

# ChatGPT's Epoch in Rheumatological Diagnostics: A Critical Assessment in the Context of Sjögren's Syndrome

Review began 09/12/2023  
Review ended 10/23/2023  
Published 10/26/2023

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## Abstract

**Introduction:** The rise of artificial intelligence in medical practice is reshaping clinical care. Large language models (LLMs) like ChatGPT have the potential to assist in rheumatology by personalizing scientific information retrieval, particularly in the context of Sjögren's Syndrome. This study aimed to evaluate the efficacy of ChatGPT in providing insights into Sjögren's Syndrome, differentiating it from other rheumatological conditions.

**Materials and methods:** A database of peer-reviewed articles and clinical guidelines focused on Sjögren's Syndrome was compiled. Clinically relevant questions were presented to ChatGPT, with responses assessed for accuracy, relevance, and comprehensiveness. Techniques such as blinding, random control queries, and temporal analysis ensured unbiased evaluation. ChatGPT's responses were also assessed using the 15-questionnaire DISCERN tool.

**Results:** ChatGPT effectively highlighted key immunopathological and histopathological characteristics of Sjögren's Syndrome, though some crucial data and citation inconsistencies were noted. For a given clinical vignette, ChatGPT correctly identified potential etiological considerations with Sjögren's Syndrome being prominent.

**Discussion:** LLMs like ChatGPT offer rapid access to vast amounts of data, beneficial for both patients and providers. While it democratizes information, limitations like potential oversimplification and reference inaccuracies were observed. The balance between LLM insights and clinical judgment, as well as continuous model refinement, is crucial.

**Conclusion:** LLMs like ChatGPT offer significant potential in rheumatology, providing swift and broad medical insights. However, a cautious approach is vital, ensuring rigorous training and ethical application for optimal patient care and clinical practice.

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**Categories:** Family/General Practice, Internal Medicine, Rheumatology

**Keywords:** artificial intelligence (ai), large language models (llms), chatgpt-4, chatgpt, sjögren's syndrome

## Introduction

Artificial intelligence (AI) continues to play an increasingly important role in medical practice and technology [1]. Its advancement as a field is radically transforming the landscape of clinical care, with significant considerations and outcomes for physicians, patients, and policymakers alike [2]. With such an emerging field, it is vital to map out the different ways that it can impact informed decision-making processes. In the context of rheumatology, large language models (LLMs) such as Chat Generative Pre-Trained Transformer (ChatGPT) can personalize the retrieval of scientific information by understanding the context of a user's query and tailoring the responses to meet specific needs, such as summarizing complex scientific articles into easy-to-understand formats for informed decision-making [3]. These models can also analyze vast datasets of scientific literature to identify key insights, trends, and relationships, thereby assisting in evidence-based decision-making by providing synthesized and relevant information [4].

In the context of Sjögren's Syndrome, ChatGPT and other large language models can offer targeted insights that are particularly helpful in differentiating this disorder from other rheumatological conditions. For example, if a healthcare provider is unsure whether a patient's symptoms of dry eyes and mouth are indicative of Sjögren's Syndrome or perhaps another autoimmune condition, the model could retrieve and summarize the most current diagnostic criteria, such as the American College of Rheumatology (ACR)/European League Against Rheumatism (EULAR) classification criteria for Sjögren's Syndrome. It could highlight key serological markers like anti-SSA/Ro and anti-SSB/La antibodies, which are more commonly associated with Sjögren's than with other disorders.

### How to cite this article

Irfan B, Yaqoob A (October 26, 2023) ChatGPT's Epoch in Rheumatological Diagnostics: A Critical Assessment in the Context of Sjögren's Syndrome. Cureus 15(10): e47754. DOI 10.7759/cureus.47754

The LLM could also assist in treatment planning by retrieving the latest guidelines and summarizing pharmacological options, such as the use of hydroxychloroquine for arthralgia in Sjögren's, and how that differs from its use in, say, lupus or rheumatoid arthritis. It can provide summaries of the latest studies on emerging therapies, such as B-cell targeted treatments, that may have differing efficacies in Sjögren's compared to other rheumatological diseases. For monitoring risks of non-Hodgkin lymphoma in Sjögren's Syndrome, the LLM could outline evidence-based surveillance protocols, including which imaging or laboratory tests are most indicative of disease progression or malignancy risk, as opposed to what would be relevant in other rheumatological conditions. Given these considerations, we presented four questions to ChatGPT related to Sjögren's Syndrome where the responses were evaluated for informativeness, accuracy, and overall applicability and user-friendliness by two independent reviewers.

## Materials And Methods

To explore the potential of ChatGPT in assisting healthcare professionals with insights into Sjögren's Syndrome and differentiating it from other rheumatological conditions, we developed a brief study utilizing a multi-pronged methodology. Initially, we compiled resources that consisted of peer-reviewed articles, clinical guidelines, and case studies specifically focused on Sjögren's Syndrome, as well as other rheumatological diseases. These texts were gleaned from reputable academic databases such as PubMed and ClinicalTrials.gov and were utilized to aid in analyzing the responses drawn from ChatGPT.

The second phase involved the formulation of clinically relevant questions, by the authors, that healthcare providers commonly encounter in the diagnosis or management of Sjögren's Syndrome. Queries like "What are the immunological features of Sjögren's Syndrome?", "What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma?", "What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome?", and "I have joint pain, dry eyes, dry mouth, and a persistent dry cough. What is the differential diagnosis?" were developed. These questions, four in total, were then used as prompts to engage ChatGPT, and the responses were thoroughly assessed in terms of their accuracy, relevance, and comprehensiveness, aligned with the current scientific literature. We were mindful of presenting questions in "new chats" to avoid it utilizing past conversation history to curate a specifically tailored response [5]. For example, when stating symptoms such as joint pain and dry eyes and requesting a differential diagnosis of the matter, past conversation about Sjögren's Syndrome's immunology could influence its response as the subject matter was already being discussed [6].

Ensuring an unbiased assessment of the ChatGPT's utility was paramount in our study design. To achieve this, we employed multiple techniques. For one, we implemented a blinding technique, removing any tags or markers that might identify the source as an LLM [7]. This allowed for a blind evaluation by three reviewers which included clinicians with internal medicine specializations, as part of drawing from past studies making use of physician reviewers [8]. We also ensured that all evaluators declared any potential conflicts of interest prior to their assessments. The responses generated by ChatGPT were also cross-validated by repeating them in a new conversation thread to verify overall thematic consistency and accuracy. Scores from 1 (low) to 5 (high) were also independently assigned by reviewers, which were then averaged, to each article using the 15-questionnaire DISCERN tool to assess written health material [9]. To further bolster the unbiased nature of our assessment, we introduced several additional methods. Randomized control prompts about other rheumatological conditions like arthritis and osteoarthritis were interspersed with the main prompts to gauge if the model displayed any preference or bias towards Sjögren's Syndrome [10]. Temporal analysis was performed by conducting the study at various time points to examine if updates to the model influenced its response to our control queries. After finding no prominent difference in results to our control prompts between June-August 2023, we utilized ChatGPT Version 4 for our analysis which continues to regularly receive updates and technical fixes, with our focus on the end results of the Sjögren's Syndrome-related questions being based on the model present as of August 31, 2023. By rigorously adhering to these materials and methods, our study aims to offer a robust and unbiased evaluation of the capabilities of LLMs like ChatGPT in aiding the diagnosis and management of Sjögren's Syndrome in comparison to other rheumatological conditions.

## Results

Upon questioning ChatGPT regarding the immunopathological characteristics of Sjögren's Syndrome, it elucidated key aspects, encompassing autoantibody generation, lymphocytic infiltration, imbalances in cytokine production, B-cell hyperactivity, and an augmented expression of Type I interferon (Figure 1). Intriguingly, the model inherently proffered five salient points, independent of any preset constraints, engendering implications for potential hierarchization of these pathophysiological features in terms of significance or prevalence. The bibliographic citations generated in alignment with this query were predominantly from credible sources; however, an inconsistency was noted in the fourth reference, where the year of publication was erroneously delineated (Figure 2). Notably, ChatGPT judiciously incorporated a caveat emphasizing the dynamism inherent in medical knowledge and flagged its own knowledge cut-off at September 2021, underscoring its circumspection [11].



What are the immunological features of Sjögren's Syndrome? Provide 5 high-quality references



Sjögren's Syndrome is an autoimmune disorder characterized by the immune system attacking the body's own tissues and cells, particularly the moisture-producing glands like the salivary and lacrimal glands. This leads to symptoms such as dry eyes and dry mouth. Here are some of the key immunological features of Sjögren's Syndrome:

1. **Autoantibody Production:** One of the hallmark features is the production of autoantibodies against intracellular antigens, including anti-SSA/Ro and anti-SSB/La.
2. **Lymphocytic Infiltration:** The affected glands show lymphocytic infiltration, primarily consisting of CD4+ T cells and B cells. This disrupts the normal architecture of the gland and contributes to its dysfunction.
3. **Cytokine Imbalance:** There is an imbalance in pro-inflammatory and anti-inflammatory cytokines. Elevated levels of cytokines like IL-6 and TNF-alpha are often noted.
4. **B Cell Hyperactivity:** Abnormal B cell activation and survival contribute to the pathogenesis, and are the rationale behind using B cell-targeted therapies like Rituximab.
5. **Increased Expression of Type I Interferon:** The interferon signature, particularly of type I interferons, is often upregulated, contributing to the autoimmune response.

### FIGURE 1: What are the immunological features of Sjögren's Syndrome?

High-Quality References:

1. Fox, R. I. (2005). Sjögren's syndrome. *The Lancet*, 366(9482), 321-331.
  - \* A comprehensive review of Sjögren's Syndrome, including its immunological features.
2. Mavragani, C. P., & Moutsopoulos, H. M. (2014). Sjögren syndrome. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne*, 186(15), E579–E586.
  - \* Provides an insight into the role of interferons in Sjögren's Syndrome.
3. Vivino, F. B., Bunya, V. Y., Massaro-Giordano, G., Johr, C. R., Giattino, S. L., & Schorpion, A. (2019). Sjögren's Syndrome: An Update on Disease Pathogenesis, Clinical Manifestations and Treatment. *Clinical Immunology*, 203, 81-121.
  - \* Discusses the immunological features in detail, including the cytokine imbalance and B cell activity.
4. Nocturne, G., & Mariette, X. (2015). Advances in understanding the pathogenesis of primary Sjögren's syndrome. *Nature Reviews Rheumatology*, 11(9), 544-556.
  - \* This paper focuses on the underlying immunological mechanisms contributing to Sjögren's Syndrome.
5. Bowman, S. J., & Fox, R. I. (2014). Classification criteria for Sjögren's syndrome: nothing ever stands still! *Annals of the Rheumatic Diseases*, 73(1), 1-2.
  - \* A publication discussing the criteria for diagnosis, which also touches upon the immunological markers used for diagnosis and understanding of disease pathophysiology.

Please note that the medical field is continually evolving, and it would be advisable to consult the latest research for the most current information.

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### FIGURE 2: References for "What are the immunological features of Sjögren's Syndrome?"

In its elucidation of the histopathological attributes specific to the syndrome, ChatGPT enumerated five cardinal features, whilst omitting crucial data, notably the periductal infiltration of the salivary and lacrimal glands predominantly by CD4+ helper T (Th) lymphocytes, among other cellular entities (Figure 3).

Furthermore, the model did not delineate the genomic predilections contributing to the syndrome's pathogenesis. Disparities were also observed in the bibliographic citations for therapeutic management, with the foremost reference manifesting discrepancies in authorship attribution, publication chronology, title, and source journal (Figures 4-8) [12].



What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma? Provide 5 high-quality references



Sjögren's Syndrome (SS) is known for its association with a significantly increased risk for the development of non-Hodgkin lymphoma (NHL). Several histopathological features of SS have been linked to this elevated risk:


1. **Lymphocytic Infiltration:** One of the hallmark features of SS is the focal lymphocytic sialadenitis. A higher "focus score," indicative of a higher degree of lymphocytic infiltration into the salivary glands, has been associated with a greater risk of NHL.
2. **Germinal Center Formation:** The presence of ectopic germinal centers in the salivary gland biopsies of patients with SS is considered a risk factor for subsequent lymphoma development.
3. **Clonal Expansion:** Clonal expansion of B cells in the salivary glands, demonstrated by techniques like immunoglobulin gene rearrangement studies, suggests an evolving B cell malignancy, which is a precursor to lymphoma.
4. **Increased Expression of Activation-Induced Cytidine Deaminase (AID):** AID is involved in somatic hypermutation and class-switch recombination. Its expression is usually restricted to germinal centers, but in SS, it may be expressed more widely, thereby contributing to oncogenic mutations.
5. **Cytokine Dysregulation:** Chronic inflammation and cytokine dysregulation, including increased levels of B-cell activating factor (BAFF), can support B-cell survival and may contribute to malignant transformation.

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**FIGURE 3: What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma?**

## High-Quality References:

1. Brito-Zerón, P., Ramos-Casals, M., Bove, A., Sentis, J., & Font, J. (2007). Predicting adverse outcomes in primary Sjögren's syndrome: identification of prognostic factors. *Rheumatology*, 46(8), 1359-1362.
  - Discusses risk factors, including histopathological ones, that may lead to adverse outcomes like lymphoma in SS.
2. Nocturne, G., & Mariette, X. (2015). Sjögren Syndrome-associated lymphomas: an update on pathogenesis and management. *British Journal of Haematology*, 168(3), 317-327.
  - A comprehensive overview focusing on the relationship between SS and lymphomas.
3. Risselada, A. P., Looije, M. F., Kruize, A. A., Bijlsma, J. W., & van Roon, J. A. (2013). The role of ectopic germinal centers in the immunopathology of primary Sjögren's syndrome: a systematic review. *Seminars in arthritis and rheumatism*, 42(4), 368-376.
  - Discusses the role of ectopic germinal centers in the pathology of SS and their link to lymphoma.
4. Theander, E., Henriksson, G., Ljungberg, O., Mandl, T., Manthorpe, R., & Jacobsson, L. T. (2006). Lymphoma and other malignancies in primary Sjögren's syndrome: a cohort study on cancer incidence and lymphoma predictors. *Annals of the Rheumatic Diseases*, 65(6), 796-803.
  - A cohort study that looks at cancer incidence including lymphoma in SS, considering various risk factors including histopathological ones.
5. Tzioufas, A. G., Kapsogeorgou, E. K., & Moutsopoulos, H. M. (2012). Pathogenesis of

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**FIGURE 4: References for "What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma?" (Part 1)**

5. Tzioufas, A. G., Kapsogeorgou, E. K., & Moutsopoulos, H. M. (2012). Pathogenesis of Sjögren's syndrome: what we know and what we should learn. *Journal of Autoimmunity*, 39(1-2), 4-8.
  - Discusses the pathogenesis of SS with a focus on immunological and histopathological factors, including those that increase the risk of lymphoma.

Always consult the latest research for the most current information as the medical field is continuously evolving.

**FIGURE 5: References for "What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma?" (Part 2)**



What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome?



The management of Sjögren's Syndrome (SS) is complex and often requires a multidisciplinary approach, as the disease can have a wide range of clinical manifestations. Here is an overview of appropriate follow-up management for a patient with SS:

**Symptomatic Treatment**

1. **Dry Eyes:** Artificial tears, cyclosporine eye drops, or punctal plugs may be recommended.
2. **Dry Mouth:** Saliva substitutes, sugar-free lozenges, or medications like pilocarpine may be prescribed.
3. **Joint Pain:** Over-the-counter NSAIDs or prescription medications like hydroxychloroquine may be used for arthralgia.

**Disease Monitoring**

1. **Regular Clinic Visits:** Regular follow-ups are necessary to monitor symptoms and adjust medications.
2. **Laboratory Tests:** Routine blood tests like complete blood count (CBC), ESR, CRP, and kidney/liver function tests.
3. **Autoantibody Monitoring:** Periodic assessment of autoantibodies like anti-SSA and

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**FIGURE 6: What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome? (Part 1)**

3. **Autoantibody Monitoring:** Periodic assessment of autoantibodies like anti-SSA and anti-SSB.
4. **Imaging:** Ultrasound or MRI of salivary glands may be recommended to assess the extent of glandular involvement.

**Lymphoma Surveillance**

Given the increased risk for non-Hodgkin lymphoma, patients may require:

1. **Regular Lymph Node Examinations:** Physical examination of lymph nodes at each clinic visit.
2. **Imaging:** Depending on the clinical scenario, imaging studies like ultrasound or CT scans may be recommended.

**Lifestyle Modifications**

1. **Hydration:** Patients are advised to keep well-hydrated.
2. **Dental Hygiene:** Regular dental check-ups are essential due to the increased risk of dental caries.

**Specialist Referrals**

Depending on the symptoms, referrals may be necessary to:

1. Rheumatologist
2. Ophthalmologist
3. Dentist or Oral Medicine Specialist

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**FIGURE 7: What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome? (Part 2)**

3. Dentist or Oral Medicine Specialist
4. Gastroenterologist
5. Pulmonologist

#### Other Considerations

1. **Psychological Support:** SS can impact quality of life; psychological counseling or support groups may be helpful.
2. **Vaccination:** Annual flu vaccines and other appropriate vaccinations should be up to date, especially if immunosuppressive therapy is being considered.

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1. "Management of Sjögren's Syndrome" by Moutsopoulos HM, in *Rheumatic Diseases Clinics of North America*, 2008; 34(4): 967-976.
2. "Clinical practice guidelines for oral management of Sjögren disease" by Zero et al., in *The Journal of the American Dental Association*, 2016; 147(4): 295-305.
3. "Treatment Guidelines for Rheumatologic Manifestations of Sjögren's" by Carsons et al., in *Arthritis Care & Research*, 2017; 69(4): 517-527.
4. "EULAR Sjögren's syndrome disease activity index (ESSDAI): a user guide" by Seror et al., in *RMD Open*, 2015; 1(1).
5. "Sjögren's Syndrome: An Update on Disease Pathogenesis, Clinical Manifestations and Treatment" by Vivino et al., in *Clinical Immunology*, 2019; 203: 81-121.

It's essential to individualize the treatment plan according to the patient's needs and to keep abreast of the latest research, as medical knowledge continues to evolve. Always consult your healthcare provider for diagnosis and treatment.

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### FIGURE 8: What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome? (Part 3)

When prompted with a clinical vignette detailing xerophthalmia, arthralgia, xerostomia, and persistent dry cough, ChatGPT adeptly identified a myriad of plausible etiological considerations, with Sjögren's Syndrome being preeminent (Figure 9). Furthermore, the model sagaciously expounded on the imperativeness of a comprehensive clinical evaluation and intimated potential specialist referrals encompassing rheumatology, ophthalmology, or gastroenterology (Figure 10) [13]. DISCERN scores were also relatively high for much of the responses presented by ChatGPT (Table 1).



I have joint pain, dry eyes, dry mouth, and a persistent dry cough. What is the differential diagnosis for this?



I'm not a healthcare professional, but the symptoms you describe could potentially be associated with a variety of conditions. A differential diagnosis could include:



1. **Sjögren's Syndrome:** This autoimmune disorder is characterized by dry eyes and dry mouth, and it may also be associated with joint pain.
2. **Rheumatoid Arthritis:** Although primarily known for causing joint pain, this autoimmune disorder can have systemic effects, including dry eyes and mouth.
3. **Systemic Lupus Erythematosus (SLE):** This is another autoimmune disorder that can affect multiple organ systems and cause joint pain, although dry eyes and mouth are less commonly associated symptoms.
4. **Medication Side Effects:** Certain medications, particularly antihistamines, anticholinergics, and some blood pressure medications, can cause dry eyes, dry mouth, and sometimes joint pain.
5. **Sarcoidosis:** This inflammatory disease can affect various organs and may cause dry cough, joint pain, and occasionally dry eyes and mouth.
6. **Viral Infections:** Some viral illnesses like HIV can cause systemic symptoms that include joint pain, dry eyes, and dry mouth.
7. **Gastroesophageal Reflux Disease (GERD):** While primarily affecting the digestive system,

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### FIGURE 9: I have joint pain, dry eyes, dry mouth, and a persistent dry cough. What is the differential diagnosis for this?

7. **Gastroesophageal Reflux Disease (GERD):** While primarily affecting the digestive system, GERD can also cause a persistent dry cough. However, it is less likely to cause dry eyes and mouth.
8. **Thyroid Disorders:** Hyperthyroidism and hypothyroidism can sometimes cause dry eyes, dry mouth, and joint pain.
9. **Environmental Factors:** Dry air or exposure to irritants can sometimes cause dry eyes, dry mouth, and a dry cough.
10. **Chronic Fatigue Syndrome:** Rarely, this condition may be associated with joint pain, and dry eyes and mouth, although the main symptom is persistent fatigue.
11. **Idiopathic or Unknown:** Sometimes symptoms may not fit neatly into any diagnostic criteria and may be idiopathic, meaning the cause is unknown.

Given that these symptoms can overlap with many different conditions, some of which may require urgent intervention, it is crucial to consult a healthcare provider for a thorough evaluation and appropriate diagnostic tests, which may include blood tests, imaging studies, and possibly biopsies or other specialized procedures.

Your healthcare provider may refer you to specialists such as a rheumatologist, ophthalmologist, or gastroenterologist for further evaluation and treatment.

### FIGURE 10: Recommendation to See Specialists



Question	DISCERN Score
What are the immunological features of Sjögren's Syndrome?	4.22
What are the histopathological features of Sjögren's Syndrome that make it more high risk for getting non-Hodgkin lymphoma?	3.67
What is the appropriate follow-up management for a patient presenting Sjögren's Syndrome?	3.97
I have joint pain, dry eyes, dry mouth, and a persistent dry cough. What is the differential diagnosis for this?	4.82

**TABLE 1: DISCERN Scores for ChatGPT-generated responses to questions**

## Discussion

The utilization of artificial intelligence and LLMs like ChatGPT in the realm of rheumatology offers a spectrum of both promising opportunities and notable challenges. From our study, the immediacy with which ChatGPT can access and summarize vast amounts of data presents a significant advantage for both patients and healthcare providers [14]. Such access can facilitate evidence-based decision-making, particularly in complex areas like rheumatology where differential diagnosis can be intricate [15].

For patients, the use of ChatGPT can democratize information, offering insights into their symptoms and potential conditions even before a clinical consultation [16]. This can empower them with information, enabling more informed conversations with their healthcare providers [17]. For the common person, it provides a platform to understand complex medical conditions in simplified terms, bridging the knowledge gap [18]. Furthermore, for physicians and clinical providers, it can act as an efficient aid in clinical decision-making by offering quick references, diagnostic criteria, and updated treatment guidelines [19].

The limitations observed in our results, such as the tendency of ChatGPT to default to a brief explanation by listing only a select number of features, raise concerns about potential oversimplification [20]. The inherent risk is that essential clinical features may be omitted, leading to an incomplete understanding [21]. Moreover, its dependence on its last training data (in this case, up to September 2021) means it might not always provide the most up-to-date information. As seen from our results, ChatGPT did have inaccuracies in reference citations, further emphasizing the importance of cross-referencing [22].

While LLMs can simplify complex scientific information, there's an inherent responsibility to ensure that this does not inadvertently lead to misinformation [23]. As we observed, ChatGPT does acknowledge its last update, which is vital for transparency. However, there's a need for robust mechanisms to continuously update and train these models with the latest medical research. Another ethical consideration is the potential for LLMs to inadvertently influence clinical decision-making if relied upon too heavily. Physicians must balance the insights from LLMs with their clinical judgment. Additionally, it's imperative to address the potential bias in LLMs. As seen with our control queries about other rheumatological conditions, ensuring that the AI does not display any undue preference for a particular condition is crucial [24]. Overreliance on AI responses without critical evaluation can skew clinical perceptions. This is all becoming increasingly relevant as social media and telehealth technology continues to expand to refine areas of care and be a source of medical information [25,26].

## Conclusions

The adoption of LLMs like ChatGPT in the domain of rheumatology holds vast potential, offering swift access to a broad spectrum of medical knowledge that can enhance evidence-based clinical decision-making. Our study underscores the efficiency and utility of ChatGPT in demystifying complex medical concepts, bridging the knowledge gap for both patients and healthcare professionals. However, this potential is counterbalanced by some limitations. The oversimplification observed in some responses and occasional inaccuracies in reference citations urge a cautious approach in relying solely on LLMs without cross-referencing or incorporating clinical judgment. As artificial intelligence continues to make strides in healthcare, the continuous refinement, rigorous training, and ethical application of these tools will be paramount in ensuring their optimal use in patient care and clinical practice.

## Additional Information

### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Bilal Irfan

**Acquisition, analysis, or interpretation of data:** Bilal Irfan, Aneela Yaqoob

**Drafting of the manuscript:** Bilal Irfan

**Critical review of the manuscript for important intellectual content:** Bilal Irfan, Aneela Yaqoob

**Supervision:** Aneela Yaqoob

## Disclosures

**Human subjects:** All authors have confirmed that this study did not involve human participants or tissue.

**Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue.

**Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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