



Is ChatGPT an Accurate and Reliable Source of Information for Patients with Vaccine and Statin Hesitancy?

ChatGPT, Aşı ve Statin Tereddütü Olan Hastalar için Doğru ve Güvenilir Bir Bilgi Kaynağı mıdır?

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ABSTRACT

Objective: Chat Generative Pre-trained Transformer (ChatGPT) is an artificial intelligence (AI) language model that is trained to respond to questions across a wide range of topics. Our aim is to elucidate whether it would be beneficial for patients who are hesitant about vaccines and statins to use ChatGPT.

Methods: This cross-sectional and observational study was conducted from March 2 to March 30, 2023, using OpenAI ChatGPT-3.5. ChatGPT provided responses to 7 questions related to vaccine and statin hesitancy. The same questions were also directed at physicians. Both the answers from ChatGPT and the physicians were assessed for accuracy, clarity, and conciseness by experts in cardiology, internal medicine, and microbiology, who possessed a minimum of 30 years of professional experience. Responses were rated on a scale of 0-4, and the ChatGPT's average score was compared with that of physicians using the Mann-Whitney U test.

Results: The mean scores of ChatGPT (3.78 ± 0.36) and physicians (3.65 ± 0.57) were similar (Mann-Whitney U test $p=0.33$). The mean scores of ChatGPT were 3.85 ± 0.34 for vaccination and 3.68 ± 0.35 for statin use. The mean scores of physicians were 3.73 ± 0.51 for vaccination and 3.58 ± 0.61 for statin use. There was no statistically significant difference between the mean scores of ChatGPT and physicians for both vaccine and statin use ($p=0.403$ for vaccination, $p=0.678$ for statin). ChatGPT did not consider sources of conspiratorial information on vaccines and statins.

Conclusions: This study suggests that ChatGPT can be a valuable source of information for guiding patients with vaccine and statin hesitancy.

Keywords: Primary prevention, artificial intelligence, medication hesitancy

ÖZ

Amaç: Sohbet Üreten Önceden Eğitilmiş Dönüştürücü (ChatGPT), geniş bir konu yelpazesinde sorulara yanıt vermek için eğitilmiş bir yapay zeka (AI) dil modelidir. Bu çalışmada amacımız, aşı ve statin kullanımı konusunda tereddüt yaşayan hastaların ChatGPT'yi kullanmalarının faydalı olup olmayacağını aydınlatmaktır.

Yöntemler: Bu kesitsel ve gözlemsel çalışma, 2 Mart-30 Mart 2023 tarihlerinde OpenAI ChatGPT-3.5 kullanılarak gerçekleştirildi. ChatGPT, aşı ve statin tereddütüyle ilgili soruların 7 soruya yanıt verdi. Aynı sorular doktorlara da yöneltildi. Hem ChatGPT'den gelen cevaplar hem de doktorlardan gelen cevaplar, kardiyoloji, iç hastalıkları ve mikrobiyoloji alanlarında en az 30 yıl profesyonel deneyime sahip uzmanlar tarafından doğruluk, açıklık ve özlülük açısından değerlendirildi. Cevaplar, 0-4 ölçeğinde değerlendirildi ve ortalama puanları hesaplanarak, Chat-GPT'nin ortalama skoru ile doktorların ortalama skoru Mann-Whitney U testi kullanılarak değerlendirildi.

Bulgular: ChatGPT'nin ortalama puanları ($3,78\pm 0,36$) ve doktorların ($3,65\pm 0,57$) puanları benzerdi (Mann-Whitney U test $p=0,33$). ChatGPT'nin ortalama puanları aşı için $3,85\pm 0,34$ ve statin kullanımı için $3,68\pm 0,35$ idi. Doktorların ortalama puanları ise aşı için $3,73\pm 0,51$ ve statin kullanımı için $3,58\pm 0,61$ idi. Hem aşı hem de statin kullanımı için ChatGPT ve doktorların ortalama puanları arasında istatistiksel olarak anlamlı bir fark yoktu (aşı için $p=0,403$, statin kullanımı için $p=0,678$). ChatGPT, aşular ve statinlerle ilgili komplo teorilerine dayalı bilgilere yer vermedi.

Sonuçlar: Bu çalışma, ChatGPT'nin aşı ve statin tereddütü yaşayan hastaları yönlendirmek için değerli bir bilgi kaynağı olduğunu göstermektedir.

Anahtar kelimeler: Primer koruma, yapay zeka, tedavi şüpheciligi

INTRODUCTION

Primary prevention is an essential strategy for preventing the onset of diseases or conditions. Vaccination

is one of the most effective primary prevention strategies. It has played a critical role in reducing the incidence of several infectious diseases and some cancers^{1,2}. While

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drugs are predominantly employed for therapeutic purposes after the onset of a disease, their role in primary prevention has proven to be highly beneficial. Statins have proven effective in both primary and secondary prevention, mitigating the onset and progression of cardiovascular diseases (CVDs)³. A meta-analysis of 65,000 patients showed that statins have a clear role in the primary prevention of CVD mortality and major events⁴. Primary prevention strategies have also been shown to reduce healthcare expenditure⁵.

Despite the significant benefits of primary prevention, some individuals and groups are skeptical about its safety and efficacy. Understanding the reasons for this skepticism is important for developing strategies to increase vaccination rates and improve the uptake of preventive medicines.

One of the main causes of skepticism is the spread of misinformation and conspiracy theories about vaccines and preventive medicine^{6,7}. Social media platforms can facilitate the spread of misinformation and create echo chambers where individuals are only exposed to information that confirms their existing beliefs.

There is a need for online platforms where patients can receive accurate, clear, and sufficient information on health-related issues. Chat Generative Pre-trained Transformer (ChatGPT) is a large language model developed by OpenAI that can generate human-like responses to various questions and topics. It is trained on large amounts of data and uses advanced machine learning techniques to generate responses that are often highly accurate and informative. As an artificial intelligence (AI) language model, ChatGPT can be a valuable source of information on health-related topics. However, ChatGPT's responses are based on the information it has been trained on and may not always be up-to-date or fully accurate. As there is limited research in this field, it is crucial to assess the reliability of ChatGPT as a source of information for patients. This study was designed to elucidate ChatGPT's success in responding to frequently asked questions by patients about vaccines and statins in terms of accuracy, clarity, and conciseness.

MATERIALS and METHODS

Study Design

This cross-sectional and observational study was conducted between March 2, 2023 and March 30, 2023. The study was approved by the Istanbul Medeniyet University Goztepe Training and Research Hospital Ethics Committee (decision no: 2023/0910, date: 13.12.2023). Written consent was obtained from all volunteers.

We conducted a qualitative search using OpenAI (OpenAI GPT-3.5, L.L.C., San Francisco, CA, USA) on March 2, 2023. The open-ended questions posed were grounded in the clinical expertise of the investigators and prior research on vaccine and statin treatment hesitancy^{8,9}. There were four questions about vaccine hesitancy and three questions about statin hesitancy (Table 1). The questions were used by a single user to interact with ChatGPT. We used the "regenerate response" button to obtain two different outputs from ChatGPT. The study involved posing the same set of questions to ten internists (with 5 to 25 years of professional experience) and ten microbiologists (with 5 to 30 years of professional experience) and recording their responses. Both the answers from ChatGPT and the physicians were assessed for accuracy (scientific correctness of content), clarity (ability to be understood by patients), and conciseness (degree to which all the available information is conveyed) by experts in cardiology, internal medicine, and microbiology, who possessed a minimum of 30 years of professional experience. Responses were rated on a scale of 0-4, with a score of (0) indicating a completely incorrect, unclear, or unconcise response and a score of (4) indicating a completely accurate, clear, or concise response. The average score of the three ratings was used as the final score for analysis.

Statistical Analysis

Descriptive statistics are expressed as mean and standard deviation. Normal distribution was tested using the Kolmogorov-Smirnov test. Because the data were not normally distributed, a non-parametric statistical test was used. The total scores of the answers were compared using the Mann-Whitney U test. A p-value

Table 1. Questions assessing ChatGPT and physicians view on vaccination and statin hesitancy.

Q1: Do statins cause memory loss and liver and kidney damage?
Q2: I am 66 years old diabetic, my LDL cholesterol is 131 mg/dL, will it be enough if I diet without using statins?
Q3: I'm using statins, my LDL cholesterol has dropped below 100. Should I continue to use it?
Q4: Can babies' immune systems handle so many vaccines?
Q5: Could vaccines cause multiple sclerosis, diabetes, and autism?
Q6: I am 66 years old with diabetes, should I get the pneumococcal vaccine recommended by physician?
Q7: Do COVID-19 vaccines increase blood clotting and cause heart attack and stroke?
ChatGPT: Chat Generative Pre-trained Transformer, LDL: Low-density lipoprotein, COVID-19: Coronavirus disease-2019

<0.05 was considered statistically significant. The sample size was considered in accordance with the minimum ratio of participants to variables required in multivariate methods, which should be at least 5¹⁰. In this study, a total of 3 variables were used, and it was seen that the minimum sample size requirement was met according to the criteria. SPSS (ver. 23) and R-4.2.2 for Windows were used for calculations.

RESULTS

Table 2 presents a comparison between the scores of ChatGPT and physicians. The final mean scores for ChatGPT and physicians were similar (3.78±0.36 and 3.65±0.57, respectively, Mann-Whitney U test p=0.33). The mean scores for ChatGPT were 3.85±0.34 and 3.68±0.35 for vaccination and statin use, respectively, whereas for physicians, they were 3.73±0.51 and 3.58±0.61 for vaccination and statin use, respectively. The mean scores of ChatGPT and physicians did not differ significantly in either subject (Mann-Whitney U test p=0.403 for vaccination, p=0.678 for statin use).

ChatGPT did not consider the sources of conspiratorial information on vaccines and statins. It received a high score for clarity and conciseness (with a mean score of 3.86±0.29 for both), but its accuracy was relatively lower (with a mean score of 3.62±0.44).

Table 2. Comparison of ChatGPT and the physicians' scores.			
Criteria for scoring the responses	Score of ChatGPT (mean ± SD)	Average score of physicians (mean ± SD)	p-value*
Questions about vaccination			
Accuracy	3.56±0.50	3.38±0.69	
Clarity	4.00±0.00	3.94±0.18	
Conciseness	4.00±0.00	3.88±0.35	
Total	3.85±0.34	3.73±0.51	p=0.403
Questions about statins			
Accuracy	3.70±0.37	3.37±0.79	
Clarity	3.67±0.38	3.87±0.16	
Conciseness	3.68±0.38	3.50±0.64	
Total	3.68±0.35	3.58±0.61	p=0.678
Overall			
Accuracy	3.62±0.44	3.37±0.72	
Clarity	3.86±0.29	3.90±0.17	
Conciseness	3.86±0.29	3.68±0.55	
Total	3.78±0.36	3.65±0.57	p=0.330
*Mann-Whitney U test, SD: Standard deviation, ChatGPT: Chat Generative Pre-trained Transformer			

Table 3 presents instances where ChatGPT provided incorrect or inadequate information, which may lead patients to make erroneous decisions. The statement that the diet has a greater impact on reducing low-density lipoprotein cholesterol (LDL-C) than other types of cholesterol is incorrect. In addition, there is no evidence from randomized controlled studies to suggest that the coronavirus disease-2019 (COVID-19) vaccine does not cause blood clots. Furthermore, failing to mention immunosuppressed children for whom live vaccines are not recommended constitutes incomplete information.

DISCUSSION

In our study, ChatGPT was shown to provide accurate, informative, and concise answers to patients' frequently asked questions about vaccines and statins, which are two primary preventive medications. When the same questions were posed to medical experts in the field, the accuracy, clarity, and conciseness of the answers were found to be comparable to those provided by ChatGPT.

The internet has become an important source of information for people with health concerns¹¹. However, studies evaluating social media content related to health issues have shown that the information is of variable quality and that inaccurate or negative content predominates¹². Scullard et al.¹³ showed that when parents researched online whether there was a link between the measles, mumps, and rubella (MMR) vaccine and autism, only half of the information sources correctly stated that there was no link between MMR vaccine and autism. Given this situation, it is clear that correct, explanatory, and reliable sources should be available to people seeking information on health-related issues.

AI is a rapidly advancing technology that has the potential to revolutionize many areas, including healthcare. With the rise of digital health records and the vast amounts of data they generate, AI has become a powerful tool for healthcare providers to analyze and interpret patient information^{14,15}. Patients are also starting to use AI tools to manage their own health concerns. Chatbots and other AI-powered tools can provide patients with personalized advice and support, thereby helping them make better decisions about their health^{16,17}. This can lead to better patient outcomes and a more proactive approach to healthcare. However, as with any technology, there are also challenges associated with the use of AI in healthcare. One of the biggest challenges is ensuring the accuracy and reliability of AI algorithms. While AI can analyze vast amounts of data, it can also be susceptible to bias and other errors if the data it is trained on is not representative of the population as a whole.

ChatGPT is an AI chatbot launched in November 2022, and studies have been conducted to explore its potential use in various fields, including healthcare. Promising results have been obtained from studies conducted with the idea that ChatGPT could be useful in medical education¹⁸. Similarly, studies have examined whether ChatGPT is useful for doctors to help them make diagnoses. In a study by Hirose et al.¹⁹, ChatGPT was asked to list possible diagnoses based on patients' common complaints, and it was shown that 93.3% of the initial diagnoses were correct, but it was not successful enough in its ranking. However, it is also important in terms of health literacy and medication adherence that patients are able to obtain useful and accurate information when consulting ChatGPT for health-related issues, but there are few studies on this area. In Johnson et al.²⁰, ChatGPT provided 96.9% correct answers to frequently asked questions about cancer myths and misconceptions. In a study related to COVID-19, ChatGPT was shown to provide clear and concise answers to patients' frequently asked questions about the COVID-19 virus and vaccine²¹.

In our study, ChatGPT's responses regarding the use of statins and vaccines for primary prevention were mostly accurate and understandable and did not consider conspiratorial sources of information, which is consistent with the results of the recent study. However, it should be noted that ChatGPT is only a powerful language bot that generates text through linguistic connections. Therefore, if the question is not phrased correctly, the possibility of misleading answer increases. In our study, although we asked questions that expressed patients' concerns, we tried to phrase the question as accurately as possible. However, when we inquired about the effectiveness of the diet in reducing LDL-C, ChatGPT responded that the diet was effective in lowering cholesterol, especially LDL-C, as the emphasis was on LDL-C. Similarly, when asked about triglycerides, ChatGPT stated that the diet had a significant impact on reducing triglycerides. Another study by Huh²² found that ChatGPT struggled to comprehend the logic of multiple-choice parasitology questions and marked multiple options as correct, demonstrating inferior performance compared with medical students. These findings indicate that ChatGPT can sometimes provide misleading information regarding healthcare-related matters. In addition, although ChatGPT can analyze vast

Table 3. Examples of ChatGPT outputs.

Question	ChatGPT response on trial 1	ChatGPT response on trial 2
<p>1. Do COVID-19 vaccines increase blood clotting and cause heart attack and stroke?</p>	<p>There is currently no evidence to suggest that COVID-19 vaccines increase blood clotting or cause heart attacks and strokes. In fact, the data shows that COVID-19 vaccines have been overwhelmingly safe and effective at preventing severe illness and hospitalization from COVID-19.</p> <p>There have been reports of rare blood clotting events associated with some COVID-19 vaccines, particularly the AstraZeneca and Johnson & Johnson vaccines, but these events are extremely rare and the benefits of vaccination still outweigh the risks for most people. The risk of developing blood clots from COVID-19 itself is also much higher than the risk from the vaccines.</p> <p>It's important to note that any vaccine or medication can potentially have side effects, but these are usually rare and outweighed by the benefits of protecting against the disease. The vaccines have undergone extensive clinical trials and have been authorized for emergency use by regulatory agencies around the world based on their safety and efficacy profiles.</p> <p>If you have concerns about the COVID-19 vaccine or any medication, it's important to talk to your healthcare provider who can provide personalized advice based on your individual health history and circumstances.</p>	<p>No, COVID-19 vaccines do not increase the risk of blood clotting, heart attacks, or strokes.</p> <p>In fact, the risk of developing blood clots, heart attacks, or strokes from COVID-19 is much higher than the risk of developing these conditions from the vaccine. COVID-19 itself has been shown to increase the risk of blood clots, particularly in people with severe illness, and can also lead to heart attacks and strokes.</p> <p>There have been some reports of rare blood clotting disorders associated with certain COVID-19 vaccines, particularly the AstraZeneca and Johnson & Johnson vaccines, but these cases are very rare and the benefits of getting vaccinated still outweigh the risks for most people. The risk of developing these blood clotting disorders is estimated to be around 1 in 100,000 to 1 in 1 million doses, depending on the vaccine and the population being vaccinated.</p> <p>It is important to note that regulatory agencies such as the FDA and EMA closely monitor the safety of COVID-19 vaccines and have recommended continued use of these vaccines due to their overwhelming benefits in preventing COVID-19 and its complications.</p>

Table 3. Continued		
Question	ChatGPT response on trial 1	ChatGPT response on trial 2
2. Can babies' immune systems handle so many vaccines?	<p>Yes, babies' immune systems can handle multiple vaccines. In fact, vaccines are carefully designed to stimulate the immune system in a way that is safe and effective.</p> <p>Babies are born with some immunity that they receive from their mothers, but this protection only lasts for a few months. Vaccines work by introducing a small amount of a weakened or inactivated virus or bacteria, or a piece of it (called an antigen) into the baby's body. This triggers the baby's immune system to recognize and respond to the antigen, building immunity against the disease without causing illness.</p> <p>The number of vaccines a baby receives may seem like a lot, but the vaccines are given over a period of time and spaced out to allow the baby's immune system to develop a response to each vaccine. The vaccine schedule is carefully designed to balance the need for protection with the ability of the baby's immune system to handle the vaccines.</p> <p>In addition, vaccines are extensively tested for safety before they are approved for use. The Centers for Disease Control and Prevention and the American Academy of Pediatrics recommend a schedule of vaccines for infants and young children based on the best available scientific evidence.</p> <p>Overall, vaccines are a crucial tool in protecting babies and children from infectious diseases, and the benefits of vaccination far outweigh the risks.</p>	<p>Yes, babies' immune systems are capable of handling multiple vaccines. In fact, infants are exposed to thousands of antigens (foreign substances that trigger an immune response) every day from the environment, and their immune systems are equipped to handle this constant exposure.</p> <p>The recommended vaccine schedule for infants and children has been extensively studied and developed to provide protection against a wide range of serious infectious diseases. While it is true that some vaccines may cause mild side effects such as fever, fussiness, or a sore arm, these are generally short-lived and are a small price to pay for the protection vaccines provide against potentially life-threatening illnesses.</p> <p>It is important to note that delaying or skipping vaccines can leave children vulnerable to serious diseases, and can also put others at risk through the spread of preventable infections. Therefore, it is important to follow the recommended vaccine schedule to ensure the best possible protection for infants and children.</p>
3. I am 66 years old diabetic, my LDL cholesterol is 131 mg/dL, will it be enough if I diet without using statins?	<p>LDL cholesterol, also known as "bad" cholesterol, is a significant risk factor for cardiovascular disease, particularly in individuals with diabetes. Current guidelines recommend keeping LDL cholesterol levels below 100 mg/dL for people with diabetes, and in some cases, below 70 mg/dL.</p> <p>While lifestyle changes such as diet and exercise can help to reduce LDL cholesterol levels, they may not always be sufficient to reach target levels. Statin medications are commonly used to lower LDL cholesterol levels in individuals at risk of cardiovascular disease.</p> <p>As a language model, I am not authorized to provide medical advice or recommendations for specific individuals. It is recommended that you consult with your healthcare provider to determine the best treatment plan for you based on your individual risk factors and medical history. They may recommend lifestyle modifications in addition to or instead of medication, depending on your specific needs.</p>	<p>As an AI language model, I cannot provide specific medical advice. It is important to discuss your cholesterol levels and treatment options with your healthcare provider.</p> <p>However, in general, lifestyle modifications such as a healthy diet and exercise can help manage cholesterol levels, particularly LDL cholesterol. A diet rich in fruits, vegetables, whole grains, lean proteins, and healthy fats such as olive oil and nuts can be beneficial for cholesterol management.</p> <p>In some cases, medication such as statins may also be recommended to help lower cholesterol levels. It is important to discuss the potential risks and benefits of any medication with your healthcare provider and make an informed decision based on your individual health profile.</p>
ChatGPT: Chat Generative Pre-trained Transformer, LDL: Low-density lipoprotein, COVID-19: Coronavirus disease-2019, FDA: Food and Drug Administration, EMA: European Medicines Agency		

amounts of data, it may be susceptible to bias and other errors if the data it is trained on is not representative of the overall population.

Nevertheless, the goal of this study was not to replace the doctor-patient relationship with ChatGPT, but rather to evaluate whether it could be a helpful supplementary tool in this relationship. The study's strength is that it is the first to assess ChatGPT conversations in the context of primary prevention. However, several limitations must be noted. First, the evaluation of ChatGPT responses was subjective, despite being assessed by field experts. Second, best practices for patient care may differ depending on the region and healthcare environment. Lastly, this study utilized GPT3.5, but with the advent of GPT4, the error rate is likely to decrease with each subsequent AI model, meaning that our results only pertain to the evaluation of a single model rather than a comprehensive assessment of AI technologies.

CONCLUSION

ChatGPT shows promise in boosting patient confidence in primary prevention. While AI provides valuable information on vaccines and statins, it is crucial to remain vigilant about AI's challenges, including potential algorithmic bias due to data imperfections.

Integrating AI responsibly can benefit patients and healthcare providers. Because ChatGPT is the first of many models that will undoubtedly improve rapidly, further studies are needed.

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Ethics

Ethics Committee Approval: The study was approved by the Istanbul Medeniyet University Goztepe Training and Research Hospital Ethics Committee (decision no: 2023/0910, date: 13.12.2023).

Informed Consent: Written consent was obtained from the volunteers.

Author Contributions

Concept: C.T., A.S., A.O., Design: C.T., A.S., A.O., Data Collection and/or Processing: C.T., A.S., Analysis and/or Interpretation: C.T., A.O., Literature Search: C.T., A.S., A.O., Writing: C.T., A.S.

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