Ann Med Res

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Annals of Medical Research

journal page: www.annalsmedres.org

Evaluation of Chat Generative Pre-trained Transformer's responses to frequently asked questions about psoriatic arthritis: A study on quality and readability

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ARTICLE INFO

Keywords:
ChatGPT
Artificial intelligence
Psoriatic arthritis
Quality information
Readability

Received: Nov 01, 2024
Accepted: Feb 11, 2025
Available Online: 26.02.2025

DOI:
10.5455/annalsmedres.2024.10.231

Abstract

Aim: The growing use of artificial intelligence (AI) in healthcare, especially through technologies such as Chat Generative Pre-trained Transformer (ChatGPT), has led to concerns regarding the quality and readability of AI-generated health data. This study aimed to evaluate ChatGPT's responses to frequently asked questions about psoriatic arthritis (PsA).

Materials and Methods: The quality of ChatGPT-generated responses was evaluated using the Ensuring Quality Information for Patients (EQIP) tool. Readability was assessed using the Flesch–Kincaid Reading Ease (FKRE) and Flesch–Kincaid Grade Level (FKGL) indices. The Kruskal–Wallis H test was used to compare subgroups, and Bonferroni correction was done for multiple comparisons.

Results: Significant differences were observed in EQIP scores across question subgroups, with treatment-related questions scoring lower than symptom-related questions. The FKRE and FKGL scores indicated that the information provided by ChatGPT could be challenging for patients with lower literacy levels.

Conclusion: Although ChatGPT provided relatively accurate information on PsA, its readability and ability to communicate complex medical information might be improved. These findings suggest the necessity for continual refinement of AI tools to address the diverse needs of patients.

Introduction

Psoriatic arthritis (PsA) is a chronic inflammatory disorder that causes joint pain and affects approximately 30% of individuals with psoriasis [1]. The complexity of PsA, including several systems and a wide range of clinical symptoms, requires comprehensive and accessible patient education [2, 3]. With the proliferation of digital health information, patients are increasingly turning to online resources to better understand their diseases and treatment options [4]. However, concerns exist about the accuracy, comprehensiveness, and readability of AI-generated health information [5, 6].

The rapid advancement of artificial intelligence (AI) has facilitated the integration of large language models (LLMS), such as Chat Generative Pretrained Transformer (ChatGPT), into healthcare. AI-driven chatbots are increasingly employed to provide medical information, address patient queries, and assist healthcare professionals in decision-making. While ChatGPT has shown promise in generating informative content, it is essential to evaluate the quality, reliability, and readability of AI-generated health data [5, 6]. Prior research indicates that AI tools often struggle to balance readability with medical accuracy, sometimes producing responses that are either overly simplistic or excessively technical [6, 7].

Several studies have assessed the performance of AI-based chatbots in various medical fields, including dermatology, rheumatology, and general medicine. Previous research has shown challenges in preservation of the readability of complex medical information generated by AI tools, particularly for patients with lower literacy levels [7].

This study aims to assess the quality and readability of Chat Generative Pre-trained Transformer's (ChatGPT's) responses to frequently asked questions related to PsA, thereby the study's findings could inform the development of AI algorithms designed to simplify medical jargon, use clearer language, and provide visual aids, thereby improving the accessibility and usefulness of digital health infor-

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mation for a broader patient population.

Materials and Methods

Study design

This study was conducted on July 10, 2024, at the Department of Physical Medicine and Rehabilitation. This study did not involve human or animal participants; therefore, ethical approval and compliance with the Helsinki Declaration were not required. Google Trends was used to identify the most commonly searched terms for PsA. All browser-related data were cleared before starting the search to eliminate bias [8]. The terms "psoriatic arthritis," "PsA," and "arthritis psoriatica" were used, with all global and health subheadings selected as search criteria [9]. The "most important" question was selected from the relevant question section of the results, and regions of interest were organized by subregion [10]. Exclusion criteria included overlapping words, non-English terminology, and irrelevant questions. The study design process are outlined in Figure 1.

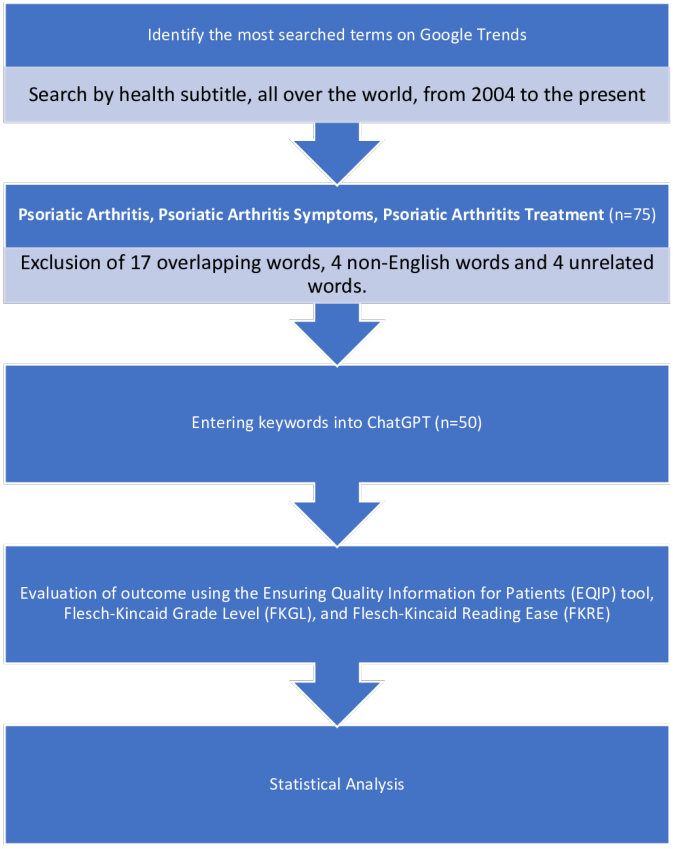

Figure 1. Flow chart of study design.

Each term was entered into ChatGPT to generate responses. This technique was developed to promote response diversity while avoiding redundancy. Subsequently, the generated responses were recorded for further analysis, which focused on quality, clarity, and readability [11].

Evaluation tools

The quality of the ChatGPT-generated responses was analyzed using the Ensuring Quality Information for Patients (EQIP) tool, which evaluated patient information across various dimensions such as clarity, accuracy, completeness, and relevance [12]. The EQIP tool evaluates information on a scale of 0–100, with higher scores indicating higher quality. This tool uses a set of 20 criteria to assess the quality of the information, and the final EQIP score is expressed as a percentage, which represents the proportion of criteria satisfied by the information provided. Responses were independently examined by two physical and rehabilitation physicians (MSK and OVY), and inconsistencies were resolved by a third evaluator (TA) [13].

Readability assessment

Readability was assessed using the Flesch–Kincaid Reading Ease (FKRE) and Flesch–Kincaid Grade Level (FKGL) indices. The FKRE score is determined using sentence length and syllable count, with higher values indicating better readability [14]. The FKGL score indicates the U.S. school grade level necessary to understand the text [15].

Statistical analysis

The Kruskal–Wallis H test was used to compare EQIP, FKRE, and FKGL scores across several subgroups of PsA-related questions (symptoms, diagnosis, treatment options, and sequelae). Bonferroni post hoc correction was used for multiple comparisons, with an adjusted significance level of $p < 0.017$. Dunn's post-hoc test with Bonferroni correction was used to identify pairwise differences between subgroups. Statistical significance for all analyses was determined at $p < 0.05$, which means any p value less than 0.05 was considered significant, not exactly 0.05.

- Kruskal–Wallis H test: It is used to examine if there are statistically significant differences in EQIP, FKRE, and FKGL scores among subgroups [16].
- Spearman's rank correlation test: It is used to determine correlations between numerical variables in data [17].
- Bonferroni post hoc correction: It is used to correct for multiple comparisons by adjusting the significance level to prevent type I errors [18].

Results

The categorization of Psoriatic Arthritis topics by EQIP criteria is detailed in Table 1. The research indicated significant differences in EQIP scores across question subgroups, with treatment-related questions consistently scoring lower than those related to symptoms and diagnosis. Descriptive statistics of patient information quality and readability scores are presented in Table 2. Additionally, the FKRE and FKGL scores revealed that the readability of ChatGPT-generated responses might be challenging, particularly for patients with lower literacy levels. These findings indicate the areas where ChatGPT excels and struggles, notably in conveying complex medical information in an accessible manner.

The Kruskal–Wallis H test was used to compare EQIP scores, FKRE scores, and FKGL scores among different subgroups of questions about PsA.

Table 1. Categorization of Psoriatic Arthritis topics by EQIP criteria.

Ranks	Keyword	Category of the based on EQIP
1	What is psoriatic arthritis?	Event or Disease
2	What are the symptoms of psoriatic arthritis?	Event or Disease
3	What causes psoriatic arthritis?	Event or Disease
4	Is psoriatic arthritis hereditary?	Event or Disease
5	What are the early signs of psoriatic arthritis?	Event or Disease
6	What triggers psoriatic arthritis flare-ups?	Event or Disease
7	Can stress worsen psoriatic arthritis?	Event or Disease
8	Is psoriatic arthritis an autoimmune disease?	Event or Disease
9	Can children get psoriatic arthritis?	Event or Disease
10	What are the complications of psoriatic arthritis?	Event or Disease
11	How does psoriatic arthritis affect the skin?	Event or Disease
12	Is psoriatic arthritis related to psoriasis?	Event or Disease
13	What is the prognosis for psoriatic arthritis?	Event or Disease
14	What is the relationship between psoriatic arthritis and other autoimmune diseases?	Event or Disease
15	Can psoriatic arthritis cause disability?	Event or Disease
16	What are the risks of untreated psoriatic arthritis?	Event or Disease
17	Can psoriatic arthritis cause eye problems?	Event or Disease
18	Can psoriatic arthritis cause heart problems?	Event or Disease
19	What is dactylitis in psoriatic arthritis?	Event or Disease
20	Can psoriatic arthritis cause kidney problems?	Event or Disease
21	Can psoriatic arthritis cause lung problems?	Event or Disease
22	How is psoriatic arthritis treated during pregnancy?	Discharge or Postoperative Care
23	How to manage psoriatic arthritis pain?	Discharge or Postoperative Care
24	How to prevent psoriatic arthritis flare-ups?	Discharge or Postoperative Care
25	How does psoriatic arthritis affect daily life?	Discharge or Postoperative Care
26	How to manage fatigue in psoriatic arthritis?	Discharge or Postoperative Care
27	What lifestyle changes help with psoriatic arthritis?	Discharge or Postoperative Care
28	Can exercise help with psoriatic arthritis?	Discharge or Postoperative Care
29	What are the best exercises for psoriatic arthritis?	Discharge or Postoperative Care
30	What are the treatment options for psoriatic arthritis?	Medication, Drug, or Product
31	What are the best medications for psoriatic arthritis?	Medication, Drug, or Product
32	What is the role of biologics in treating psoriatic arthritis?	Medication, Drug, or Product
33	What are the common side effects of psoriatic arthritis medications?	Medication, Drug, or Product
34	What is the role of corticosteroids in treating psoriatic arthritis?	Medication, Drug, or Product
35	What is the role of methotrexate in psoriatic arthritis treatment?	Medication, Drug, or Product
36	What is the role of TNF inhibitors in treating psoriatic arthritis?	Medication, Drug, or Product
37	Are there natural remedies for psoriatic arthritis?	Medication, Drug, or Product
38	Can diet affect psoriatic arthritis?	Medication, Drug, or Product
39	Are there specific diets for psoriatic arthritis?	Medication, Drug, or Product
40	Can smoking affect psoriatic arthritis?	Medication, Drug, or Product
41	Can alcohol affect psoriatic arthritis?	Medication, Drug, or Product
42	How is psoriatic arthritis diagnosed?	Procedure, Test, Process, Study, or Method
43	What is enthesitis in psoriatic arthritis?	Procedure, Test, Process, Study, or Method
44	What is the difference between rheumatoid arthritis and psoriatic arthritis?	Procedure, Test, Process, Study, or Method
45	What is the difference between psoriatic arthritis and osteoarthritis?	Procedure, Test, Process, Study, or Method
46	What is the role of physical therapy in psoriatic arthritis?	Procedure, Test, Process, Study, or Method
47	What are the differences between psoriatic arthritis and osteoarthritis?	Procedure, Test, Process, Study, or Method
48	What is the role of TNF inhibitors in psoriatic arthritis treatment?	Procedure, Test, Process, Study, or Method
49	What are the risks of untreated psoriatic arthritis?	Procedure, Test, Process, Study, or Method
50	Can psoriatic arthritis cause disability?	Procedure, Test, Process, Study, or Method

These subgroups included following:

1. Symptoms: Questions related to PsA symptoms, such as joint pain, edema, and skin involvement.
2. Diagnosis: Questions focused on the diagnostic criteria and procedures used to detect PsA.
3. Treatment options: Questions about the different treatments for PsA, including medications and lifestyle changes.
4. Complications: Questions about the possible complications and long-term effects of PsA.

Table 2. Descriptive statistics of patient information quality and readability scores.

	Minimum	Maximum	Mean ± SD
Ensuring Quality Information for Patients Score	50	69	59 (5.2)
The Flesch-Kincaid Reading Ease Score	45	59	50 (4.1)
The Flesch-Kincaid Grade Level Score	8	12	9.5 (1.2)

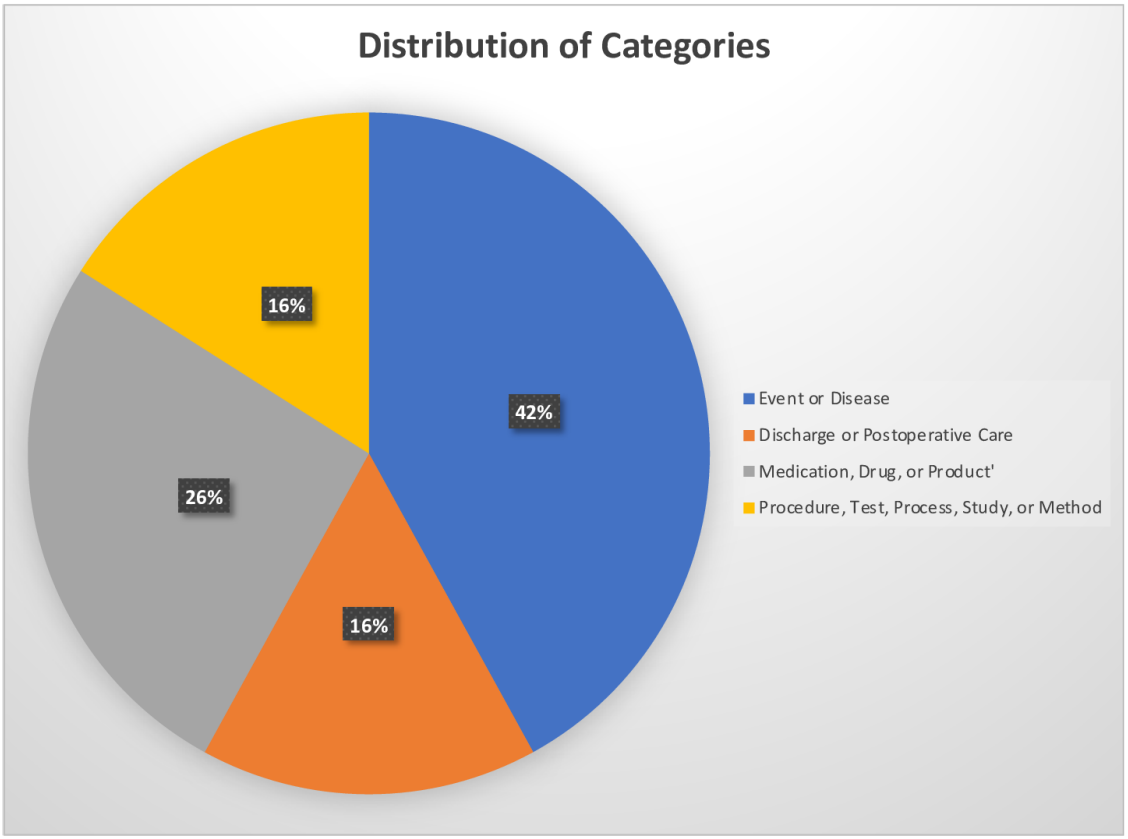

Figure 2. Distribution of categories in study analysis.

Significant differences in EQIP scores were observed among subgroups ($H(3) = 9.56$, $p < 0.05$). The treatment options subgroup had significantly lower EQIP scores than the symptoms and diagnosis subgroups, which indicated that ChatGPT's responses were less clear and complete while presenting treatment regimens. The Bonferroni post hoc correction revealed a significant difference between treatment option and symptom subgroups ($p<0.017$).

The distribution of categories in the study analysis is illustrated in Figure 2. Along with the overall analysis, a subgroup analysis was performed to evaluate the EQIP, FKRE, and FKGL scores within each question category (symptoms, diagnosis, treatment options, and complications). This analysis revealed that ChatGPT performed weaker in the treatment options category, with significantly lower EQIP scores (mean = 65.3, SD = 8.7) than in the symptoms category (mean = 78.2, SD = 5.4). The results indicated that, while ChatGPT accurately defined common PsA symptoms, such as joint pain and swelling, it was unable to provide detailed and clear information about treatment options.

The EQIP scores in the symptoms subgroup provided additional evidence for ChatGPT's responses to common PsA symptoms, such as joint pain, swelling, and skin patches. The high mean EQIP score in this subgroup (78.2) indicates that ChatGPT is reliable in reporting symptoms but less effective in answering treatment-related questions, as indicated by the lower EQIP scores in that subgroup.

Discussion

This study provides several significant insights into ChatGPT's efficacy in providing health information for PsA. The EQIP scores reveal that while ChatGPT could provide high-quality information, there are notable deficiencies in several areas, particularly in the discussion of complex treatment options [19]. This finding is consistent with a previous study on AI-generated health information, which revealed that AI platforms fail to explain complex medical content [20].

One of the primary challenges identified in this study is the readability of the information generated by ChatGPT. The FKRE and FKGL scores indicate that the relatively high reading level is necessary to fully comprehend the content, which might limit its accessibility to patients with lower literacy levels [21]. Since health literacy is a significant predictor of health outcomes [22], patients with limited literacy skills might not fully understand the information

provided, which could limit their ability to make informed healthcare decisions [23].

ChatGPT's responses to questions concerning common PsA symptoms, such as joint pain, swelling, and skin involvement, were consistent with existing medical knowledge [24]. For example, in response to a question regarding the common PsA symptoms, ChatGPT accurately recognized the characteristic indicators of the condition, such as dactylitis and enthesitis, which are well-documented in medical literature [25]. Furthermore, ChatGPT identified that PsA can cause peripheral and axial joint involvement, which indicated its consistency with established clinical descriptions of the condition [26].

However, the study also identified areas where ChatGPT's responses were less consistent with medical knowledge, notably in terms of treatment strategies. While ChatGPT highlighted commonly prescribed medications such as NSAIDs and biologics, it often failed to provide detailed information on proper usage, possible side effects, and long-term management concerns, which are crucial for patient education and effective disease management [27].

The findings of this study are consistent with and build upon earlier studies on AI-generated health information. Studies on AI-generated content for conditions such as diabetes and hypertension have also shown challenges in preserving the accuracy and readability of complex medical information. Previous research has shown that, while AI tools can effectively provide general health information, they often struggle with more subtle issues that need detailed explanations or patient-specific guidance [28]. Comparing the EQIP and readability scores from this study with those reported in similar studies reveals that these issues are not unique to PsA but rather reflect broader limitations in current AI technologies [29].

Similar studies on AI-generated content for chronic conditions such as diabetes have found that, while the general information provided is accurate, the level of detail required for patient management often falls short, particularly in areas requiring personalized advice [30]. This comparison emphasizes the importance of continued development and refinement of AI tools to ensure they reach the high standards necessary for patient education and support [31].

The FKRE and FKGL scores presented in this study reveal a significant challenge in the accessibility of ChatGPT-generated health information. The FKGL scores, which show a reading level between high school and college, indicate that patients with lower literacy levels may struggle to understand the content [32]. This is particularly problematic considering that health literacy has a significant influence on patient outcomes [33]. Patients with limited literacy skills may struggle to interpret medical information offered at a higher reading level, potentially leading to miscommunication regarding their condition and treatment options [34]. This accessibility gap highlights the need to tailor AI-generated content to the demands of a diverse patient population, ensuring that all individuals, regardless of literacy level, have access to and benefit from accurate and comprehensible health information [35].

To improve the readability of ChatGPT's responses and better meet the demands of a diverse patient population, several strategies might be used. First, AI algorithms could be programmed to reduce medical jargon using more common language and shorter sentences to make the content more understandable [36]. Additionally, developers might include a function that allows the complexity of the language to be modified based on the user's literacy level, ensuring the information is more accessible to a larger audience [37]. Another potential improvement is the use of visual aids, such as diagrams or videos, to help convey complex medical concepts more effectively [38]. These guidelines are intended to make AI-generated health information more inclusive, ensuring that patients of all literacy levels can access, comprehend, and act on the medical advice provided [39].

Several possible confounding factors might have impacted the EQIP and readability scores observed in this study. One important factor is the complexity of the medical content; more complex topics, such as treatment options or detailed diagnostic criteria, might have lower readability scores due to the need to use technical terminology and provide longer explanations. Additionally, the specific words used in the questions might influence the results. For example, unclear or broad questions elicit less detailed responses and reduce the EQIP score. In contrast, more specific questions might prompt responses that are more technical and less readable, thus increasing the difficulty of understanding as indicated by the FKRE and FKGL scores. These confounding factors emphasize the importance of careful attention when interpreting the results. Future studies should consider these characteristics to better understand how AI-generated content performs across diverse types of medical information.

While this study provides valuable insights into ChatGPT's ability to generate health information on PsA, several limitations must be acknowledged. First, our study did not examine the potential link between PsA and cardiovascular conditions such as subclinical atherosclerosis, a well-documented association in the literature [40]. Future research could explore how AI-generated responses address comorbidities associated with PsA, particularly cardiovascular risk factors.

Another limitation is that our readability assessment relied on standardized readability formulas, which do not fully capture comprehension levels across diverse patient populations. Future studies could incorporate patient surveys to evaluate real-world readability and comprehension. Additionally, AI-generated health information, it is crucial to investigate the broader implications of these results and potential solutions. One of the main challenges in improving AI for patient education is ensuring that the information provided is accurate and accessible to a diverse patient group. This includes addressing the technical aspects of AI, such as refining algorithms for better understanding and generating medical content along with considering the social and ethical components, such as providing equal access to information. Furthermore, AI tools must be designed to accommodate patients' diverse literacy levels, cultural backgrounds, and individual needs. Potential solutions include developing configurable AI systems that allow users to select desired level of detail or complexity

and incorporate feedback loops that allow patients to rate helpfulness or understandability of the information. Addressing these factors could help in optimizing AI to serve as a reliable and effective tool for patient education, eventually improving health outcomes and patient empowerment.

Conclusion

Although ChatGPT shows potential to provide accessible health information on PsA, this study highlights significant areas for improvement, notably in the readability and complexity of the information presented. By addressing these challenges, AI tools might be modified to effectively meet the demands of diverse patient populations, which could result in improved health outcomes.

Ethical approval

An ethics committee decision is not required for the study.

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