

Evaluating Artificial Intelligence Models in Dermatology: A Comparative Analysis

Aneri B Patel, William Driscoll, Conan H Lee, Cameron Zachary, Nicole M Golbari, Janellen Smith

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Table of Contents

Original Manuscript.....	5
Supplementary Files.....	16
Figures	17
Figure 1.....	18
Figure 2.....	19
Multimedia Appendixes	20
Multimedia Appendix 1.....	21
Multimedia Appendix 2.....	21
Multimedia Appendix 3.....	21
Multimedia Appendix 4.....	21
Related publication(s) - for reviewers eyes onlies	22
Related publication(s) - for reviewers eyes only 0.....	22

Evaluating Artificial Intelligence Models in Dermatology: A Comparative Analysis

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Abstract

Background: Dermatology is an ever-evolving field; the integration of artificial intelligence (AI) offers promising avenues for enhancing clinical decision-making and improving patient outcomes. This study focuses on evaluating the effectiveness of DermGPT, an AI model specifically designed to address dermatological inquiries with precision, compared to ChatGPT-4o (OpenAI), an AI chatbot and virtual assistant developed by OpenAI. DermGPT was developed by a practicing dermatologist, and it is marketed as a superior alternative to general-purpose AI models like ChatGPT; it contains a curated database of authoritative sources tailored to the community of dermatological professionals.

Objective: To assess the validity of these claims, we conducted a comparative analysis between ChatGPT and DermGPT.

Methods: We conducted a survey study. A series of 15 dermatology-specific questions were presented to both AI tools, with the responses subsequently evaluated by a cohort of 19+ practicing dermatologists (attendings, residents and fellows) across two institutions. The dermatologists, who were blinded to the origin of the answers, rated the quality and accuracy of the responses in the form of a survey. Preferences for answers and comparison of sources references were evaluated, and the efficacy of the sources of data were compared. Statistical analysis was performed using SAS OnDemand. Univariable analysis was performed for categorical variables via chi-square tests, with statistical significance set at $p < 0.05$.

Results: A total of 19 attendings, dermatology residents and fellows completed the survey. For answer preference, DermGPT responses were favored overall (48%) compared to ChatGPT (28%), with a statistically significant chi-square test result ($p = 0.039$). In subgroup analysis, attendings preferred DermGPT (47%) over ChatGPT (28%), while residents showed a narrower preference margin (32% vs. 31%). For source preference, ChatGPT citations were favored (46%) over DermGPT (24%), though the chi-square test did not reach statistical significance ($p = 1.385$). Attendings preferred ChatGPT sources (48%) over DermGPT (23%), while residents also favored ChatGPT (41%) over DermGPT (24%).

Conclusions: DermGPT demonstrated strong potential for improving answer clarity and conciseness in dermatology-related queries, while ChatGPT provided more robust source citations, enhancing trust in evidence-based responses. Notably, ChatGPT's citation quality was preferred, whereas DermGPT's concise style made it more accessible for quick clinical reference. These findings suggest that integrating the strengths of both models could optimize AI-assisted medical consultations, balancing clarity with academic rigor. Clinical Trial: N/A

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Title: Evaluating Artificial Intelligence Models in Dermatology: A Comparative Analysis

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ABSTRACT

Background: Dermatology is an ever-evolving field; the integration of artificial intelligence (AI) offers promising avenues for enhancing clinical decision-making and improving patient outcomes. This study focuses on evaluating the effectiveness of DermGPT, an AI model specifically designed to address dermatological inquiries with precision, compared to ChatGPT-4o (OpenAI), an AI chatbot and virtual assistant developed by OpenAI. DermGPT was developed by a practicing dermatologist, and it is marketed as a superior alternative to general-purpose AI models like ChatGPT; it contains a curated database of authoritative sources tailored to the community of dermatological professionals.

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Conclusions: DermGPT demonstrated strong potential for improving answer clarity and conciseness in dermatology-related queries, while ChatGPT provided more robust source citations, enhancing trust in evidence-based responses. Notably, ChatGPT's citation quality was preferred, whereas DermGPT's concise style made it more accessible for quick clinical reference. These findings suggest that integrating the strengths of both models could optimize AI-assisted medical consultations, balancing clarity with academic rigor.

Keywords: ChatGPT; DermGPT; Artificial Intelligence; Dermatology; Education; LLM

INTRODUCTION

Large Language Models (LLMs) are natural-language-processing tools that are trained on large quantities of text data to render coherent, often human-like responses to a wide range of text queries. Modern LLMs, such as OpenAI's GPT-4o, employ a transformer architecture, which utilizes self-attention mechanisms to process and generate text based on patterns present in the training corpus.

ChatGPT, a widely used chatbot developed by OpenAI, is built by applying reinforcement learning from human feedback (RLHF) to a baseline GPT-4 model ¹. This process enhances the model's ability to generate conversational and user-friendly responses. RLHF involves human evaluators providing feedback on the model's outputs, helping to refine its responses to align with human preferences—such as improved conversational flow or the avoidance of vulgar language ².

LLMs like ChatGPT operate using a next-token prediction system, meaning they analyze the context of previous words in a sentence to predict the most likely next word. But LLMs do more than just predict the next word based on statistical patterns, the model constructs a conceptual framework that allows it to make sense of relationships, events and cause-and-effect dynamics. Researchers argue that for an LLM to generate coherent and contextually appropriate responses across a wide range of topics, it must infer underlying structures of reality, much like how humans develop mental models to navigate the world ³. This implicit “world model” helps the AI understand abstract concepts, reason through problems, and even make predictions about situations it has not directly encountered in its training data. Some even believe that GPT-4 shows early signs of general intelligence. These models are trained on a vast dataset that includes a significant portion of publicly available text from the internet – they can answer questions across a wide range of fields, including specialized areas like dermatology.

Despite their broad knowledge base, LLMs can exhibit “hallucinatory,” tendencies, confidently and coherently providing plausible answers that are nevertheless incorrect ⁴. These tendencies complicate their suitability for clinical settings such as dermatology, where accuracy is of paramount importance.

Developed by a cohort led by the Chair of the Dermatology Department at the Palo Alto Medical Foundation, “DermGPT” is an LLM developed specifically for use in clinical dermatology. In addition to boilerplate functionalities such as drafting patient notes and prior authorization requests, it is marketed as being able to answer general-purpose questions about dermatology ⁵.

DermGPT uses OpenAI's GPT family of models as its base model while adding other architectural elements that purportedly optimize it for usage in a dermatology context, most notably a vector database of primary-source research material curated and approved by subject-matter experts. DermGPT's marketing materials state that by sourcing its answers to dermatology questions from this curated database and displaying these sources with every answer, the model can reduce

hallucination issues experienced by LLMs and provide an overall superior experience for practicing dermatologists⁶. To test these claims, we designed a study to directly compare the answers of ChatGPT, a general-purpose LLM, with DermGPT, an LLM specifically designed for dermatology.

STUDY DESIGN AND METHODOLOGY

LLM

usage

ChatGPT was chosen both because of its general popularity and because previous studies have suggested a superiority to other commercially available language models for dermatology purposes: A double-blind study pitting Chat-GPT against Google's "Bard" model indicated that ChatGPT was preferred by dermatologists for generating patient handout material⁷.

The specific model of ChatGPT chosen was the most up-to-date, commercially available model at the time of the study, "ChatGPT 4o." DermGPT did not offer multiple models, and the model chosen, therefore, was simply the one available on DermGPT's website on the date that the comparison was conducted.

Creating the survey

Twenty questions about dermatology were posed to each model. These questions were generated by two resident dermatologists (CZ and NMG) who did not have foreknowledge of either of the models' strengths and weaknesses. The questions were designed to span many different subdisciplines of dermatology—including medical dermatology, dermatopathology, and dermatologic surgery—and to be challenging but have a definite answer generally agreed upon by the dermatology community.

Example of survey questions

An identical prompt was given to both models: "Please answer this question about dermatology and provide a source from a scientific journal or another authoritative source." For example, here is one of the questions that would be presented to the model after the prompt: "What is the best treatment for mild psoriasis?"

The responses from the two models were inputted into the survey [Figure 1, Figure 2], appearing as two separate questions:

What is the best treatment for mild psoriasis? *

A The best treatment for mild psoriasis can vary depending on the individual and their specific symptoms. However, topical therapies are often recommended as the first-line treatment for mild psoriasis. These may include corticosteroids, vitamin D analogs, retinoids, or coal tar preparations. Topical corticosteroids, in particular, are commonly used and have been shown to effectively reduce inflammation and relieve symptoms associated with mild psoriasis. It is important to note that treatment decisions should be made in consultation with a dermatologist who can assess the severity of the condition and tailor the treatment plan accordingly.	B Topical Corticosteroids: These are the most commonly used treatments for mild psoriasis. They help reduce inflammation and slow down the rapid turnover of skin cells. Low to medium potency corticosteroids are usually recommended for most cases of mild psoriasis. Vitamin D Analogues (e.g., Calcipotriene): These compounds help to slow the growth of skin cells. They are often used in combination with corticosteroids to enhance effectiveness. Topical Retinoids (e.g., Tazarotene): Retinoids help normalize skin cell production and are effective in treating plaque psoriasis. However, they can cause irritation, so they are often used in combination with corticosteroids. Moisturizers and Emollients: Regular use of moisturizers can help reduce dryness, scaling, and itching, which are common symptoms of psoriasis.
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- ☐ A is a better response
- ☐ B is a better response
- ☐ A and B are about equal in quality of response
- ☐ I think both answers are inadequate in answering the posed question

Figure 1: Answers by both models, incorporated into the original survey.

Each source below aligns with answer above. Pick the better source in terms of quality. *

A Armstrong AW, Koning JW, Rowse S, Tan H, Mamolo C, Kaur M. Under-Treatment of Patients with Moderate to Severe Psoriasis in the United States: Analysis of Medication Usage with Health Plan Data. <i>Dermatol Ther (Heidelb)</i>. 2017 Mar;7(1):97-109. doi: 10.1007/s13555-016-0153-2. Epub 2016 Nov 30. PMID: 27905011; PMCID: PMC5336424.	B Journal of the American Academy of Dermatology (JAAD) Dermatology: Therapy and Practice (Springer)
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- ☐ A has a better reference
- ☐ B has a better reference
- ☐ References in A and B are about equal in quality of response
- ☐ I think both answers are inadequate in answering the posed question

Figure 2: Sources that were provided by two models, incorporated into the original survey.

Survey sharing

The models' answers/ sources were evaluated by a cohort of practicing dermatologists, including attendings, residents and Mohs fellows at University of California, Irvine and University of California, Davis. The surveys were distributed using email on the listserv and as QR codes during grand rounds. For each question, every member of the rating cohort was given answers from ChatGPT and DermGPT. Participants were blinded to knowing which answers were generated by ChatGPT or DermGPT. The answers were presented in a simple text format with all potentially identifying features stripped away.

The members of the cohort were instructed to compare the models on two axes: The first was overall satisfaction with the accuracy and quality of the model's answer; the second, satisfaction with the model's transparency/sourcing. The reviewers were instructed to grade these criteria independently: A well-answered question could be sourced poorly, and vice-versa.

Reviewers were asked to directly compare the answers of the two models, rather than evaluating them independently, with four different rating options available, where Model A and Model B were either ChatGPT or DermGPT (randomized):

1. Model A's answer was better
2. Model B's answer was better
3. Model A's and Model B's answers were of generally equal quality
4. I think both answers are inadequate in answering the posed question

Statistical Analysis

Statistical analyses were performed using SAS OnDemand, with chi-square tests employed to evaluate differences in answer and source preferences between ChatGPT and DermGPT. Statistical significance was determined at $p < 0.05$. Additionally, graphs and tables were generated using SAS OnDemand to effectively illustrate the distribution of preferences and highlight key trends in the data.

RESULTS

Summary of responses

A total of 19 respondents completed the survey across University of California, Irvine, Department of Dermatology and University of California, Davis, Department of Dermatology. This included 6 residents/fellows (31.5%) and 13 attendings 68.4%. There was a total of 285 answers collected, across answers and sources categories.

Which answer was better: ChatGPT or DermGPT?

Overall, DermGPT answers (48%) were preferred over ChatGPT (28%); the chi-square test is significant with $p = 0.039$ ($p < 0.05$). In the attending group, DermGPT answers were also preferred (47%) over ChatGPT (28%). Likewise, in the resident group, DermGPT answers were preferred but by a lower margin (32%) versus ChatGPT (31%) [Figure 3, Table 1]

Which answer's source was better: ChatGPT or DermGPT?

Overall, ChatGPT sources (46%) were preferred over DermGPT (24%); the chi-square test statistic has a $p = 1.385$ ($p > 0.05$). In the attending group, ChatGPT sources were also preferred (48%) over DermGPT (23%). Likewise, in the resident group, ChatGPT sources were preferred (41%) versus DermGPT (24%) [Figure 4, Table 2]

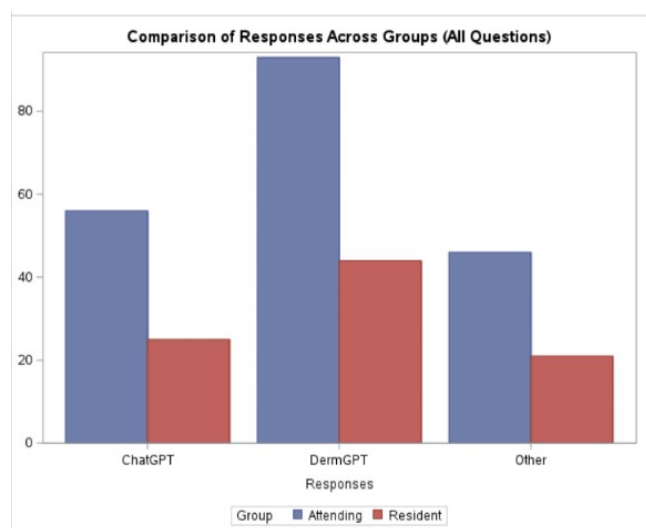


Figure 3: Overall preference for answers.

Group/ Responses	ChatGPT	DermGPT	Other	Total answers
Attending	56 (28.71%)	93 (47.69%)	46 (23.58%)	195
% of total responses	19.65%	32%	16.14%	68.42%
Resident	25 (27.77%)	44 (48.88%)	21 (23.33%)	90
% of total responses	8.77%	15.44%	7.37%	31.58%
Total	81	137	67	285
	28.42%	48.07%	23.51%	100.0%
Chi square test	$p=0.039$			

Table 1: User Preferred AI Answer.

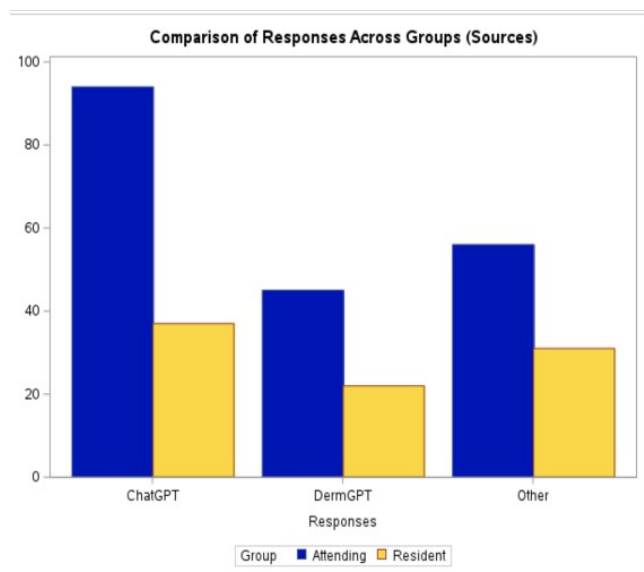


Figure 4: User Preferred AI Source.

Group/ Responses	ChatGPT	DermGPT	Other	Total answers
Attending	94 (48.20%)	45 (23.07%)	56 (28.72%)	195
% of total responses	32.98%	15.79%	19.65%	68.42%
Resident	37 (41.11%)	22 (24.44%)	31 (34.44%)	90
% of total responses	12.98%	7.72%	10.88%	31.58%
Total	131	67	87	285
	45.96%	23.51%	30.53%	100.0%
Chi-square test	p=1.385			

Table 2: Overall preference for sources.

DISCUSSION

Principal results

Out of 195 answers from the survey, results revealed that while users generally preferred DermGPT's responses in terms of answer quality, ChatGPT was favored for its source citations across both attendings and residents [Tables 2 and 4].

DermGPT may have delivered more concise and well-phrased responses, potentially making it more

accessible for quick clinical reference. However, it is worth noting that during the initial phase involving over 25 survey questions, three questions were excluded because DermGPT provided a disclaimer instead of a direct answer. This disclaimer recommended consulting current dermatology guidelines or a dermatologist, which, while cautious and responsible, affected the comprehensiveness of the survey data.

In contrast, ChatGPT showed an advantage in its sourcing methodology. By routinely citing reputable sources—such as JAAD and JAMA—ChatGPT provided a stronger foundation for evidence-based responses, a factor that dermatologists across the board appeared to value highly. This reliance on well-known, reliable citations may contribute significantly to user trust and perceived academic rigor.

The findings indicate that while DermGPT may offer improvements in clarity and brevity, the robustness of ChatGPT's citations cannot be overlooked. This duality opens intriguing possibilities for integrated approaches, wherein the strengths of both models could be combined to deliver comprehensive and well-supported answers in dermatological contexts.

Limitations

Our survey was conducted on a sample size of 19 dermatology residents, attendings and Mohs fellows. A larger sample size would reduce the confounding variables allowing for a higher power and a multivariable analysis can be performed.

Comparison with Prior Work

There are numerous studies comparing quality of answers between LLMs, and between LLMs and between humans and LLMs. One interesting study, He Z, Bhasuran B, Jin Q, et al compared LLMs' ability to generating responses to patients' lab test results related questions, to not only other three LLMs but also to human answers; they found some cases of GPT-4 responses that were inaccurate and not individualized⁸. Another study by Iannantuono GM et.al looked at ChatGPT-4 and ChatGPT-3.5 compared to Google Bard in immuno-oncology, overall underscoring the importance of expert verification of the outputs provided by these LLMs⁹. Lastly, there was a study conducted by Fernández-Pichel, M et.al. that looked at the ability of LLMs to answer health-related questions and found that LLMs may deliver higher accuracy, (correctly answering 80% of questions), however, their performance is highly dependent and sensitive to input prompts that are given¹⁰. To our knowledge, this is the first study comparing ChatGPT to DermGPT for dermatologic questions and answers.

Conclusions and Future Directions

For future research, we recommend broadening the scope of the study by including additional large language models such as Anthropic's Claude and Google's Gemini^{11,12}. Incorporating a larger sample size would not only enhance the statistical power of the study but also provide a more nuanced understanding of how different models perform across various clinical scenarios. Additionally, exploring hybrid models that merge the concise response style of DermGPT with the thorough sourcing of ChatGPT could offer new insights into optimizing AI-assisted medical consultations.

Overall, these findings show the importance of balancing answer clarity with citation quality, and they provide a foundation for further investigation into the evolving landscape of education and the role of AI in education, dermatology and medicine.

ACKNOWLEDGMENTS

We are grateful to the dermatology residents, attendings and fellows at University of California, Irvine and University of California, Davis that took the time to take our survey and make this study possible.

We used the generative AI tool ChatGPT by OpenAI and DermGPT by OpenAI to generate answers and sources for our survey, which we analyzed. The original answers and questions posed in the survey are made available as Multimedia Appendix.

CONFLICTS OF INTEREST

All authors on this publication declare no financial or non-financial competing interests.

ABBREVIATIONS

ChatGPT: Chat Generative Pre-Trained Transformer

DermGPT: Derm Generative Pre-Trained Transformer

LLM: Large Language Model

Multimedia Appendix 1: Survey questionnaire

Multimedia Appendix 2-4: SAS files with original data and graphs

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Supplementary Files

Figures

Table 1: User Preferred AI Answer.

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Chi-square test	p=1.385			

Multimedia Appendixes

Survey questionnaire.

URL: <http://asset.jmir.pub/assets/66646e331642dff4a22863af2aeb4e23.docx>

SAS Results, part1.

URL: <http://asset.jmir.pub/assets/8caf0fcddfb17f256218faa058d7e7d.docx>

SAS results, part 2.

URL: <http://asset.jmir.pub/assets/bafbdbc175e5e812f3964fa2f41460ca.docx>

SAS results, part 4.

URL: <http://asset.jmir.pub/assets/b47a57224e824cd5bc577ef056f9efa1.docx>



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