

ORIGINAL ARTICLE

Assessing the utility of ChatGPT as an artificial intelligence-based large language model for information to answer questions on myopia

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Abstract

Purpose: ChatGPT is an artificial intelligence language model, which uses natural language processing to simulate human conversation. It has seen a wide range of applications including healthcare education, research and clinical practice. This study evaluated the accuracy of ChatGPT in providing accurate and quality information to answer questions on myopia.

Methods: A series of 11 questions (nine categories of general summary, cause, symptom, onset, prevention, complication, natural history, treatment and prognosis) were generated for this cross-sectional study. Each question was entered five times into fresh ChatGPT sessions (free from influence of prior questions). The responses were evaluated by a five-member team of optometry teaching and research staff. The evaluators individually rated the accuracy and quality of responses on a Likert scale, where a higher score indicated greater quality of information (1: very poor; 2: poor; 3: acceptable; 4: good; 5: very good). Median scores for each question were estimated and compared between evaluators. Agreement between the five evaluators and the reliability statistics of the questions were estimated.

Results: Of the 11 questions on myopia, ChatGPT provided good quality information (median scores: 4.0) for 10 questions and acceptable responses (median scores: 3.0) for one question. Out of 275 responses in total, 66 (24%) were rated very good, 134 (49%) were rated good, whereas 60 (22%) were rated acceptable, 10 (3.6%) were rated poor and 5 (1.8%) were rated very poor. Cronbach's α of 0.807 indicated good level of agreement between test items. Evaluators' ratings demonstrated 'slight agreement' (Fleiss's κ , 0.005) with a significant difference in scoring among the evaluators (Kruskal–Wallis test, $p < 0.001$).

Conclusion: Overall, ChatGPT generated good quality information to answer questions on myopia. Although ChatGPT shows great potential in rapidly providing information on myopia, the presence of inaccurate responses demonstrates that further evaluation and awareness concerning its limitations are crucial to avoid potential misinterpretation.

KEYWORDS

artificial intelligence, ChatGPT, chatbot response, myopia, patient information

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BACKGROUND

There has been a major shift towards virtual healthcare following the COVID-19 pandemic.¹ This adoption of virtual care has been associated with a tremendous rise in electronic patient messaging and phone calls. Existing healthcare systems are inadequately equipped to handle this additional electronic workload, which means more waiting time for patients, burnout for clinicians and increased burden on the healthcare system.² Patients relying on the internet and social media³ for health-related information often receive inaccurate and flawed responses.⁴ Further, misinformation and misalignment between information gathered from the health or eye care practitioner and the internet may result in patient dissatisfaction.⁵

Information-motivation-behaviour theory⁶ tells us that high quality information can change attitudes, promoting behavioural motivation, and may eventually encourage relevant behaviour change. This future behaviour is affected by accessible and stable attitude.⁶ Therefore, positive parental attitude originating from information can lead to healthy and effective behaviour regarding one's own and their children's vision, which might reduce the prevalence and incidence of childhood myopia.^{7,8}

Artificial intelligence-based chatbot functions are increasingly used for customer service and to obtain information for education, research and healthcare practice.⁹ With the widespread availability of smartphones and the internet, chatbots are cheap and readily accessible. ChatGPT (openai.com) is one of the latest AI-based large language models, generating human-like responses. It uses supervised and reinforcement learning strategies and has recently gained widespread attention in the medical community.¹⁰ This AI uses natural language processing to respond automatically to questions and simulate human conversation.¹¹ Although this system was not built for healthcare, with the extent of its popularity and use among the general public,¹² its potential in answering ophthalmic patient queries remains underexplored. The present study, therefore, evaluated the accuracy and quality of information provided by ChatGPT on myopia.

METHODS

A series of 11 questions on myopia (involving nine categories: one each for disease summary, cause, symptom, onset, prevention, complication, natural history of untreated myopia, prognosis and three on treatments) (Table 1) were constructed on the basis of the 'frequently asked questions on myopia' webpage of the Association of British Dispensing Opticians (www.abdo.org.uk/eyecarefaq/myopia/) and the College of Optometrists (www.college-optometrists.org/category-landing-pages/clinical-topics/myopia/myopia-management-guidance-faqs) (accessed 15 March 2023). On 16 March 2023, the original full text of the questions was entered into ChatGPT (version GPT-3.5, OpenAI)

Key points

- Artificial intelligence is increasingly used to obtain information on education, research and practice. Since its launch, ChatGPT has gained widespread attention with its natural language processing to mimic human responses.
- In total, 24% of the responses on myopia by ChatGPT were rated very good and 49% good, whereas 22% were rated acceptable, 3.6% poor and 1.8% very poor.
- ChatGPT has the potential to provide accurate and quality information on myopia over the internet, but further evaluation and awareness concerning its limitations are crucial to avoid potential misinterpretation.

sessions, and the responses were saved. Each of the question sessions was fresh and free from prior questions asked that could bias the results. A total of 55 responses were obtained (examples in Table 1). Questions and responses from ChatGPT were reviewed by a five-member team of optometry teaching and research staff working on myopia and glaucoma, myopia, physiological optics, presbyopia, contact lenses and dry eye (S.B., N.S.L., L.N.D., A.L.S., J.S.W.) with over 100 years of clinical and academic experience between them. The evaluators independently rated the quality of information provided on a Likert scale, where higher ratings indicated greater quality of information (1: very poor; 2: poor; 3: acceptable; 4: good; 5: very good).

We relied upon the principles of crowdsourcing strategy¹³ as the outcomes being studied (ChatGPT responses) lack ground truth and their quality ratings are inherently subjective. The median scores across the evaluators for each response were studied. The score represents evaluator (rater) consensus, whereas the score variance (e.g., interquartile range [IQR]) represents disagreements between evaluators.¹⁴

STATA version 12.0 ([stata.com](https://www.stata.com)) was used to estimate the median, IQR and range of scores for each question. Evaluators were randomly assigned with a number and the inter-evaluator agreement was assessed using Fleiss's kappa. Cronbach's α was used to estimate the reliability of the test scale (questions). The Kruskal–Wallis H omnibus test statistic was used to compare the score between evaluators. The significance level for all statistical tests was set at $p < 0.05$ with Bonferroni correction for post-hoc pairwise comparisons. A violin plot, which is a hybrid of a box and kernel density plot,¹⁵ was used to visualise the distribution of the evaluator scores.

RESULTS

Table 1 shows examples of the responses obtained from ChatGPT. Reliability indices of the questions (test scale) were

TABLE 1 Examples of responses from ChatGPT.

Type of question	Question input to ChatGPT	Response provided by ChatGPT
General summary	What is myopia?	<p>Myopia, also known as short-sightedness, is a refractive error of the eye in which light rays entering the eye are focussed in front of the retina, instead of directly on the retina. This results in distant objects appearing blurry or out of focus, while close-up objects appear clear.</p> <p>Myopia is a common condition that often begins in childhood and tends to worsen during the teenage years. It is typically caused by a combination of genetic and environmental factors, such as spending too much time reading, using electronic devices or doing close work.</p> <p>Myopia can be corrected with eyeglasses, contact lenses or refractive surgery, which can help to refocus the light rays directly onto the retina, thereby improving vision. If left untreated, however, myopia can lead to more serious eye problems, such as retinal detachment, glaucoma and cataracts.</p>
Cause	What causes myopia?	<p>Myopia, also known as short-sightedness, occurs when the eyeball is too long or the cornea (the clear front part of the eye) is too curved. This causes light entering the eye to be focussed in front of the retina, rather than directly on it, resulting in blurred distance vision.</p> <p>The exact cause of myopia is not completely understood, but it is believed to be a combination of genetic and environmental factors. Some of the factors that may contribute to the development of myopia include:</p> <ol style="list-style-type: none"> 1. Genetics: Myopia tends to run in families, suggesting that there may be a genetic component to the condition. 2. Environmental factors: Spending a lot of time doing near work, such as reading or using a computer, may increase the risk of developing myopia. Outdoor activities and exposure to sunlight may help protect against myopia. 3. Age: Myopia typically develops in childhood and adolescence and tends to stabilise in early adulthood. 4. Other health conditions: Certain health conditions, such as diabetes or cataracts, may increase the risk of developing myopia. <p>While there is no known cure for myopia, it can be corrected with eyeglasses, contact lenses or refractive surgery. Regular eye examinations can help detect and monitor myopia and may also help identify other eye conditions that may be affecting your vision.</p>
Symptom	What are the symptoms of myopia?	<p>The most common symptom of myopia or short-sightedness is blurred distance vision. Other symptoms may include:</p> <ol style="list-style-type: none"> 1. Difficulty seeing objects in the distance, such as road signs or chalkboards. 2. Squinting to try to see distant objects more clearly. 3. Eye strain or fatigue, especially after reading, watching television or using a computer for extended periods of time. 4. Headaches, especially after prolonged periods of reading or other close work. 5. Difficulty seeing clearly while driving at night. 6. Feeling like you need to constantly adjust the distance between your eyes and the object you are looking at. <p>If you experience any of these symptoms, it is important to schedule an eye examination with an optometrist or ophthalmologist to determine whether you have myopia or another vision problem. Regular eye examinations can also help detect and monitor changes in your vision over time.</p>
Onset	At what age does myopia develop?	<p>Myopia or short-sightedness can develop at any age but it most commonly begins during childhood and adolescence. The condition usually progresses until the age of 20 or 30, when the eye has finished growing.</p> <p>According to the American Optometric Association, myopia often first appears between the ages of 6 and 14. The prevalence of myopia tends to increase with age, with an estimated 30% of the US population being affected by myopia.</p> <p>It is important to monitor children's vision regularly, as early detection and treatment of myopia can help prevent it from worsening and potentially leading to more serious vision problems later in life. Regular eye examinations, including vision screenings in school, can help detect myopia and other vision problems in children.</p>
Prevention	How to prevent myopia?	<p>While there is no sure-fire way to prevent myopia, there are some steps you can take to reduce the risk or slow the progression of the condition:</p> <ol style="list-style-type: none"> 1. Spend more time outdoors: Studies have shown that spending more time outdoors, particularly during childhood and adolescence, may help reduce the risk of developing myopia. 2. Take regular breaks from close work: If you spend a lot of time doing close work, such as reading or using a computer, take frequent breaks to rest your eyes and give them a chance to focus on objects at a distance. 3. Practice good posture and ergonomics: Make sure your workspace is set up ergonomically, with proper lighting and good posture to avoid unnecessary strain on your eyes. 4. Use proper lighting: Make sure your work area is well lit and that your screen or reading material is properly illuminated to reduce eye strain. 5. Get regular eye examinations: Regular eye examinations can help detect myopia and other vision problems early, allowing for timely treatment and potentially reducing the risk of more serious vision problems in the future. 6. Consider orthokeratology: Orthokeratology or 'ortho-k' involves wearing special contact lenses at night to reshape the cornea and reduce myopia. This treatment has been shown to be effective in slowing the progression of myopia in some individuals, although it is not suitable for everyone. <p>It is important to consult with an eye care professional to determine the best course of action for your individual needs and situation.</p>

(Continues)

TABLE 1 (Continued)

Type of question	Question input to ChatGPT	Response provided by ChatGPT
Complication	What are the complications of myopia?	<p>Myopia or short-sightedness can lead to several complications, particularly if it is left untreated or if it is severe. Some of the potential complications of myopia include:</p> <ol style="list-style-type: none"> 1. Strain on the eyes: Myopia can cause eye strain, headaches and fatigue, especially during activities that require visual acuity, such as reading, driving or working on a computer. 2. Reduced quality of life: If left untreated, myopia can reduce the quality of life by interfering with daily activities and limiting participation in sports and other outdoor activities. 3. Increased risk of eye problems: People with myopia are at increased risk of developing other eye problems, such as cataracts, glaucoma and retinal detachment. 4. Chorioretinal degeneration: High myopia or severe short-sightedness can lead to the thinning of the retina and the choroid, which can increase the risk of chorioretinal degeneration and other serious eye conditions. 5. Poor academic performance: Children with myopia may have difficulty seeing the board or reading materials in the classroom, which can lead to poor academic performance. <p>It is important to have regular eye examinations to monitor your vision and detect any potential complications of myopia. If you have myopia, your eye care professional may recommend corrective lenses, such as glasses or contact lenses or other treatments to help manage your condition and reduce your risk of complications.</p>
Natural history	What happens if myopia is left untreated?	<p>If myopia or short-sightedness is left untreated, it can lead to several potential complications, particularly if it is severe or progresses over time. Some of the potential complications of untreated myopia include:</p> <ol style="list-style-type: none"> 1. Eye strain: Myopia can cause eye strain, headaches and fatigue, especially during activities that require visual acuity, such as reading, driving or working on a computer. 2. Reduced quality of life: If left untreated, myopia can reduce the quality of life by interfering with daily activities and limiting participation in sports and other outdoor activities. 3. Increased risk of eye problems: People with myopia are at increased risk of developing other eye problems, such as cataracts, glaucoma and retinal detachment. 4. Chorioretinal degeneration: High myopia or severe short-sightedness can lead to the thinning of the retina and the choroid, which can increase the risk of chorioretinal degeneration and other serious eye conditions. 5. Poor academic performance: Children with myopia may have difficulty seeing the board or reading materials in the classroom, which can lead to poor academic performance. <p>It is important to have regular eye examinations to monitor your vision and detect any potential complications of myopia. If you have myopia, your eye care professional may recommend corrective lenses, such as glasses, contact lenses or other treatments to help manage your condition and reduce your risk of complications.</p>
Treatment	Can myopia be treated?	<p>Yes, myopia can be treated with a variety of methods depending on the severity of the condition and the individual's needs. Some of the most common treatment options for myopia include:</p> <ol style="list-style-type: none"> 1. Corrective lenses: Glasses or contact lenses can help correct myopia and improve vision. 2. Refractive surgery: Procedures such as laser-assisted in situ keratomileusis (LASIK), photorefractive keratectomy (PRK) and small incision lenticule extraction (SMILE) can reshape the cornea to correct myopia. 3. Orthokeratology: Also known as 'ortho-k', this treatment involves wearing specialised contact lenses at night that reshape the cornea to temporarily reduce myopia. 4. Atropine eye drops: These eye drops can help slow the progression of myopia, particularly in children. 5. Multifocal contact lenses: These contact lenses have different powers in different areas, allowing for clear vision both up close and at a distance. <p>It is important to consult with an eye care professional to determine the best treatment option for your individual needs and situation. While some treatments can help correct myopia, they may not be appropriate for everyone and may have risks and side effects that should be carefully considered. Regular eye examinations can help monitor the progression of myopia and detect any potential complications early on.</p>
Treatment	Who can treat myopia?	<p>Myopia or short-sightedness can be treated by a variety of eye care professionals, including:</p> <ol style="list-style-type: none"> 1. Optometrists: Optometrists are eye care professionals who can diagnose and treat myopia with corrective lenses, such as glasses or contact lenses. 2. Ophthalmologists: Ophthalmologists are medical doctors who specialise in eye care and can diagnose and treat myopia with corrective lenses or surgical procedures. 3. Orthoptists: Orthoptists are eye care professionals who specialise in diagnosing and treating eye movement and coordination problems, including myopia. 4. Paediatric ophthalmologists: Paediatric ophthalmologists are medical doctors who specialise in eye care for children, including the diagnosis and treatment of myopia. 5. Opticians: Opticians are eye care professionals who can help fit and adjust corrective lenses, such as glasses or contact lenses, to correct myopia. <p>It is important to consult with an eye care professional to determine the best course of treatment for your individual needs and situation. Regular eye examinations can help monitor the progression of myopia and detect any potential complications early on.</p>

TABLE 1 (Continued)

Type of question	Question input to ChatGPT	Response provided by ChatGPT
Treatment	Which is the single most successful treatment strategy for myopia?	<p>There is no single most successful treatment strategy for myopia, as the best approach will depend on the individual's age, severity of myopia, lifestyle and personal preferences. Each treatment option has its own benefits and risks and what works best for one person may not work as well for another person.</p> <p>That being said, some treatments may be more appropriate for certain individuals or situations. For example, corrective lenses, such as glasses or contact lenses, are often the first line of treatment for myopia and can be effective in correcting vision. Refractive surgery, such as LASIK, PRK or SMILE, can also be highly effective in correcting myopia but it may not be appropriate for everyone.</p> <p>Orthokeratology or 'ortho-k' is another treatment option that can be effective in reducing myopia, particularly in children. Atropine eye drops can also be effective in slowing the progression of myopia, particularly in children, but it may not be appropriate for everyone and may have side effects.</p> <p>It is important to consult with an eye care professional to determine the best treatment option for your individual needs and situation. Regular eye examinations can help monitor the progression of myopia and detect any potential complications early on.</p>
Prognosis	What is the prognosis for myopia?	<p>The prognosis for myopia or short-sightedness is generally good. Most people with myopia can manage their condition with corrective lenses, such as glasses or contact lenses, and lead normal lives with minimal impact on their daily activities.</p> <p>However, the severity of myopia can vary and, in some cases, can progress over time, leading to higher levels of short-sightedness and an increased risk of complications. High myopia or severe short-sightedness can increase the risk of chorioretinal degeneration, retinal detachment and other serious eye conditions.</p> <p>The prognosis for children with myopia can also vary depending on when the condition is diagnosed and how it is managed. If myopia is detected early and treated appropriately, the progression of short-sightedness can be slowed or halted, reducing the risk of complications later in life. However, if myopia is left untreated or poorly managed, it can lead to complications and a higher risk of vision problems.</p> <p>It is important to have regular eye examinations to monitor your vision and detect any potential complications of myopia. Your eye care professional can recommend appropriate treatments and management strategies based on your individual needs and situation.</p>

TABLE 2 Summary of ratings of the ChatGPT responses.

Question number	Type of question	Question input to ChatGPT	Median	IQR	Range
1	General summary	What is myopia?	4.0	3.0–4.0	2.0–5.0
2	Cause	What causes myopia?	4.0	4.0–5.0	3.0–5.0
3	Symptom	What are the symptoms of Myopia?	4.0	4.0–5.0	3.0–5.0
4	Onset	At what age does myopia develop?	4.0	4.0–5.0	3.0–5.0
5	Prevention	How to prevent myopia?	3.0	3.0–4.0	2.0–5.0
6	Complication	What are the complications of myopia?	4.0	4.0–4.0	3.0–5.0
7	Treatment	Can myopia be treated?	4.0	3.0–4.0	3.0–4.0
8	Treatment	Who can treat myopia?	4.0	3.0–5.0	3.0–5.0
9	Treatment	Which is the single most successful treatment strategy for myopia?	4.0	3.0–4.0	1.0–5.0
10	Treatment	What happens if myopia is left untreated?	4.0	4.0–5.0	3.0–5.0
11	Prognosis	What is the prognosis for myopia?	4.0	4.0–5.0	4.0–5.0

Abbreviation: IQR, interquartile range.

calculated which revealed a Cronbach's α of 0.807, which shows a high degree of internal consistency. The average inter-item correlation was 0.28, indicating good reliability.

Overall, for myopia, evaluators rated ChatGPT to provide good information on myopia (combined median score 4.0; IQR: 3.0–4.0) by all the evaluators. The quality of information on all the categories of general information or summary of myopia, its causes, symptoms, onset, complication, treatments and myopia prognosis were good (median scores: 4.0), except for the prevention of myopia which was deemed acceptable (median score 3.0) (Table 2). Of the 275 responses from 55 questions, 66 (24.0%) were rated as very good, 134 (48.7%) as good, 60 (21.8%) as acceptable,

10 (3.6%) as poor and 5 (1.8%) as very poor. The question 'Which is the single most successful treatment strategy for myopia?' showed the highest variation in the evaluators' response, with median scores ranging between 1.0 and 5.0. It was followed by 'What is myopia?' and 'How to prevent myopia?', where the scores ranged between 2.0 and 5.0. The remainder of the questions had similar variation in their median scores (ranging between 3.0 and 5.0). Refer to Table S1 for detailed scoring by individual evaluators.

Four of the evaluators gave identical overall scores (median score 4), with one exception (median score 3). The proportion of ratings for individual evaluators is shown in Table 3. The evaluators' scores had a 'slight agreement'¹⁶

TABLE 3 Overall number and percentage of median scores by the evaluators.

Evaluator	1: Very poor	2: Poor	3: Acceptable	4: Good	5: Very good
1	0 (0)	0 (0)	4 (7.3)	30 (54.5)	21 (38.2)
2	5 (9.1)	5 (9.1)	20 (36.4)	15 (27.3)	10 (18.2)
3	0 (0)	2 (3.6)	6 (10.9)	26 (47.3)	21 (38.2)
4	0 (0)	3 (5.5)	23 (41.8)	28 (50.9)	1 (1.8)
5	0 (0)	0 (0)	7 (12.7)	35 (63.6)	13 (23.6)
Overall	5 (1.8)	10 (3.6)	60 (21.8)	134 (48.7)	66 (24.0)

with a combined Fleiss's κ of 0.005. The Kruskal–Wallis omnibus test revealed a significant difference in scoring among the evaluators ($p < 0.001$). Pairwise comparison of scores is shown in Table 4. The violin plot (Figure 1) depicts the wide distribution of scores (Y-axis) across the evaluators. The white dot, thick blue bar and thin blue line represent the median score, IQR and the rest of the score distribution, respectively. On either side of the blue line is the kernel density estimation to show the distribution shape of the response scores. Wider sections of the violin plot represent a higher probability with more frequent scores, whereas the narrower sections represent a lower probability with less frequent scores. Evaluator 5 had the minimum variance in the data, while Evaluator 2 had the maximum variance. The grading by Evaluator 5 was closest to the median spread of the combined score (Figure 1).

DISCUSSION

To the best of the authors' knowledge, this is the first cross-sectional study assessing the accuracy of ChatGPT to answer common questions on myopia. Almost half (48.7%) of the ChatGPT responses were rated good and 24% were rated very good by the evaluators. This is in contrast to the previously reported accuracy of ChatGPT on common retinal diseases, where the authors described 26% good and 45% very good responses.¹⁰ Overall, a high proportion of the responses on myopia were good (~73%) without inaccuracies. Almost 22% of responses was acceptable with minor inaccuracies (score 3), whereas a small proportion of the responses was inaccurate or flawed (score 2: 3.6% and score 1: 1.8%). The reported inaccuracies of ChatGPT for common retinal diseases were 17% moderate and 12% poor responses, with none in the very poor rating group.¹⁰ The difference in the present results with a higher proportion of responses which were rated very poor could be due to the methodological differences, where only four questions for five retinal diseases (general summary, prevention, treatment options and prognosis) were asked of ChatGPT, lacking in-depth questions on the cause, symptom, treatment, etc.¹⁰ Another reason for the difference could be the inherently surgical nature of the treatments for retinal diseases compared with myopia, where processing information for the AI is straightforward without

TABLE 4 Pairwise comparison of evaluator scores.

Evaluator	Bonferroni pairwise comparison	
	t	p
2 vs. 5	-4.98	<0.001
4 vs. 5	-4.13	<0.001
3 vs. 5	0.61	>0.99
1 vs. 3	0.73	>0.99
4 vs. 2	0.85	>0.99
1 vs. 5	1.34	>0.99
3 vs. 4	4.74	<0.001
1 vs. 4	5.47	<0.001
3 vs. 2	5.59	<0.001
1 vs. 2	6.32	<0.001

diversity and ambiguity. Myopia control strategies can be surgical, pharmacological, optical, lifestyle, environmental or a combination of these therapies. Besides, these strategies are ever evolving with constant updating of the evidence base with several ongoing randomised clinical trials around the world.¹⁷

The responses for 'Which is the single most successful treatment strategy for myopia?' received mixed rating from the evaluators (median score 4.0, range 1.0–5.0). The criticism was that the most successful treatment was not addressed, some responses lacked information or alternative options especially on combination therapies and that responses were too focussed on myopia correction and not on slowing the myopia progression such as using optical interventions. Responses of 'How to prevent myopia?' were another example where the evaluators had a variable rating (median score 3.0, range 2.0–5.0). The critique was ChatGPT-listed treatment modalities for myopia management or control when outdoor time is the only established way to prevent myopia. Other critiques were that the advice was non-specific, they were not evidence-based and did not mention myopia control interventions. In general, the responses were not supported by the literature and were misleading. Another response which received a wide range of ratings from the evaluators was the question 'What is myopia?' (median score 4.0, range 2.0–5.0). Assessors noted the overemphasis on genetics and near

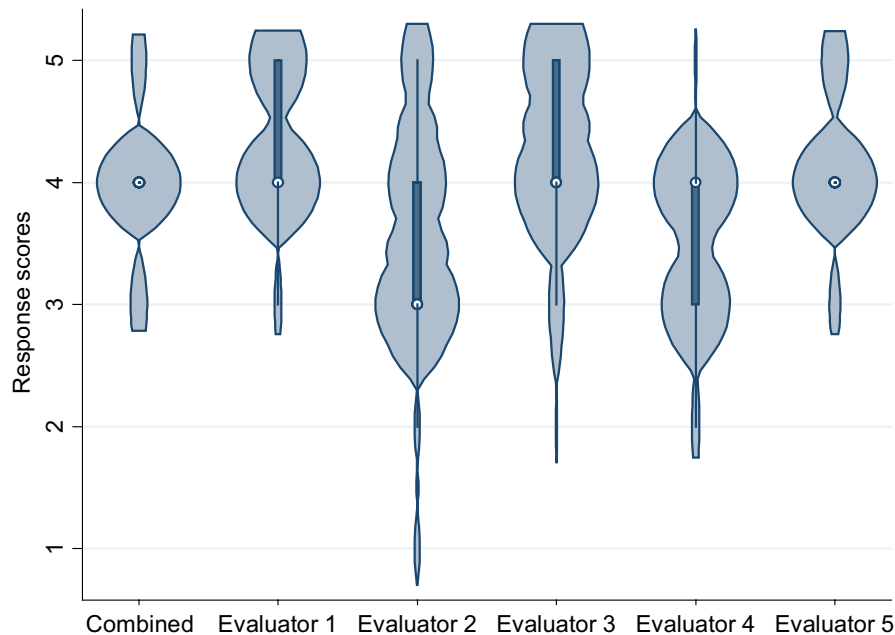


FIGURE 1 Violin plot illustrating the distribution of scores across the evaluators. The median score is represented by the white dot, interquartile range by the thick blue bar and the rest of the score distribution is characterised by the thin blue line. Kernel density estimation on either side of the blue line depicts the distribution of the response scores. Higher probability with more frequent scores has wider sections on the violin plot and vice versa.

work, no mention of the consequences of having myopia, lack of description as to how myopia is detected and the ocular structural changes associated with myopia or the need for axial length measurement. Further, they did not distinguish between the natural course of myopia when left untreated versus myopia control, that is, the effect of treatment versus no treatment was unclear. ChatGPT was also indefinite about the age range of myopia onset, presenting a variety of age ranges which might be misleading.

Other minor inaccuracies noted by the evaluators were specifying computer video games, eye strain, fatigue and injury as causative factors for myopia. These relationships are not proven, and recent meta-analyses regarding digital devices and myopia found the results to be mixed, with insufficient evidence of a definite risk between myopia and screen time.^{18,19} Equally, ChatGPT did not mention the association of low light levels,²⁰ close reading/working distances and intensity of near work with myopia.²¹ Another error was the linking of vitamin D and other nutrients with myopia, which is a spurious link with the real association being outdoor ambient light and myopia.²² ChatGPT incorrectly linked digital eye strain and myopia and suggested following the 20-20-20 rule to avoid myopia.²³ Similarly, eating a balanced diet, cleaning contact lenses, avoiding rubbing of eyes, sleeping and exercising regularly were mentioned as preventive measures for myopia showing lack of scientific rigour. Additionally, 2 h of outdoor activity every day was suggested to prevent myopia, which may not only be impractical but also inaccurate given that evidence from randomised controlled trials over 1–3 years suggests 40–80 min of interrupted outdoor time per day can slow and/or delay the onset of myopia in

children.^{24,25} The studies which suggested >2 h per day of outdoor activity to reduce myopia progression are either cross-sectional²⁶ or a year-long observational study,²⁷ subject to recall bias by using a questionnaire. Complications of myopia had minor inaccuracies with the absence of chorioretinal atrophy and lacquer cracks among its common complications. The responses as to whether myopia can be treated did not talk about the limitations of low-dose atropine (e.g., the discordance between axial elongation and refractive error change for $\leq 0.01\%$ concentrations of atropine),²⁸ combination therapies (atropine + orthokeratology)²⁹ and artificial red light as an emerging potential therapy.³⁰ The question as to ‘who can treat myopia’ elicited moderately accurate responses except that opticians were included along with optometrists and ophthalmologists. Even though the role of optician was appropriately mentioned as ‘fit and dispense corrective lenses, including eyeglasses and contact lenses, prescribed by optometrists or ophthalmologists’, this response has scope for misinterpretation and confusion for patients who might end up visiting the optician, only to be referred to an optometrist or ophthalmologist for their examination. The reply to the prognosis of myopia was precise, except that the prognosis is dependent upon both the age of myopia onset and diagnosis, not only on the age of diagnosis.

The lack of agreement and difference in median score between the evaluators reflects the ambiguity of the ChatGPT responses and inherent subjectivity of the outcome responses being studied, as some of the evaluators were not ‘experts’ in myopia. In the absence of a ground truth in the responses, we have tried to reduce this subjectivity by using crowd scoring strategy¹³ of using multiple evaluators and

taking their median scores. The median score represents the evaluator consensus, while the IQR signifies their disagreements.¹⁴ The evaluators with their unique fields of expertise were bound to have difference in opinions, but it reflects the consensus of optometric academicians on myopia.

Although ChatGPT shows an overall accuracy in its responses on myopia, it was limited by: (1) inability to critically appraise/analyse results from the literature, (2) knowledge database limited till 2021 (not updated), (3) misinterpretation of medical terms, (4) incapability to differentiate between predatory and reputable journal articles, (5) lack of scientific accuracy and reliability, biased and potential misinformation for readers.⁹

The main limitation of this study was the use of questions which may not reflect real-life queries and interactions. We do not know how ChatGPT will perform in a clinical setting while answering actual patient questions. We studied the responses in isolation to previous questions or context, whereas a clinician might benefit from a previously asked question or established relationships with the patient. However, this study should encourage future investigations into how AI can be useful in drafting a response to a patient's query, with the clinician able to modify it before sending. Such AI-assisted drafts might be very useful for both clinicians and support staff in saving time to be used for other tasks.¹⁴ This could improve the quality of responses and their consistencies. Furthermore, providing quality answers to the patient's questions might even reduce unnecessary visits and reduce the overall burden on the healthcare system. The system is even more helpful for those working in remote locations, irregular working hours, having mobility restrictions and those who cannot afford additional medical bills.³¹ Another limitation can be the constraint of categories questioned. The present study consisted of common myopia questions (general summary, cause, symptom, onset, prevention, complication, natural history, treatment and prognosis) and is not all pervasive. For example, it lacks questioning on areas of the 'inheritance pattern of myopia' or the 'effect of screentime on myopia' (although risk factor is included). Finally, AI assistants pose ethical concerns,³² such as a lack of transparency on training and testing data used, data bias, data abuse, unreliable fact checking and others that need to be addressed prior to its implementation.³³ Little is known about the content creation, its origin and weightage towards any industry or entity (potential source of bias).

While this cross-sectional study has demonstrated encouraging results in the use of AI assistants for common patient questions on myopia, further investigation on their potential effect in clinical settings is relevant before any definitive conclusions can be made regarding ChatGPT. With the rising global prevalence of myopia, both the vision impairment resulting from uncorrected myopia and the vision loss due to pathological changes associated with myopia are expected to rise.³⁴ Eye care practitioners may not be readily available, and their services are expensive and time consuming. Whereas chatbots are a click away on

the internet, with huge attention and popularity among the global community. AI may be the tool for the future, and this is an opportunity to understand the utility of AI in interacting with patients and providing valuable information on eye diseases. Despite the limitations of this study and that of ChatGPT, AI holds the promise to lower the cost of healthcare by reducing consultation time and provide valuable patient information.⁹ This may reduce the patient load from the already burdened healthcare and eye care systems worldwide by enhancing patient information, thus refining the workflow and improving patient outcomes.

AUTHOR CONTRIBUTIONS

Sayantana Biswas: Conceptualization (lead); data curation (lead); formal analysis (lead); investigation (equal); methodology (equal); project administration (equal); resources (equal); software (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal). **Nicola S. Logan:** Data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal). **Leon N. Davies:** Data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); supervision (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal). **Amy L. Sheppard:** Data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); supervision (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal). **James S. Wolffsohn:** Data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); project administration (equal); supervision (equal); validation (equal); visualization (equal); writing – original draft (equal); writing – review and editing (equal).

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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