

ChatGPT and Vaccines: Can AI Chatbots Boost Awareness and Uptake?

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Abstract: The global COVID-19 pandemic has affected all spheres of human life, resulting in millions of deaths and overwhelming medical facilities. Moreover, the world has witnessed great financial hardship because of job losses resulting in economic havoc. Many sections of society have contributed in different ways to slow the spread of the virus and protect public health. For example, medical scientists are praised for their efforts to develop COVID-19 vaccines. Clinical trials have shown that the COVID-19 vaccines are highly effective in preventing symptomatic COVID-19 infections. However, many people around the world have been hesitant to get vaccinated. Vaccine misconceptions have emerged and increased due to a combination of factors, including the availability of information on the Internet and the influence of celebrities and opinion leaders. In this context, we have analyzed ChatGPT responses to relevant queries on vaccine misconceptions. The positive responses and supportive opinions provided by the AI chatbot could be instrumental in shaping people's perceptions of vaccines and in encouraging users to get vaccinated and reduce misconceptions.

Keywords: COVID-19; Vaccine; Vaccine hesitancy; ChatGPT; Artificial Intelligence

1. Introduction

1.2 COVID-19 and vaccine hesitancy

Recently, the world has experienced great financial hardship due to job losses resulting in economic havoc [1, 2]. Many sections of society have contributed in different ways to slow the spread of the virus and protect public health. For instance, governments around the world have implemented measures such as lockdowns [3, 4] and social distancing [5, 6], social workers have tried to support vulnerable populations [7], and medical scientists have worked on getting a vaccine [8]. The COVID-19 vaccines are highly effective in preventing COVID-19 and reducing the severity of illness in those who contract the virus [9]. In addition, clinical trials have shown that COVID-19 vaccines are highly effective in preventing symptomatic COVID-19 infections. For example, the Pfizer BioNTech vaccine is approximately 95% effective in preventing symptomatic COVID-19 infections, while the Moderna vaccine is about 94.1% effective [10].

However, many people around the world have been hesitant to get vaccines. Vaccine misconceptions have emerged due to a combination of factors, including the availability of information on the Internet and the influence of celebrities and opinion leaders [11, 12]. The consequences of these misconceptions are significant, ranging from an increased risk of disease outbreaks to the erosion of public trust in science and public health measures [13, 14]. To this end, it is vital to promote accurate and evidence-based information on vaccines and their benefits to counteract the rise of anti-vaccine movements and their consequences [15]. In this context, an artificial intelligence-generated promotion of vaccines can help in minimizing hesitancy as it is reported that people rely more on automated entities (e.g., self-driving cars) than humans (e.g., human-driven cars) [16].

1.3 ChatGPT

Generative Pre-trained Transformer 3 (GPT-3) is an autoregressive language model that uses deep learning to generate text that resembles human speech and was launched in 2020 [17, 18]. With this model, OpenAI has created ChatGPT (Chat Generative Pre-Trained Transformer) and launched in November 2022 [19]. It uses GPT-3.5 and is fine-tuned with both supervised and reinforcement learning techniques. Several works have been reported in this short span covering many real-life applications, and different ways in which ChatGPT can be instrumental in these applications. For example, research and publications [20], academia and education [21-23], medical science [24, 25], business [26], and global warming [27], to name just a few areas of application.

Typically, articles published on ChatGPT consist of an interactive exchange between users and the AI bot, in which the bot answers questions posed by users. These answers are then analyzed with a specific objective in mind. For example, Howard et al. have explored its applicability in infectious diseases [28]. Similarly, Nogradi et al. have identified the potential of ChatGPT in neurology and other medical fields [29]. In this context, we have explored the possible role ChatGPT can play in avoiding vaccine misinformation and reducing hesitancy.

The curated questions, corresponding answers, and inferences from the conversation are given in the subsequent sections.

2. Interaction with ChatGPT on issues regarding the COVID-19 vaccine

We asked ChatGPT five different questions regarding vaccine hesitancy and possible efforts to stop vaccine misinformation. Table 1 provides an overview of the questions and answers. The questions are curated so that different angles on vaccine hesitancy can be covered, and a satisfactorily decisive message can be conveyed to the user.

Question number 1 (Q1) is a general question about whether the vaccine for COVID-19 is created to cure or whether it is propaganda. Similarly, Q2 counterattacks the narrative given by ChatGPT in the answers to the first question, with the aim of getting ChatGPT to provide a firm opinion. The purpose of Q3 is to assess how ChatGPT responds to the misinformation perspective. The objective of Q4 is to get some technical answers and an assured response regarding COVID-19 vaccine efficacy and the impact of the vaccine. Finally, Q5 is a general question related to how we can reduce vaccine hesitancy.

Table 1. Queries and corresponding responses from ChatGPT on vaccine hesitancy illustrating the position on vaccine misinformation and the approach to curb the spread of misinformation.

Q1.	Is the COVID-19 vaccine safe or is it propaganda?
A1.	The COVID-19 vaccine has undergone extensive clinical trials and has been shown to be safe and effective in preventing COVID-19 infection. The safety and efficacy of the vaccine have been studied and reviewed by regulatory agencies such as the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA).
	The vaccines have been tested on thousands of people during clinical trials, and the results have shown that they are highly effective at preventing COVID-19 infection. Additionally, the vaccines have been shown to be safe, with side effects generally mild and temporary, such as sore arms or fatigue. Serious side effects are rare.
	The widespread vaccination effort against COVID-19 is not propaganda, but rather a necessary public health measure to protect individuals, communities, and the world at large from the ongoing pandemic. The vaccines have been shown to be highly effective at preventing severe illness, hospitalization, and death from COVID-19, which is why health officials worldwide are strongly encouraging people to get vaccinated.
Q2.	Why do you lie about the COVID-19 vaccines? It is a conspiracy to harm the masses and make them infertile!
A2.	I am programmed to provide factual and unbiased information based on the latest scientific research and data. The claim that the COVID-19 vaccines are a conspiracy to harm the

masses and make them infertile is not supported by any credible evidence or scientific research.

In fact, the COVID-19 vaccines have undergone rigorous clinical trials and have been shown to be safe and effective in preventing COVID-19 infections. They have been authorized by regulatory agencies worldwide, including the US FDA and the European Medicines Agency, after rigorous testing and evaluation.

There is also no evidence to suggest that the COVID-19 vaccines affect fertility. In fact, the American Society for Reproductive Medicine and the Society for Maternal-Fetal Medicine have both issued statements supporting COVID-19 vaccination for people who are pregnant, considering pregnancy, or lactating.

It is important to rely on factual information and scientific research when making decisions about your health. It is recommended to consult with your healthcare provider and reliable sources of information, such as public health agencies, when considering COVID-19 vaccination.

Q3. *What is your opinion on the misinformation and misconceptions about the COVID-19 vaccines?*

As an AI language model, I don't have personal opinions. However, I can provide factual information about the COVID-19 vaccines and the misinformation and misconceptions that have been circulating about them.

Misinformation and misconceptions about the COVID-19 vaccines have been a significant challenge in the fight against the pandemic. Some people may be hesitant to get vaccinated due to concerns about the safety and efficacy of the vaccines, or because of misinformation they have seen or heard.

A3. It is important to rely on reliable sources of information, such as public health agencies, when considering COVID-19 vaccination. They provide the latest information on the safety and efficacy of the vaccine, and can answer any questions or concerns you may have.

Misinformation and misconceptions about the COVID-19 vaccines can be harmful and may lead to people not getting vaccinated, which can have serious consequences for public health. It is important to fact-check information and rely on credible sources of information to make informed decisions about your health.

Q4. *How can I ensure that the COVID-19 vaccine is safe and necessary to prevent an infection?*

The COVID-19 vaccines have undergone rigorous testing and have been authorized for emergency use by regulatory agencies worldwide, including the US FDA and the European Medicines Agency. They have been shown to be safe and effective in preventing COVID-19 infections, and millions of people have already received the vaccine without serious side effects.

To ensure that the COVID-19 vaccine is safe and necessary for you, you should consult with your healthcare provider. They can help you understand the benefits and risks of getting vaccinated, based on your personal health history and any medical conditions you may have.

A4. It is also important to rely on reliable sources of information, such as public health agencies, when considering COVID-19 vaccination. They provide the latest information on the safety and efficacy of the vaccine, and can answer any questions or concerns you may have.

It is important to remember that getting vaccinated not only protects yourself, but also helps protect others in your community, particularly those who are more vulnerable to severe illness from COVID-19. By getting vaccinated, you can help bring an end to the pandemic and return to a more normal way of life.

Q5. *How can vaccine hesitancy be reduced?*

Reducing vaccine hesitancy is important in ensuring that as many people as possible receive the COVID-19 vaccine, which is essential to ending the pandemic. Here are some strategies that can be effective in reducing vaccine hesitancy:

1. Provide accurate and clear information: It is important to provide clear, accurate, and up-to-date information about the COVID-19 vaccine, its safety, and its effectiveness. This information should be available in different languages and should be accessible to people with disabilities.
2. Build trust: Building trust with communities is important to reduce vaccine hesitancy. This can be achieved through partnerships with community organizations, faith-based organizations, and other trusted sources.
3. Address concerns: Addressing people's concerns and questions about the COVID-19 vaccine is important. Healthcare providers, public health officials, and community leaders should be available to answer questions and address concerns about the vaccine.
- A5. 4. Share success stories: Sharing success stories of people who have been vaccinated and their positive experiences can help reduce vaccine hesitancy.
5. Make the vaccine accessible: Making the COVID-19 vaccine accessible and available in a variety of locations can also help reduce vaccine hesitancy. This can include setting up vaccine clinics in community centers, schools, and workplaces.
6. Use social media: Social media can be a powerful tool to reach people and provide accurate information about the COVID-19 vaccine. Public health agencies and community leaders can use social media platforms to share information, answer questions, and address concerns.

Reducing vaccine hesitancy is a complex issue that requires a multifaceted approach. By working together, healthcare providers, public health officials, community leaders, and individuals can help increase vaccine acceptance and help end the pandemic.

3. Discussion

The five questions we asked ChatGPT reflect both pro-vaccine and anti-vaccine perspectives. In previous research, it has been found that vaccine hesitancy played a significant role in the spread of COVID-19 and harmed the efforts to control the pandemic [30]. The primary basis for asking ChatGPT these questions is that recent research has indicated that humans are more likely to trust artificial intelligence than humans [16, 31]. Therefore, people may trust AI-based chatbots more than other sources of vaccine information provided by humans, for example, via the news or direct contact. The reported queries and responses also demonstrate that the automated suggestions could help provide scientifically based narratives free from misleading information. Ultimately, this could boost vaccine acceptance.

The present article is a promising first step toward avoiding the most immediate consequences of vaccine misconceptions. However, misinformation and misconceptions could increase the risk of disease outbreaks since individuals and groups who refuse to vaccinate themselves or their children can become carriers of infectious diseases. ChatGPT's responses can be considered very clear, concise, and firm. They communicate that people should rely on scientific, logical, and evidence-based theories rather than conspiracy theories (see Q1, Q2 and Q4). Furthermore, the chatbot explains the potential harm caused by misinformation (Q3) and outlines essential measures to prevent the spread of misinformation and ways to reduce vaccine hesitancy (Q5).

4. Conclusions

Misconceptions or misinformation can play a significant role in accepting COVID-19 vaccines. There have been many false claims and myths circulating about the COVID-19 vaccines, which have contributed to hesitancy and resistance among parts of the population. Furthermore, the emergence of GPT-3 and similar AI-generated chatbots have made a technology-driven automated answering mechanism available to the public. To this end,

the present article has aimed to explore the possible role of ChatGPT in boosting the vaccination drive and reducing vaccine misconception and hesitancy. The answers provided by ChatGPT supports the scientific narrative around COVID-19 vaccines. The ideas presented in this paper could inspire researchers and healthcare professionals to develop innovative procedures and solutions to fight vaccine misconceptions and help reduce hesitancy about vaccination.

5. Future Directions

Anti-vaccine activists use a variety of tactics to spread misinformation, including the use of social media platforms and the promotion of alternative and unproven treatments. However, having seen the attraction of the masses towards ChatGPT, and the increasing faith and use of the AI-generated chatbot, the message generated in favor of an evidence-based approach and opting to follow scientific discoveries rather than myths, could be a possible way to reduce COVID-19 vaccine hesitancy as well as similar tendencies in future pandemics. Moreover, social networking sites and government-aided advertisements can use the responses of ChatGPT to counsel people regarding possible vaccination. In addition, these chatbots can be used to fact-check conspiracy theories and myths people believe in. Therefore, chatbots like ChatGPT can help reduce the impact of conspiracy theories and misinformation propagated by specific social and political movements.

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