers for 22 (61.1%), with three responses receiving the lowest grade (4). Reproducibility of ChatGPT's responses was 88.8% across all FAQs and 83.3% for guideline-specific questions.

Conclusion: This study highlights the potential of ChatGPT as a supportive tool for patient education and clinician reference, particularly for general FAQs. However, accuracy for questions derived from ACR and ASAS-EULAR guidelines was lower (61.1%), emphasizing the need for clinician oversight.

Keywords: Artificial intelligence, ankylosing spondylitis, ChatGPT, guideline

INTRODUCTION

Ankylosing spondylitis (AS) is a chronic, systemic, inflammatory rheumatic complication that impacts the axial spine and sacroiliac joints (1). If left untreated, new bone formation in the axial skeleton and entheses can occur, leading to the fusion of the spine (2). AS patients have many challenges due to the inherent nature of the illness and its many physical and mental complications leading to a reduced quality of life and a significant financial burden for patients, their families and the communities.

The high rate of comorbidities in AS may stem from overlapping risk factors, ongoing systemic inflammation,

or particular treatments, such as long-term use of non-steroidal anti-inflammatory drugs or corticosteroids. The co-occurrence of other medical conditions in AS patients is related to negative impacts such as reduced quality of life, higher healthcare expenses, increased mortality rates, and increased disease activity (3,4). AS typically manifests in the third decade of life or earlier, with rare presentations occurring after the age of 45. The global prevalence of AS is estimated to range from 0.1% to 1.4% (5).

In recent years, online sources have played a crucial role in enhancing public health awareness, with many patients turning to platforms like YouTube, Twitter, Instagram, and tools like generative pre-trained transformers (such as

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ChatGPT) for information on health issues (6). The rapid advancement of artificial intelligence (AI) models brings substantial ethical challenges, especially concerning the risks of misuse. Key concerns include vulnerabilities, limited transparency in AI algorithms, the risk of inaccuracies or fabricated information in AI-generated content, and the need for high levels of security and precision—particularly in sensitive fields like medical diagnostics, where outcomes can directly impact lives (7).

ChatGPT, an AI application developed by OpenAI, is capable of understanding and generating natural language. The potential applications of ChatGPT have been extensively explored, with recent research focusing on its effectiveness and reliability in healthcare settings (8). Previous studies have examined the accuracy of ChatGPT's responses to various diseases (9-11). However, late diagnosis and treatment of AS, which is common in the society especially in young adult ages when productivity is high, increases the healthcare burden. However, it is known that it negatively affects returns to work.

For this reason, it is important to increase the knowledge of both the public and healthcare professionals about this disease in today's world where computer and artificial intelligence systems are used extensively. No artificial intelligence-based information research on AS has been found in the literature. It is important to note that ChatGPT includes a disclaimer emphasizing that its outputs do not replace medical advice. This study appraises the reliability, accuracy, and reproducibility of ChatGPT's responses regarding AS, thereby providing insights into its potential role in augmenting patient and clinician education.

MATERIAL AND METHOD

AS-related frequently asked questions (FAQs) were developed by reviewing websites commonly accessed by patients, along with official hospital sites. Preference was given to sources linked to credible and authoritative organizations, such as federal health agencies, prominent medical institutions, academic research bodies, and well-known AS advocacy groups. Additionally, inquiries posed by patients on social media platforms such as Instagram, YouTube and Facebook along with their accompanying comments, were leveraged in the development of the question list.

These scientifically based questions were crafted to align with the American College of Rheumatology (ACR) and Assessment of SpondyloArthritis international Society (ASAS)-European League Against Rheumatism (EULAR) guidelines for axial spondyloarthritis, and all questions were compiled into a separate questionnaire. Questions that were unrealistic, repetitive, contained advertisements, had grammatical errors, or required personal responses were excluded from the study. The FAQs were classified into five distinct categories: 11 questions addressed general information, 10 focused on risk factors, 13 covered non-pharmacological treatments, 26 pertained to pharmacological treatments, and 12 explored prevention strategies. The full list of the 72 questions used in the study, categorized by topic, is presented in Table 1. A total of 36 questions, based on the ACR and ASAS-EULAR axial spondyloarthritis guidelines, were included. The specific ACR and ASAS-EULAR guideline recommendations used for response evaluation are summarized in Table 2.

Table 1. Frequently asked questions about ankylosing spondylitis
General
1) What is ankylosing spondylitis, and how does it affect the body?
2) Who is at risk for the development of ankylosing spondylitis and in which age group is it more common?
3) What are the signs and symptoms of ankylosing spondylitis, and what signs and symptoms does it cause if it is left untreated?
4) What are the early warning signs of ankylosing spondylitis and inflammatory back pain?
5) How is ankylosing spondylitis diagnosed, which auxiliary tests are mainly used in the diagnosis?
6) Is it inherited through genetics, is there a racial origin?
7) Which parts of the body are most commonly affected by the disease and how it can affect life?
8) What medical treatments and medications are available for the management of ankylosing spondylitis and the slowing of disease progression?
9) How important is early detection and treatment in preventing the progression of ankylosing spondylitis?
10) What kind of exercise program and physical activity should be used in people with ankylosing spondylitis to improve the symptoms associated with the disease?
11) Which vitamin and mineral supplements are preferred to help manage ankylosing spondylitis?
Risk factors
1) Is age a significant risk factor for ankylosing spondylitis? Is there a particular age range for the onset of the disease?
2) What is the role of gender in the development of ankylosing spondylitis, and how do men and women differ in their experience of the condition?
3) Is there an increased risk of developing ankylosing spondylitis due to genetics, autoimmune disease, or family history?
4) What is the impact of race and ethnicity on the risk of developing ankylosing spondylitis? Is there a correlation between living in a specific geographical area and the likelihood of ankylosing spondylitis?
5) Which lifestyle factors, including smoking and excessive alcohol consumption, contribute to the risk of ankylosing spondylitis?
6) What is the link between the gut microbiome and the development of ankylosing spondylitis, and how is this linked to gastrointestinal health?
7) Is there a correlation between stress-related hormonal changes and the development of ankylosing spondylitis?
8) What is the impact of pregnancy and postnatal hormonal changes on the development of ankylosing spondylitis, and how do hormonal imbalances affect the risk?
9) What is the relationship between immune system dysfunctions and the development of ankylosing spondylitis?
10) Is there a specific test that identifies a risk factor for the disease?

Table 1. Frequently asked questions about ankylosing spondylitis**Non-pharmacological treatments**

- 1) What non-pharmacological approaches are available for managing ankylosing spondylitis, and how do they compare in effectiveness to medications?
- 2) What is the role of physical activity in the management of ankylosing spondylitis and what types of exercise are recommended?
- 3) Are there any specific lifestyle changes or non-pharmacological interventions that ankylosing spondylitis patients can adopt to reduce their disease activity?
- 4) Can stress management techniques, such as yoga and tai chi, positively impact disease progression?
- 5) What is the significance of abstaining from smoking and limiting alcohol consumption in relation to the progression of ankylosing spondylitis disease activity?
- 6) How can the risk of disease activity in ankylosing spondylitis be reduced by maintaining a healthy body weight?
- 7) How does the implementation of physical therapy programs in ankylosing spondylitis affect disease activity, and why?
- 8) What are the benefits of providing posture and posture training to patients in relation to the disease?
- 9) Are there any benefits of heat applications (hot towels, hot shower) or cold applications (ice packs) on pain and inflammation?
- 10) Does swimming and aquatic exercise have any benefits in disease management?

Pharmacological treatments

- 1) What is the first line of treatment for ankylosing spondylitis?
- 2) What are non-steroidal anti-inflammatory drugs, and how do they work to treat ankylosing spondylitis? What are some common non-steroidal anti-inflammatory drugs, medications used for ankylosing spondylitis treatment?
- 3) How are non-steroidal anti-inflammatory drugs taken, and what are the dosing schedules?
- 4) What are the potential side effects and risks associated with non-steroidal anti-inflammatory drugs use?
- 5) How long is non-steroidal anti-inflammatory drugs treatment typically recommended, and is there a maximum duration of use?
- 6) What is the role of corticosteroids in the treatment of ankylosing spondylitis? Is their use a long-term treatment?
- 7) What are the potential side effects and risks associated with corticosteroids drugs use?
- 8) What are tumor necrosis factor inhibitors drugs and how do they help to treat ankylosing spondylitis?
- 9) Is the anti-TNF drug group composed of corticosteroid drugs?
- 10) What are the biological drugs used in ankylosing spondylitis?
- 11) What drugs are IL-17 inhibitors? What are their mechanisms of action?
- 12) How are anti-TNF drugs taken, and what are the dosing schedules?
- 13) How are IL-17 inhibitors drugs taken, and what are the dosing schedules?
- 14) When are anti-TNF drugs and IL-17 inhibitors started as a treatment option?
- 15) What are the potential benefits and risks associated with anti-TNF drugs treatment?
- 16) What are the potential benefits and risks associated with IL-17 inhibitors drugs treatment?
- 17) How long is anti-TNF drugs treatment typically recommended, and is there a maximum duration of use?
- 18) How long is IL-17 inhibitors drugs treatment typically recommended, and is there a maximum duration of use?
- 19) What are conventional synthetic antirheumatic drugs and how does it work to treat ankylosing spondylitis?
- 20) How are conventional synthetic antirheumatic drugs taken, and what are the dosing schedules?
- 21) What are the potential side effects and risks associated with DMARDs use?
- 22) How long is conventional synthetic antirheumatic drugs treatment typically recommended, and is there a maximum duration of use?
- 23) What is methotrexate and what group of medicines does it belong to? How is it used?
- 24) Is anti-TNF therapies an immunosuppressant?
- 25) What is the meaning of primary non-responsiveness to an anti-TNF? Which drug group should be used as an alternative?
- 26) What is the meaning of secondary non-responsiveness to an anti-TNF? Which drug group should be considered for switching?

Prevention

- 1) Is there any way to prevent ankylosing spondylitis? What are the steps that can be taken to help control the disease?
- 2) Is it possible that regular physical activity may help alleviate symptoms associated with ankylosing spondylitis?
- 3) What lifestyle changes could be considered by patients with ankylosing spondylitis to potentially reduce their disease activity?
- 4) Is stress an aggravating factor in ankylosing spondylitis? What are the methods for dealing with stress?
- 5) What effect does smoking cessation have on controlling the symptoms or reducing the effects of the disease?
- 6) Which changes in daily life can help us to reduce and control the symptoms of the disease?
- 7) In which way does the implementation of physiotherapy programs in ankylosing spondylitis affect disease activity?
- 8) What is the impact of the control of the posture on the disease?
- 9) Is it important for people with ankylosing spondylitis symptoms to take the medication prescribed by their doctor regularly? Can consistently use of medication effectively manage symptoms and impede disease progression?
- 10) What are the positive effects of swimming and water-based exercise programs on the symptoms of the disease?
- 11) Do psychosocial interventions have a positive impact on disease outcomes?
- 12) Can disease activity be managed through a balanced and healthy diet? What is the impact of gluten or dairy products on disease symptoms?
- 13) Can regular education and counselling on ankylosing spondylitis increase treatment adherence?

Table 2. Guideline recommendations

1. Which is the first treatment option for adults with active ankylosing spondylitis?
2. Which non-steroidal anti-inflammatory drugs are preferred for treatment?
3. What is the recommended treatment option for adults with active ankylosing spondylitis that persists despite treatment with NSAIDs?
4. What is the preferred drug for patients with severe peripheral arthritis or in the absence of TNFi?
5. Is there a particular TNFi that is preferred?
6. Is treatment with TNFi conditionally recommended for adults with active AS despite treatment with NSAIDs, compared to treatment with secukinumab or ixekizumab?
7. What treatment is conditionally recommended for adults with active AS despite NSAID therapy and contraindications to TNFi?
8. For adults with active AS who don't respond to the first TNFi used, is switching to a different TNFi or treating with secukinumab or ixekizumab conditionally recommended?
9. For adults with active AS who have not responded to the first TNFi treatment, is treatment with another TNFi conditionally recommended?
10. What is the local parenteral treatment option for adults with isolated active sacroiliitis despite treatment with NSAIDs?
11. What should be the duration of treatment with NSAIDs for adults with stable AS?
12. In adults with active enthesitis despite treatment with NSAIDs, treatment with locally administered parenteral glucocorticoids is conditionally recommended over no treatment with local glucocorticoids. Which tendon sites should be avoided?
13. What are the recommended intervals for monitoring confirmed AS disease activity?
14. Which laboratory tests should be monitored regularly for assessment of disease activity?
15. What scoring criteria are used to decide how to treat active non-radiographic axial SpA in adults?
16. When using biological medication in adults with uncertain axial SpA activity, which radiological method is conditionally recommended for evaluating disease activity?
17. Are radiological methods used to confirm inactivity in adults with stable nonradiographic axial SpA?
18. Should adults with axial SpA who are active or radiographically unstable on any treatment require repeated spine radiographs at a scheduled interval as a standard approach?
19. Which drugs should be considered first in patients with peripheral arthritis involvement?
20. How do we determine that patients are unresponsive to the impact of NSAIDs?
21. Should lower doses of methotrexate be recommended for adults receiving TNFi therapy?
22. What are the options for treatment in the first, second and third lines?
23. What treatment is used for a patient with isolated sacroiliitis and enthesitis?
24. Which agent is used to treat recurrent uveitis or inflammatory bowel disease in patients?
25. What should be done if a patient has a high degree of kyphosis, hip arthritis and a spinal fusion?
26. If a patient has achieved stability while taking one or a combination of drugs as part of their treatment, how should their medication be managed?
27. What medications reduce the risk of worsening symptoms in adults with inflammatory bowel disease?
28. Should dual energy X-ray absorptiometry (DXA) scanning be used to screen for osteopenia/osteoporosis?
29. Is it necessary to have an echocardiogram to screen for heart valve disease?
30. Is physical therapy recommended for people with ankylosing spondylitis?
31. Is there a physical therapy intervention that is preferred to another?
32. Are there any exercises recommended to improve posture and balance control?
33. What lifestyle changes should be recommended to patients in order to manage ankylosing spondylitis?
34. Which foods should be recommended for patients to consume in order to manage ankylosing spondylitis?
35. What kind of exercises should be recommended to patients in order to manage ankylosing spondylitis?
36. For which muscle groups should exercise programs be applied for patients?

The answers were evaluated by two clinician physicians (physiatrists) with seven years of clinical and academic experience in AS. It was evaluated by two different clinicians and the same clinician's answers were accepted as correct. Clinicians were consulted when there were different opinions. The evaluator rated each ChatGPT response on a scale from 1 to 4: a score of 1 indicated fully correct information, 2 indicated correct but incomplete information, 3 indicated partially correct information with some inaccuracies, and 4 indicated entirely incorrect information. A response was considered accurate if an

experienced physiotherapist deemed it complete without needing further input. For questions based on ACR and ASAS-EULAR axial spondyloarthritis guidelines, guideline-specific information was used as a benchmark to assess the accuracy of ChatGPT's responses.

To assess the reproducibility of ChatGPT's responses on AS, each question was asked in written form twice on separate days. Consistent responses—those receiving the same score on both occasions—were considered repeatable. If ChatGPT's answers fell into different score

categories or varied in detail, they were viewed as lacking reproducibility. Ethics committee approval was not needed for this study, as no patient data was used.

Statistical Analysis

The statistical analysis was performed using Excel Version 22 (Microsoft, Redmond, WA, USA). The scores assigned to each answer were reported as percentages. The questions were divided into two main groups: general FAQs and those formulated based on ACR and ASAS-EULAR guidelines. Scores assigned to each response were calculated and presented as percentages, thereby providing a clear overview of ChatGPT's performance across different question categories.

RESULTS

Analyzing the flowchart of the study, which shows the reasons for excluding some questions related to AS, 85 of the 157 questions evaluated were excluded from the study because they were not able to meet the criteria.

These included 25 repetitive questions, 19 grammatically inadequate questions, 27 questions with subjective responses and 13 questions concerning personal health. The remaining 72 questions were included in the study. ChatGPT achieved an accuracy rate of 81.9% across 72 FAQs, correctly answering 59 questions. In total, eight responses (11.1%) were rated as grade 2, and five responses (7.0%) as grade 3, with no responses falling into grade 4. The most accurate responses were observed in the categories of prevention (91.7%) and general information (90.9%). In contrast, responses pertaining to non-pharmacological treatments demonstrated the lowest level of accuracy with a recorded rate of 69.2%. Additionally, a mere 22 out of the 36 questions (61.1%) based on the ACR and ASAS-EULAR guidelines were answered correctly, with three responses (8.3%) categorized as grade 4. The evaluation of responses to AS-related FAQs, as well as the grading of answers to questions aligned with ACR and ASAS-EULAR guidelines, is documented in Table 3 and illustrated in Figure 1.

Table 3. Evaluation of responses to ankylosing spondylitis-related questions categorized by question type				
	Grade 1	Grade 2	Grade 3	Grade 4
All questions (n=72)	59 (81.9%)	8 (11.1%)	5 (7.0%)	
General information (n=11)	10 (90.9%)	1 (9.1%)	-	-
Risk factors (n=10)	8 (80.0%)	1 (10.0%)	1 (10.0%)	-
Non-pharmacological treatments (n=13)	9 (69.2%)	2 (15.4%)	2 (15.4%)	-
Pharmacological treatments (n=26)	21 (80.7%)	3 (11.5%)	2 (7.8%)	-
Prevention (n=12)	11 (91.7%)	1 (8.3%)	-	-
ACR/ASAS-EULAR Guideline (n=36)	22 (61.1%)	7 (19.4%)	4 (11.1%)	3 (8.3%)

ACR: American College of Rheumatology, ASAS: Assessment of SpondyloArthritis International Society, EULAR: European League Against Rheumatism

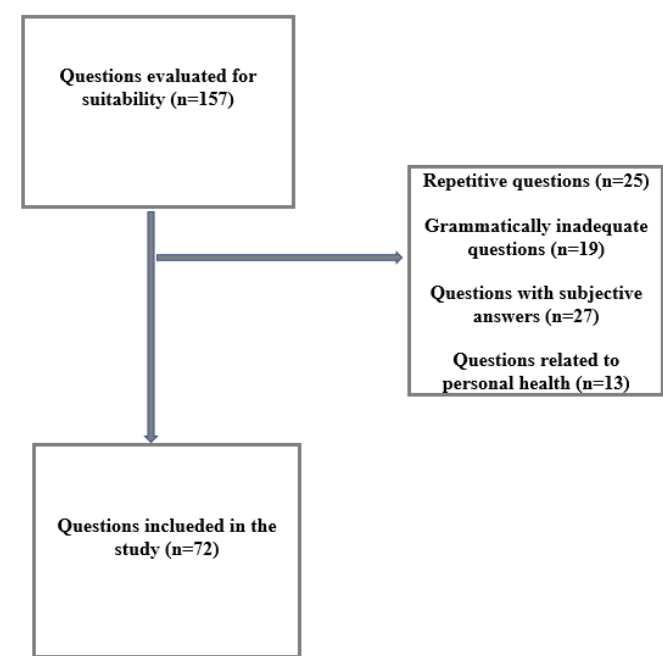


Figure 1. Flow chart of the study

ChatGPT's reproducibility rate across 72 FAQs was 88.8%, while its reproducibility for responses based on

ACR guidelines was 83.3%. The highest repeatability was observed in responses related to AS prevention (92.8%) and general information (90.9%) (Table 4). A full list of the 72 frequently asked questions used in this study is provided in Table 3.

Table 4. The consistency rate of answers provided for repeated questions	
	Reproducibility, n (%)
All questions (n=72)	64 (88.8%)
General information (n=11)	10 (90.9%)
Risk factors (n=10)	9 (90.0%)
Non-pharmacological treatments (n=13)	11 (84.6%)
Pharmacological treatments (n=26)	23 (88.4%)
Prevention (n=12)	11 (91.6%)
ACR Guideline (n=36)	30 (83.3%)

ACR: American College of Rheumatology

DISCUSSION

Machine learning has evolved with the ever-expanding development of artificial neural networks that resemble human neurons, with inputs and outputs affected by biases and weights. AI technology is becoming an increasingly important part of our daily lives. Its potential

is being exploited more and more in the field of healthcare. Although there are benefits to be gained from AI, there are also many concerns about its use in health care (8,9,12). Key knowledge gaps regarding ChatGPT's role in medical research and clinical practice include its accuracy in providing reliable health information, ethical and legal considerations, the interpretability of AI-driven decisions, potential biases, integration into healthcare systems, professional AI literacy, patient perspectives, and privacy concern (11,13).

The study aimed to assess awareness of ChatGPT about AS, a disease that affects approximately 1 to 1.5 percent of the global population. The study discovered that ChatGPT was capable of providing accurate answers to 81.9% of the most frequently asked questions about AS. In addition, the highest accuracy rate of responses of ChatGPT belonged to the questions regarding the prevention of AS questions. Conversely, ChatGPT yielded accurate responses in only 61.1% of the inquiries formulated in accordance with AS guideline specifications. This finding underscores a deficiency in the platform's capacity to manage intricate, evidence-based clinical recommendations.

The reliability and accuracy of online health sources are often questionable, and various research studies have shown that online material contains information which might be inaccurate and not complete. In their study, Alsyoud et al. examined the contents of online web sources concerning prostate cancer. The researchers found that inaccurate information was encountered 30 times more frequently than legitimate and reliable information (14). Also, Yeo et al. referred questions on cirrhosis and hepatocellular carcinoma to ChatGPT, which yielded a 76.9% success rate in providing accurate responses. However, the model was unable to ascertain decision making boundaries and the duration of treatment (15). Lastly, Moraht et al. entered a sample of 50 questions about medicines into ChatGPT. Only 13 out of 50 answers (26%) were correct (16). In contrast, Ozgor and Simavi analysed ChatGPT's performance in answering endometriosis questions and concluded that ChatGPT answered endometriosis questions satisfactorily, correctly answering over 90% of questions (17). Also, Cinar analysed ChatGPT's performance in answering questions about osteoporosis. The author found that ChatGPT provided appropriate responses to inquiries regarding osteoporosis and accurately responded to over 80% of the FAQ (10).

Finally, Dyckhoff-Shen et al. The accuracy of ChatGPT's responses to ten essential questions on brain abscess diagnosis and treatment was assessed against the guidelines issued by the European Society for Clinical Microbiology and Infectious Diseases. Without any data manipulation, 70% of the answers closely aligned with the guideline recommendations (18). The results of the study showed that more than four out of five responses to ChatGPT on the subject of AS provided accurate and entirely truthful data. In contrast to numerous alternative online sources, ChatGPT utilizes a multitude of references

when formulating responses to inquiries, thereby ensuring the precision and caliber of its outputs.

Guidelines are valuable resources that synthesize findings from numerous meta-analyses and clinical trials; they are scientifically rigorous and provide recommendations for everyday practice. In contrast, inquiries about where to locate evidence-based scientific literature can be more difficult to address (19). Antaki et al. conducted a study in which ChatGPT was utilized to respond to the examination questions posed by first-year ophthalmology residents. The results indicated that ChatGPT correctly answered 55.8% of the questions, which was comparable to the performance of the residents (20). Research by Caglar et al. (9) revealed that ChatGPT demonstrated an accuracy rate of 93.6% in responses to inquiries based on pediatric urology guidelines. Nonetheless, the present study found that the rate of accuracy for ChatGPT responses to inquiries aligned with ACR guidelines stood at 61.1%, a figure that falls short when benchmarked against the accuracy rate of the FAQ concerning AS.

One intriguing question is whether computers may eventually replace a clinician. The emergence of ChatGPT last year further increased interest in this area. Research has indicated that AI can achieve performance levels comparable to or exceeding those of humans on licensing exams, including the United States Medical Licensing Examination (USMLE), as well as specialist recruitment assessments like the UK's Multi-Specialty Recruitment Assessment (21,22). According to Gilson et al., ChatGPT was able to correctly answer 60% of the questions in medical school exams (13).

As seen in our study, artificial intelligence; gave less accurate answers to complex questions about AS diagnosis and treatment recommended by the guidelines. Additionally, in real life, patients' presentations are often atypical, so many people consider medicine to be an art as well as a science (23).

Limitations

It is important to note that this study has some limitations, such as only covering a certain period and not including all contents about AS uploaded to the internet. Furthermore, the observed variability in outputs due to minor variations in wording underscores the necessity for expeditious standardization. Moreover, it is important to recognize that the study was carried out exclusively in English. It is evident that English maintains its preeminence in academic and social online environments. It is essential to highlight that this study did not assess the clarity of ChatGPT's responses. Nevertheless, future research could examine how intelligible ChatGPT's answers are to individuals with different educational backgrounds.

CONCLUSION

The findings of the current study revealed for the first time that ChatGPT offered satisfactory responses to over 81% of FAQs related to AS. However, the accuracy of its

answers to questions based on the ACR and ASAS-EULAR axial spondyloarthritis guidelines dropped to 61.1%. While it exhibits potential as an educational resource, clinicians must critically interpret its outputs, ensuring accuracy and contextual relevance.

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