LETTER TO THE EDITOR

Huang et al. Journal of Translational Medicine

https://doi.org/10.1186/s12967-023-04354-6

Open Access



Evaluate the accuracy of ChatGPT's responses to diabetes questions and misconceptions

(2023) 21:502

Chunling Huang^{1†}, Lijun Chen^{2†}, Huibin Huang^{2*}, Qingyan Cai², Ruhai Lin², Xiaohong Wu², Yong Zhuang² and Zhengrong Jiang²

Letter to the editor:

Epidemiology data reveals a fourfold increase in the global number of diabetes patients over the past three decades, with projections indicating a reach of 642 million by 2040 [1]. More and more patients and their families are relying on the internet for diabetes-related information. In the last 10 years, significant advancements in artificial intelligence have emerged, and ChatGPT has emerged as a prominent AI model. Developed by OpenAI, ChatGPT is part of the Generative Pre-trained Transformer (GPT) model family and was launched on November 30, 2022. By employing deep learning techniques, ChatGPT generates human-like responses to natural language inputs [2]. The primary challenge faced by ChatGPT lies in ensuring the precision and dependability of the system, especially when providing medical advice and information.

[†]Chunling Huang and Lijun Chen contributed equally to this work.

Methods

In this research, we employed web searches to identify prevalent inquiries and misunderstandings regarding diabetes-related knowledge. Frequently encountered questions were selected and presented to Chat-GPT (ChatGPT-3.5-turbo, mode), with the generated responses being recorded (Fig. 1A, B). The quality of these responses was independently evaluated by experienced professionals in the field of endocrinology. Evaluation scores ranged from 0 to 10, with 10 indicating high accuracy, $8 \le \text{score} < 10$ representing fairly accurate responses, $6 \le \text{score} < 8$ indicating average accuracy, and scores below 6 indicating inaccuracies. From July 1, 2023, to July 3, 2023, five experts assessed and analyzed the limitations of ChatGPT's answers.

Results

Each response provided by ChatGPT consists of approximately 157 ± 29 words, and the Flesch-Kincaid Grade Level averages at 13.8 ± 1.1 . Out of the 12 answers evaluated, 3 received a rating of 10, indicating a high level of accuracy. The remaining 9 answers had an average \pm standard deviation rating of 9.5 ± 0.2 , indicating a consistently high level of accuracy (Fig. 2). To examine the impact of repeated questions on the output answers, we conducted five runs for each of the 12 questions. The results revealed slight variations in sentence structure, but the answers remained consistent.

The findings indicate that ChatGPT generally provides reasonably accurate information regarding misconceptions about diabetes. However, experts have identified



Quanzhou 362000, Fujian, China

© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

^{*}Correspondence:

Huibin Huang

huibinhuang@aliyun.com

¹ Department of Outpatient Electrocardiography, The Second Affiliated Hospital of Fujian Medical University, Quanzhou 362000, Fujian, China ² Department of Endocrinology, The Second Affiliated Hospital of Fujian Medical University, No. 950 Donghai Street, Fengze District,

certain instances where ChatGPT's responses lack completeness and precision. For instance, in response to question 3: "Does consuming sugar substitutes affect blood sugar levels in diabetic patients?", ChatGPT's answer stating that it does not cause blood sugar elevation is not sufficiently accurate. Research conducted by Mathur et al. [3] suggests that the use of sugar substitutes can increase insulin resistance. Similarly, for question 4: "Can diabetes be ruled out if fasting blood sugar is normal?", ChatGPT's response stating that the normal range for fasting blood sugar is 70–100 mg per deciliter (mg/dL) is incorrect. The current standard for fasting blood sugar has been adjusted to 79–110 mg/dL. Additionally, in response to question 12: "Can diabetes be cured?", ChatGPT's answer stating that it cannot be cured is not entirely accurate. Research indicates that surgical treatment can lead to remission of diabetes in obese patients [4].

ltem	Questions and ChatGPT's answers	wc	FKG	Score	I
Question 1	Does being overweight or obese make it more likely to develop diabetes?				1
ChatGPT's answer	Yes, being overweight or obese increases the risk of developing diabetes. Obesity can lead to insulin resistance, which is one of the main causes of diabetes. Additionally, obesity can also contribute to other health issues such as high blood pressure and high cholesterol, which are also associated with an increased risk of diabetes. Therefore, maintaining a healthy weight is crucial for preventing diabetes. If you are concerned about your weight and diabetes risk, it is recommended to consult with a doctor or nutritionist who can provide you with professional advice and guidance.	92	12.4	9.8	
Question 2	Does drinking sugary beverages lead to diabetes?				1
ChatGPT's answer	Drinking excessive amounts of sugary beverages may increase the risk of developing diabetes. The sugar in these beverages is rapidly absorbed, leading to a spike in blood sugar levels. Prolonged high blood sugar levels can negatively impact insulin sensitivity, ultimately leading to insulin resistance and the development of diabetes.Furthermore, sugary beverages typically provide empty calories without any nutritional value. Consuming excessive amounts of these empty calories can lead to weight gain, further increasing the risk of developing diabetes.Therefore, to prevent diabetes, it is recommended to reduce or avoid the consumption of sugary beverages and opt for water, tea, or other low-sugar or sugar-free alternatives. If you have diabetes or risk factors for diabetes, it is best to consult with a doctor or nutritionist for personalized dietary advice.	129	15.2	9.4	
Question 3	Does consuming sugar substitutes affect blood sugar levels in diabetic patients?				1
ChatGPT's answer	Consuming sugar substitutes in food typically does not directly affect blood sugar levels in individuals with diabetes. Sugar substitutes are substances that mimic the sweetness of sugar but are not fully absorbed and metabolized by the body, thus not causing a rise in blood sugar. However, it is important to note that certain sugar substitutes may have different effects on different individuals. Some people may be sensitive to certain sugar substitutes and may experience gastrointestinal discomfort or other adverse reactions after consumption. Additionally, some sugar substitutes may impact appetite and food choices, potentially leading to increased calorie intake or consumption of other unhealthy foods. Therefore, if you have diabetes, it is best to consult with a doctor or nutritionist before choosing and consuming foods with sugar substitutes. They can provide appropriate guidance and advice based on your individual circumstances and health goals.	142	14.1	9	
Question 4	Can diabetes be ruled out if fasting blood sugar is normal?				
ChatGPT's answer	Having a normal fasting blood sugar level does not completely rule out the possibility of diabetes. Diabetes is a chronic condition that requires consideration of multiple factors for diagnosis, not just fasting blood sugar levels. Typically, fasting blood sugar levels within the normal range are between 70-100 milligrams per deciliter (mg/dL). If your fasting blood sugar level falls within this range, your risk of diabetes is lower. However, if you have other risk factors for diabetes such as a family history, obesity, high blood pressure, or if you have symptoms of diabetes such as frequent urination, thirst, fatigue, etc., you may still be at risk for diabetes. In addition to fasting blood sugar, there are other diagnostic criteria for diabetes, such as the oral glucose tolerance test (OGTT) and random blood sugar testing. These tests can provide a more comprehensive assessment of your blood sugar control. If you are concerned about the possibility of having diabetes, it is recommended to consult with a doctor for a comprehensive diabetes screening and evaluation. Only a doctor, based on your medical history, physical examination, and necessary laboratory test results, can make an accurate diagnosis.	191	14.2	9.4	
Question 5	Does diabetes have a hereditary component?				1
ChatGPT's answer	Yes, diabetes has a hereditary tendency. Genetic factors play an important role in the development of diabetes. If your parents or close relatives have diabetes, your risk of developing diabetes may be increased.Specifically, the hereditary tendency of diabetes is primarily associated with genetic variations. There are certain gene mutations that are related to the occurrence and progression of both type 1 and type 2 diabetes. However, genetics is just one factor in the development of diabetes, and environmental and lifestyle factors also play a significant role.While genetic factors may increase the risk of developing diabetes, it does not mean that you will definitely develop diabetes. By adopting a healthy lifestyle, such as maintaining a balanced diet, engaging in regular physical activity, maintaining a healthy weight, and undergoing regular check-ups, you can reduce the risk of diabetes, even if you have a family history of the disease. If you are concerned about your genetic risk, it is advisable to consult a doctor for assessment and guidance.	167	13.4	9.4	
Question 6	Does diabetes affect sexual function?				+
ChatGPT's answer	Yes, diabetes can affect sexual function. Diabetes patients may experience decreased libido, erectile dysfunction, and difficulties with sexual intercourse. The impact of diabetes on sexual function is primarily due to the damage high blood sugar levels can cause to the nerves and blood vessels. Prolonged high blood sugar can damage the nervous system, leading to abnormal nerve conduction and affecting sexual desire and response. Additionally, high blood sugar can also damage endothelial cells in blood vessels, leading to vascular dysfunction and impacting erectile function. In addition to high blood sugar, other diabetes-related factors can also affect sexual function, such as cardiovascular disease, neuropathy, and medication treatments. If you are experiencing issues with sexual function and have diabetes, it is advisable to consult a doctor. The doctor can assess your diabetes control and provide appropriate treatment and advice to improve sexual function.	141	13.7	10	

Fig. 1 Diabetes knowledge misconceptions and ChatGPT's answers. A Q1–Q6 and ChatGPT's answers. B Q7–Q12 and ChatGPT's answers

					-
Question 7	Does diabetes increase the risk of tumors?				+
ChatGPT's ansv	Yes, diabetes patients may have an increased risk of developing certain types of tumors. Research has shown that diabetes is associated with the occurrence of certain cancers, particularly pancreatic cancer, liver cancer, colorectal cancer, breast cancer, and endometrial cancer. There are several potential reasons why diabetes may increase the risk of cancer. On one hand, high blood sugar and insulin resistance may promote tumor growth and development. On the other hand, diabetes patients often have other metabolic abnormalities such as obesity, hypertension, and very dyslipidemia, which are also associated with the occurrence of cancer. However, it is important to note that diabetes itself does not directly cause the development of tumors but rather increases the risk of developing certain types of cancer. Diabetes patients can reduce their risk of cancer by controlling blood sugar, maintaining a healthy weight, adopting a balanced diet, engaging in moderate exercise, and undergoing regular check-ups. If you are concerned about the relationship between diabetes and tumors, it is advisable to consult a doctor for more detailed information and personalized advice.	174	15.2	10	
Question 8	If a doctor recommends starting insulin for type 2 diabetes, does it mean that the disease has worsened?				
ChatGPT's ansv	It does not necessarily mean that the disease has worsened, but rather it may indicate that your diabetes management needs further control. Type 2 diabetes is a chronic condition that can initially be managed through diet control, exercise, and oral medications to regulate blood sugar levels. However, as the disease progresses, insulin may become a necessary option for managing blood sugar. The purpose of using insulin is to help control blood sugar levels and keep them within a normal range. Insulin can provide more precise blood sugar control and may be a more effective treatment option for certain diabetes patients. If a doctor recommends starting insulin, it may be because your blood sugar control is not ideal, oral medications are not meeting your needs, or your diabetes has progressed to a stage where insulin therapy is necessary. This does not mean that your disease has worsened, but rather that a more proactive approach to blood sugar management is required. It is important to work closely with your doctor, follow their advice, and regularly monitor and follow up on your blood sugar levels. This will ensure that your diabetes is effectively controlled and reduce the risk of complications.	197	12.7	9.6	
Question 9	Do type 2 diabetes patients become addicted to insulin after using it?				1
ChatGPT's answ	Type 2 diabetes patients do not become addicted to insulin when using it for treatment. Insulin is a physiological hormone that is used in diabetes patients to help regulate blood sugar levels. The use of insulin is done under the prescription and guidance of a doctor to ensure safe and effective treatment.Insulin therapy does not lead to physical dependence or addiction to insulin. On the contrary, insulin is an important tool in diabetes management that can help control blood sugar and prevent complications.However, it is important to note that the use of insulin should be done following the advice and guidance of a doctor. When using insulin, it should be injected according to the prescribed dosage and timing, and blood sugar levels should be regularly monitored. If there are any questions or concerns, it is recommended to communicate with a doctor for more detailed information and guidance.	149	12	9.8	
Question 10	Should all oral antidiabetic medications be taken on an empty stomach?				1
ChatGPT's answ	Not all oral antidiabetic medications need to be taken on an empty stomach. The specific medication instructions should be followed according to the doctor's advice. Different oral antidiabetic medications have different requirements, some of which need to be taken on an empty stomach, while others can be taken with meals. Some common oral antidiabetic medications, such as Metformin, are usually recommended to be taken before or during meals to help control blood sugar levels. Other oral antidiabetic medications, such as sulforylureas (e.g., Glipzide) or insulin secretagogues (e.g., Repaglinide, Nateglinide), may need to be taken on an empty stomach. Therefore, it is important to follow the doctor's guidance and take oral antidiabetic medications as advised in the medication instructions. If there are any questions or uncertainties, it is recommended to consult further with the doctor or pharmacist. They can provide detailed information on the usage and dosage of specific medications.	150	15.1	9.6	
ChatGPT's answ	Diabetic patients should not stop medication on their own after their blood sugar levels are within the normal range. Diabetes is a chronic disease that requires long-term management and control. Even if blood sugar levels are normal, stopping medication can lead to a rise in blood sugar levels again and increase the risk of complications.Before stopping medication, it is important to consult with a doctor. The doctor will assess whether it is possible to gradually reduce the dosage or stop the medication based on the patient's specific condition and blood sugar control. This usually requires regular blood sugar monitoring and guidance from the doctor.In addition, diabetic patients should also pay attention to dietary and lifestyle adjustments, including a balanced diet, moderate exercise, maintaining a healthy weight, and regular check-ups. These measures help maintain blood sugar control blood sugar levels, and ensure effective management of diabetes. Do not stop medication on your own to avoid compromising disease control and health.	177	12.7	10	
Question 12	Currently, there is no cure for diabetes. Diabetes is a chronic disease that requires long-term management and				+
ChatGPT's answ	 Control. However, through proper treatment and lifestyle adjustments, individuals with diabetes can effectively control their blood sugar levels, reduce the risk of complications, and improve their quality of life. Treatment methods for diabetes include medication, dietary control, physical exercise, and blood sugar monitoring. Oral antidiabetic drugs and insulin are commonly used medication treatments that help control blood sugar levels. Dietary control is an important component of diabetes management, including carbohydrate intake control, choosing healthy foods, and portion control. Physical exercise helps improve insulin sensitivity and control blood sugar levels. Blood sugar monitoring helps individuals understand their blood sugar levels and adjust treatment plans as needed.While diabetes cannot be completely cured, individuals with diabetes can maintain good blood sugar control, reduce the risk of complications, and improve their quality of life through active treatment and management. It is important to follow the advice of healthcare professionals, undergo regular check-ups and blood sugar monitoring, and take proactive measures to control diabetes. 	177	14.7	9.4	

Fig. 1 continued

ChatGPT's answers may lack completeness and precision due to its reliance on existing information and text, without real-time updating capabilities. As ChatGPT is not connected to the internet and has limited knowledge, there is a possibility of generating inaccurate or biased content. However, users have the option to provide feedback using the "Not Satisfied" button, enabling ChatGPT to learn and enhance its responses.



Fig. 2 Evaluation ChatGPT's answers' scores and suggestions

Limitations

This study encountered several limitations. Firstly, we did not evaluate patients' ratings of ChatGPT's answers, and their empathetic assessments may vary from those of healthcare professionals. Secondly, ChatGPT does not provide citations, preventing users from verifying the accuracy of the information or delving deeper into the topic. Thirdly, although we assessed a range of questions, the selected ones may not encompass all the diabetes-related issues comprehensively.

Conclusion

Our study revealed that ChatGPT has the potential to offer valuable and precise health information regarding diabetes. Nonetheless, further investigation is necessary to ascertain the consistent accuracy of artificial intelligence in providing diabetes-related information. Additionally, it is crucial to establish supervisory mechanisms to evaluate the quality of information delivered by chatbots and other AI systems. Furthermore, real-time updates of health information are essential to cater to the requirements of individuals with diabetes.

Acknowledgements

Not applicable.

Author contributions

HH designed the study. CH and LC contributed to the acquisition and analysis of data, as well as the drafting of the manuscript. QC, RL, XW, YZ, and ZJ contributed to the statistical analysis and interpretation of the data.

Funding

This study was supported by the startup fund for scientific research, Fujian Medical University (2022QH1126) and Fujian Provincial Young and Middleaged Teachers' Education Research Project (JAT220109).

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declared no competing interests.

Received: 10 July 2023 Accepted: 12 July 2023 Published online: 26 July 2023

References

- Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol. 2018;14(2):88–98.
- Radford A, Narasimhan K. Improving language understanding by generative pre-training. 2018.
- Mathur K, et al. Effect of artificial sweeteners on insulin resistance among type-2 diabetes mellitus patients. J Fam Med Primary Care. 2020;9(1):69–71.
- Zhou X, Zeng C. Diabetes remission of bariatric surgery and nonsurgical treatments in type 2 diabetes patients who failure to meet the criteria for surgery: a systematic review and meta-analysis. BMC Endocr Disord. 2023;23(1):46.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.