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# CAN ARTIFICIAL INTELLIGENCE EFFECTIVELY RESPOND TO FREQUENTLY ASKED QUESTIONS ABOUT FLUORIDE USAGE AND EFFECTS? A QUALITATIVE STUDY ON CHATGPT

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**ABSTRACT:** *Objectives:* **The frequently asked questions about fluoride, as determined by the American Dental Association (ADA), were asked to Generative Pre-trained Transformer (ChatGPT) and the answers were qualitatively compared with those of the ADA.**

*Methods:* **Questions were posed to ChatGPT on May 8th and 16th, 2023, and the responses were recorded. The answers from the ADA webpage were also recorded. The responses were compared for similarity in word and meaning, both within ChatGPT's responses over a one-week interval and between ChatGPT's responses and ADA's responses.**

*Results:* **While the responses provided by ChatGPT with a one-week interval had similar information content, in the comparison made with the ADA, ChatGPT provided more detailed and scientific answers. However, both shared the same central idea about fluoride and its role in oral health.**

*Conclusions:* **The accuracy and reliability of the answers given by the applications developed with artificial intelligence (AI) are of great importance, and it has been seen that the answers given by ChatGPT to the questions asked about fluoride are sufficient and reliable.**

*Clinical Relevance:* **Advancements in technology, particularly in artificial intelligence, enable individuals to access accurate and reliable information about a topic quickly and in appropriate ways.**

Keywords: Artificial Intelligence; Fluoride; Health Informatics; Public Health.

## INTRODUCTION

Artificial Intelligence (AI) encompasses Large Language Models (LLMs), which replicate the capability of humans to comprehend written text. Language models are developed using deep learning algorithms that employ massive quantities of textual data collected from diverse sources like books, articles, and websites. Through the analysis of patterns and connections in the input data, language models learn to anticipate the occurrence of specific words or phrases in a particular context. The latest addition to the category of LLMs is Chat Generative Pre-trained Transformer (ChatGPT).[1] Utilizing deep learning techniques, ChatGPT has been trained on copious amounts of data to generate responses to user inquiries that closely resemble human-like language. This model consists of 175 billion parameters.[2] Designed to function as a dialog agent for multiple purposes, ChatGPT can provide responses on a vast range of topics. The effectiveness of ChatGPT in challenging real-life situations and scenarios, particularly in areas that demand high levels of complex thinking such as medicine, remains uncertain, despite its remarkable performance in generating

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responses.[3] Possibly introducing a new era of models that can enhance the representation of the amalgamation of clinical knowledge and conversation-based interaction, ChatGPT may be the pioneer. As a simulated physician or patient, ChatGPT's response-generating interface, driven by narratives, has the potential to offer significant benefits. As a means of achieving personalized patient interaction and educating consumers on health-related issues, LLMs have been under investigation in the medical industry.[4,5] Although demonstrating promise, these models have not yet been entirely successful in assessing clinical knowledge by means of question-answering tasks.[6,7] According to a different study, promoting awareness and education regarding the proper utilization and concealed risks of LLMs based on artificial intelligence in the medical field is crucial.[8]

Dental fluoride research has been going on for over 100 years.[9] For the prevention of dental caries, both topical and systemic applications of fluoride have become prevalent public health measures that are utilized worldwide, given their effectiveness. Fluoride can be integrated into dental tissues formed during the development of teeth via systemic applications such as fluoridated water, milk, salt, tablets, drops, or lozenges. In addition, systemic fluorides can act as a fluorine reservoir in saliva, which may offer some topical protection for teeth that have erupted.[10] Enamel demineralization can be reduced, and remineralization can be promoted by topical fluoride applications, such as fluoride toothpaste, mouthwashes, polishes, gels, foams, and slow-release fluoride devices. This, in turn, can inhibit bacterial metabolism in dental plaques.[11] Dentists have been utilizing topical fluorides for a considerable amount of time now as a regular procedure to prevent dental caries. Despite the benefits, excessive exposure to flora can have adverse effects on teeth and overall health.[12,13] Therefore, patients are confused about the amount of fluoride that is considered safe to use. In addition, the addition of this mineral to food, hygiene products, and water sources raises doubts. In particular, anti-fluoridation information is widely shared on social media, misleading people about the benefits of fluoride.[14] In parallel, the denial of fluoride practices observed in dental practices is a phenomenon likely created or reinforced by misinformation created and disseminated on social media.[15,16]

In order to prevent the spread of false information on the subject and for the public to receive correct information on this subject, dentistry and public health institutions provide great benefits by informing by answering the questions frequently asked by patients. There is no research in the literature evaluating the answers of ChatGPT to the questions frequently asked by patients about fluoride. The aim of this study is to ask the frequently asked questions about fluoride, as determined by the American Dental Association (ADA), to ChatGPT and to compare the content and information level of the answers given by the application with the answers of the ADA, qualitatively.

## MATERIALS AND METHODS

A new email address was established for registering on the ChatGPT app, with the purpose of avoiding any impact from search algorithms. The ChatGPT app was accessed via Google's (Google Inc., California, United States of America) search engine query entry. Prior to the question-and-answer (Q&A) session, all search history and cookies were cleared from the computer. As part of the research, 8

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questions from the frequently asked questions section of the ADA webpage were selected and analyzed.[17] On May 8th and May 16th, 2023, the same questions were asked uninterruptedly and in the same order within a single text message, to the publicly available ChatGPT app, and the first answers were recorded.[18] At the same time, the answers on the ADA web page are also recorded and listed. The similarity of the responses given to the same questions with a one-week interval, as well as the similarity of these responses to the ADA responses in terms of word and meaning, was also investigated by conducting a dialogue through ChatGPT in the same manner. Ethical approval is not required as the study was conducted on publicly available internet data.

## RESULTS

The ChatGPT was used to obtain the following answer for the similarity of questions asked with a one-week interval and the similarity of the answers provided in terms of both meaning and word usage:

*"The two texts are very similar in terms of both words and meaning. They both provide information on what fluoride is, where it is found, and how it helps prevent tooth decay. They also both discuss how excessive exposure to fluoride can lead to dental fluorosis, a condition that can cause white spots or streaks on teeth, and skeletal fluorosis in rare cases. Both texts also emphasize the importance of using fluoride products as directed and supervising young children when they brush their teeth to prevent excessive ingestion of fluoride. The main difference between the two texts is that the second one* (second Q&A period) *provides more detail on how fluoride works to strengthen tooth enamel and how it is absorbed into the bloodstream and incorporated into developing teeth and bones. Overall, the two texts are highly consistent in their descriptions of fluoride and its effects on dental health."*

When comparing the responses given by ChatGPT and ADA during the first Q&A period, the answer provided by the application was as follows:

"*The two texts are similar in terms of meaning as they both discuss fluoride and its role in preventing tooth decay. They also mention the natural occurrence of fluoride in water sources and its addition to dental products like toothpaste. However, the second text* (ChatGPT) *provides more detail about the chemical nature of fluoride, how it is absorbed and incorporated into teeth and bones, and the potential risks of excessive ingestion. Overall, the second text is more detailed and scientific than the first, but they both share the same central idea about fluoride and its role in oral health."*

In the first Q&A session, the answers provided by ChatGPT are listed below. The ADA's answers are shared at the link provided on the web.

(https://www.ada.org/resources/community-initiatives/fluoride-in-water/fluoridation-faqs)

ChatGPT's Responses to 8 Selected Questions From The Frequently Asked Questions About Fluoride As Determined By The American Dental Association.

1.How does fluoride protect teeth? (Table 1)

2.Is water fluoridation safe? How effective is it in preventing cavities? (Table 2)

3.How can I get the benefits of fluoride and minimize the risk of fluorosis for my child? (Table 3)

4.What are the benefits of fluoridated water? (Table 4)

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5.What are the benefits of fluoride toothpaste? (Table 5)

6.Should children use fluoride toothpaste? (Table 6)

7.What are the benefits of fluoride mouthrinse? (Table 7)

8.What are the benefits of dietary fluoride supplements? (Table 8)

**Table 1.** Responses to Question 1 by ChatGPT and ADA

| Question 1: How does fluoride protect teeth? |
|---|
| ChatGPT's response |
| "Fluoride helps to protect teeth by strengthening the enamel, which is the hard, outer layer of the teeth that protects the more vulnerable inner layers.When fluoride is present in the mouth, it reacts with the calcium and phosphate ions in the saliva to form a protective layer on the teeth. This layer is called fluorapatite, and it makes the enamel more resistant to acid attacks from the bacteria that live in dental plaque. Acid attacks occur when the bacteria in dental plaque break down sugars and produce acid. This acid can erode the enamel, leading to tooth decay. However, if the enamel has been strengthened by fluoride, it is better able to withstand these acid attacks.<br><br>In addition to strengthening the enamel, fluoride can also help to repair early stages of tooth decay by remineralizing the damaged enamel. This means that fluoride can actually reverse early stages of tooth decay, before a cavity has formed. Overall, fluoride is an important tool in preventing tooth decay and promoting good dental health." |
| ADA Information |
| "Fluoride benefits both children and adults. Here's how:<br><br>Before teeth break through the gums (erupt), the fluoride taken in from foods, beverages and dietary supplements makes tooth enamel (the hard surface of the tooth) stronger, making it easier to resist tooth decay. This provides what is called a "systemic" benefit.<br><br>After teeth erupt, fluoride helps rebuild (remineralize) weakened tooth enamel and reverses early signs of tooth decay. When you brush your teeth with fluoride toothpaste, or use other fluoride dental products, the fluoride is applied to the surface of your teeth. This provides what is called a "topical" benefit.<br><br>In addition, the fluoride you take in from foods and beverages continues to provide a topical benefit because it becomes part of your saliva, constantly bathing the teeth with tiny amounts of fluoride that help rebuild weakened tooth enamel." |

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**Table 2.** Responses to Question 2 by ChatGPT and ADA

| Question 2: Is water fluoridation safe?; How effective is it in preventing cavities? |
|---|
| ChatGPT's response |
| "Water fluoridation is considered safe and effective when fluoride levels are maintained within the recommended range. The optimal level of fluoride in drinking water is 0.7 to 1.2 parts per million (ppm), which has been shown to be effective in reducing the incidence of tooth decay by 20-40%.<br><br>Numerous studies have shown that water fluoridation is a safe and effective way to improve dental health. The CDC considers water fluoridation to be one of the top 10 public health achievements of the 20th century.<br><br>However, like any public health intervention, water fluoridation is not without controversy. Some people have raised concerns about the safety and ethics of water fluoridation. However, these concerns have largely been debunked by scientific research and expert panels.<br><br>The benefits of water fluoridation are well-established. According to the CDC, fluoridation of water supplies has been shown to:<br><br>• reduce tooth decay by 25% in children and adults<br><br>• save money by reducing the need for costly dental treatments<br><br>• benefit people of all ages, races, and socioeconomic backgrounds<br><br>Overall, water fluoridation is considered a safe and effective way to prevent tooth decay and improve dental health, provided that fluoride levels are maintained within the recommended range." |
| ADA Information |
| "Water fluoridation is safe, effective and healthy. Seventy years of research, thousands of studies and the experience of more than 210 million Americans tell us that water fluoridation is effective in preventing cavities and is safe for children and adults." |

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**Table 3.** Responses to Question 3 by ChatGPT and ADA

| Question 3: How can I get the benefits of fluoride and minimize the risk of fluorosis for my child? |
|---|
| ChatGPT's response |
| "Getting the benefits of fluoride while minimizing the risk of fluorosis for your child involves finding the right balance of fluoride intake. Here are some tips to help you achieve this:<br>1. Use fluoride toothpaste in the right amount: Use a pea-sized amount of fluoride toothpaste for children under six years old, and a slightly larger amount for children aged 6-12 years. This will help ensure that they are getting enough fluoride to protect their teeth from decay, while minimizing the risk of fluorosis.<br>2. Avoid swallowing toothpaste: Teach your child to spit out the toothpaste after brushing, and supervise them to ensure that they do not swallow any of it.<br>3. Limit other sources of fluoride: Be aware of other sources of fluoride that your child may be exposed to, such as fluoride supplements or certain foods and beverages. Speak to your child's dentist about the appropriate level of fluoride intake for your child, based on their age and risk of developing fluorosis.<br>4. Use optimally fluoridated water: If your community water supply is fluoridated, encourage your child to drink tap water to benefit from the fluoride. If your water supply is not fluoridated, consider using fluoridated bottled water for drinking and cooking.<br>5. Consider dental sealants: Dental sealants are a protective coating that can be applied to the chewing surfaces of back teeth to prevent tooth decay. This can help reduce the need for fluoride treatments, which can increase the risk of fluorosis.<br>Overall, the key is to find the right balance of fluoride intake to benefit your child's dental health while minimizing the risk of fluorosis. Working with your child's dentist and following their recommendations can help you achieve this balance." |
| ADA Information |
| "Getting the right amount of fluoride is best-not too much and not too little. Your dentist, pediatrician or family physician can help you determine the proper amount of fluoride for your child." |

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**Table 4.** Responses to Question 4 by ChatGPT and ADA

| Question 4: What are the benefits of fluoridated water? |
|---|
| ChatGPT's response |
| "Fluoridated water has several benefits for dental health, including:<br>1. Prevention of tooth decay: Fluoride helps to strengthen tooth enamel and make it more resistant to decay. Drinking fluoridated water can reduce the incidence of tooth decay in both children and adults.<br>2. Cost-effectiveness: Water fluoridation is a cost-effective way to prevent tooth decay. It is estimated that every $1 spent on water fluoridation saves $38 in dental treatment costs.<br>3. Equitable distribution: Water fluoridation provides a community-wide benefit to all residents, regardless of age, income, or access to dental care. It is a simple and effective way to improve oral health equity.<br>4. Safety: Water fluoridation has been extensively studied and is considered safe and effective in preventing tooth decay. It is endorsed by major public health organizations, including the WHO, ADA, and the CDC.<br>5. Lifetime benefits: Drinking fluoridated water during childhood can lead to a lifetime of improved oral health. The benefits of water fluoridation are long-lasting and can help prevent tooth decay and other oral health problems throughout a person's life.<br>Overall, fluoridated water is a safe and effective way to improve dental health and prevent tooth decay in the community." |
| ADA Information |
| "Fluoridated water helps prevent tooth decay in children and adults. Studies prove water fluoridation continues to be effective in reducing tooth decay by at least 25% in children and adults, even in the of era widespread availability of fluoride from other sources, such as fluoride toothpaste. Simply by drinking water, people can benefit from fluoridation's cavity protection whether they are at home, work or school.<br>Because of its role in the prevention of tooth decay, the CDC has proclaimed community water fluoridation as one of ten great public health achievements of the 20th century." |

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**Table 5.** Responses to Question 5 by ChatGPT and ADA

| Question 5: What are the benefits of fluoride toothpaste? |
|---|
| ChatGPT's response |
| "Fluoride toothpaste has several benefits for dental health, including:<br>1.Prevention of tooth decay: Fluoride helps to strengthen tooth enamel and make it more resistant to decay. Brushing with fluoride toothpaste can reduce the incidence of tooth decay in both children and adults.<br>2.Reversal of early tooth decay: Fluoride can also help to reverse early stages of tooth decay, known as "white spots," by remineralizing the enamel.<br>3.Reduced sensitivity: Fluoride can help to reduce tooth sensitivity by strengthening the enamel and blocking the tiny tubules in the dentin that transmit sensations to the nerve.<br>4.Cost-effectiveness: Using fluoride toothpaste is a cost-effective way to prevent tooth decay and reduce the need for costly dental treatments.<br>5.Easy to use: Fluoride toothpaste is widely available and easy to use. It can be incorporated into daily oral hygiene routines without any additional effort or expense.<br>Overall, fluoride toothpaste is a safe and effective way to improve dental health and prevent tooth decay. Brushing with fluoride toothpaste twice a day, in combination with other oral hygiene practices such as flossing and regular dental check-ups, can help to maintain healthy teeth and gums throughout a person's life." |
| ADA Information |
| "All toothpaste helps remove plaque, a film of bacteria that forms on teeth and gums every day. Plaque can cause gum disease and tooth decay. In addition to helping remove plaque, fluoride toothpaste provides an extra benefit in preventing tooth decay by making tooth enamel stronger." |

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**Table 6.** Responses to Question 6 by ChatGPT and ADA

| Question 6: Should children use fluoride toothpaste? |
|---|
| ChatGPT's response |
| "Yes, children should use fluoride toothpaste. ADA recommends that children use fluoride toothpaste as soon as their first tooth appears. For children under the age of 3, parents should use a smear of fluoride toothpaste no larger than a grain of rice. For children between the ages of 3 and 6, parents should use a pea-sized amount of fluoride toothpaste.<br><br>Fluoride helps to strengthen tooth enamel and make it more resistant to decay. Using fluoride toothpaste can reduce the incidence of tooth decay in both children and adults. However, it's important to use the right amount of fluoride toothpaste and supervise children when they brush their teeth to ensure they don't swallow the toothpaste.<br><br>Fluoride toothpaste is a safe and effective way to improve dental health and prevent tooth decay in children. However, if you have concerns about fluoride intake or your child is at a higher risk of developing fluorosis, speak to your child's dentist to determine the best course of action for your child's oral health." |
| ADA Information |
| "For children younger than 3 years, parents and caregivers should begin brushing children's teeth as soon as they begin to come into the mouth by using fluoride toothpaste in an amount no more than a smear or the size of a grain of rice.<br><br>For children 3 to 6 years of age, parents and caregivers should dispense no more than a pea-sized amount of fluoride toothpaste.<br><br>Teeth should be brushed thoroughly twice a day (morning and night) or as directed by a dentist or physician. Children's brushing should be supervised to ensure that they use the appropriate amount of toothpaste." |

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**Table 7.** Responses to Question 7 by ChatGPT and ADA

| Question 7: What are the benefits of fluoride mouthrinse? |
| --- |
| ChatGPT's response |
| "Fluoride mouthrinse has several benefits for dental health, including:<br>1.Prevention of tooth decay: Fluoride helps to strengthen tooth enamel and make it more resistant to decay. Using fluoride mouthrinse can reduce the incidence of tooth decay in both children and adults.<br>2.Reversal of early tooth decay: Fluoride can also help to reverse early stages of tooth decay, known as "white spots," by remineralizing the enamel.<br>3.Reduced sensitivity: Fluoride can help to reduce tooth sensitivity by strengthening the enamel and blocking the tiny tubules in the dentin that transmit sensations to the nerve.<br>4.Easy to use: Fluoride mouthrinse is widely available and easy to use. It can be incorporated into daily oral hygiene routines without any additional effort or expense.<br>5.Accessible: Fluoride mouthrinse is accessible to everyone and is an affordable option to maintain good oral health.<br>Overall, fluoride mouthrinse is a safe and effective way to improve dental health and prevent tooth decay. It can be used in conjunction with other oral hygiene practices such as brushing and flossing to maintain healthy teeth and gums. However, it's important to follow the instructions on the label and not to swallow the mouthrinse. If you have concerns about fluoride intake or your oral health, speak to your dentist to determine the best course of action for your oral health." |
| ADA Information |
| "A mouthrinse with fluoride helps reduce tooth decay by making teeth more resistant to decay. Unless you are advised to do so by a dentist or other health professional, the ADA does not recommend the use of fluoride mouthrinses for children younger than six years old. Many children younger than six have not yet fully developed their swallowing reflex and may be more likely to swallow fluoride mouthrinse rather than spitting it out." |

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**Table 8.** Responses to Question 8 by ChatGPT and ADA

| Question 8: What are the benefits of dietary fluoride supplements? |
|---|
| ChatGPT's response |
| "Dietary fluoride supplements are not recommended for routine use and are only prescribed by a dentist or healthcare provider for individuals who live in areas with low levels of fluoride in the water and who are at high risk of tooth decay. ADA recommends that fluoride supplements be prescribed for children who are at least 6 months old and whose primary source of drinking water contains less than 0.3 ppm (parts per million) of fluoride.<br>The benefits of dietary fluoride supplements are:<br>1. Prevention of tooth decay: Fluoride helps to strengthen tooth enamel and make it more resistant to decay. Taking fluoride supplements can reduce the incidence of tooth decay in both children and adults.<br>2. Reversal of early tooth decay: Fluoride can also help to reverse early stages of tooth decay, known as "white spots," by remineralizing the enamel.<br>3. Reduction of dental treatment costs: Taking fluoride supplements can reduce the need for costly dental treatments such as fillings and extractions.<br>However, it's important to note that taking too much fluoride can lead to dental fluorosis, a condition that affects the appearance of teeth. Therefore, it's essential to follow the recommended dosage and frequency of fluoride supplements prescribed by a dentist or healthcare provider.<br>In summary, fluoride supplements are only recommended for individuals who live in areas with low levels of fluoride in the water and who are at high risk of tooth decay. When taken correctly, fluoride supplements can help to prevent tooth decay and reduce dental treatment costs". |
| ADA Information |
| "Dietary fluoride supplements can be as effective in preventing tooth decay as water fluoridation. With supplements, fluoride is incorporated into the tooth during its formation making the tooth more resistant to decay. In addition, supplements provide a topical benefit as teeth are bathed in fluoride while the lozenges or tablets are chewed. Once the fluoride is absorbed, it will be present in the saliva which delivers fluoride to the tooth surface to help repair the enamel.<br>Dietary fluoride supplements should be prescribed only for children living in areas without optimal levels of fluoride in their community drinking water and who are at high risk of developing cavities. Talk to your dentist, pediatrician or family physician about your child's specific fluoride needs." |

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**Table 8 continued.** Responses to Question 8 by ChatGPT and ADA

| Question 8: What are the benefits of dietary fluoride supplements? |
|---|
| ADA information (continued) |
| Note: The ADA's dietary fluoride supplement recommendations remain unchanged in light of the new guidelines for community water fluoridation in the U.S. released in April 2015 by the U.S. Public Health Service. The recommendation for fluoride levels in drinking water is newly calibrated at 0.7 milligrams of fluoride per liter of water. The new recommendation, which was supported by the ADA, does not change the ADA Council on Scientific Affairs' systematic review and clinical recommendation for the use of dietary fluoride supplements that was released in 2010." |

## DISCUSSION

The term AI, which emerged in the 1950s and is increasingly used today, basically describes the idea of producing machines that can perform tasks performed by humans. The development of AI and machine learning, especially in the last decade, raises questions about the future of this subject. The text outputs of AI-based natural language models are so professional and believable that readers cannot tell if the answers were given by humans or machines. As a result, today, it is seen that AI technologies in every field, from politics to health, from sociology to economy, have turned from a dream or a fantasy into a reality.[19]

Chatbot software, developed with AI technologies such as machine learning and natural language processing, is an advanced application that can communicate with people or respond to questions asked by people.[20] These applications, which are designed and developed as a user interface, are used in practical applications in the global system for mobile communications operators, banks, post offices, shipping companies, hospitals, and many other sectors. In the healthcare industry, it is highly demanded, especially by patients who demand access to information in a short time.[21] For this reason, although their use has become increasingly widespread today, it is a fact that professional patient-physician relationships and communication do not replace them. On the other hand, people's expectations from these applications are not always based on disease.[22] They can also be preferred and requested to reach information about a product, a method, or a health professional’s information used in the field of health. In this context, the existence of chatbot applications that respond to people’s questions in a reliable, accurate, fast, and economical way is of great importance in the context of the developing technological world.

Topical fluoride applications, together with community-based applications, are approaches accepted as the gold standard in the prevention of dental caries. Topical fluoride applied individually and professionally prevents demineralization and

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contributes to remineralization. On the other hand, systemic exposure to high doses of fluoride, both acutely and chronically, can cause toxicity. Acute fluoride toxicity manifests itself with a picture that can lead to death as a result of the mixing of high amounts of fluoride into the circulatory system in a short time.[23] Chronic fluoride toxicity is frequently seen in individuals living in areas with high levels of fluoride in groundwater and drinking water and basically has two findings: skeletal and dental fluorosis.[24,25] Some of the largest fluoro-mineral deposits are found in China, Mexico, Mongolia, South Africa, and Russia; this is strongly associated with areas whose populations suffer from endemic fluoride toxicity.[26] Again, although some studies conducted in these countries aiming to evaluate the relationship between fluoride intake and neurodevelopment show that fluoride intake has negative effects on cognitive and neural development, the methodology of these studies is insufficient.[27] However, these studies have contributed to the strengthening of the worldwide anti-fluoride lobby since the day they were published. It is increasingly emphasized that fluoride taken at the appropriate dose and time by organizations and institutions whose scientific validity has been proven worldwide does not have a negative effect on the neural and cognitive development of the individual. The most important methodological error of these criticized studies is that they were made with individuals who were already exposed to excessive amounts of fluoride from nature, and they did not evaluate the effects of many possible factors that may have an effect on cognitive and neural development.[27] Finally, in the study of Do et al., published in 2023, in which they evaluated the effect of water fluoridation on cognitive, emotional, and behavioral development on a population-based and longitudinal basis, researchers clearly state the following: Exposure to fluoridated water during the first five years of life was not associated with altered measures of child emotional and behavioral development and executive functioning.[28] All these studies have caused individuals to be divided into two groups about fluoride around the world: those who believe that topical fluoride applications protect from tooth decay in the light of scientific developments and that there is no harm when applied in the appropriate dose and time for children, and the anti-fluoride lobby. In this context, it is of great importance that individuals are enlightened in line with scientific information about the use of fluoride, especially in the last decade. Moreover, during our clinical experience, we noticed that the questions of individuals on this subject have increased in recent years.

In line with both the developments in technology and the increase in research on fluoride, it is of great importance for individuals to reach the right information in a short time and effectively. Although many online and offline applications developed in this regard are helpful, the validity and reliability of each application must be tested. ChatGPT is an application that was released towards the end of 2022, and studies on its validity and reliability continue. To the best of our knowledge, our study is the first in the scientific literature to evaluate ChatGPT responses to fluoride usage and effects. Limited studies have been conducted in the field of dentistry, and most of them are related to dental education.[29,30] In a study evaluating the usability of the information produced by ChatGPT in the field of maxillofacial surgery, the quality of patient and educational information was measured, and as a result, it was reported that ChatGPT has significant potential in this field. On the other hand, concerns were expressed about the reliability of using the application for training,

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and it was emphasized that such applications should be used in addition to clinical knowledge and experience.[31] In a study evaluating ChatGPT responses in total joint arthroplasty, the authors evaluated the effectiveness of the application on frequently asked questions, just as in our study, and expressed concerns about heterogeneity, although they reported that the answers were sufficient.[32] In parallel, in our study, ChatGPT's answers to frequently asked questions about fluoride on the ADA website were similar and consistent with the ADA's answers. In fact, ChatGPT's answers to some questions are more comprehensive than ADA's answers. On the other hand, the heterogeneity of responses will continue to exist as one of the main limitations of AI applications. Moreover, since ChatGPT has limited knowledge of scientific developments that occurred after September 2021, it can provide incomplete and misleading information in response to current questions, which is another significant limitation.

## CONCLUSIONS

We believe that the findings of our study, in which the official answers to the questions people frequently ask about fluoride were compared with the ChatGPT answers and it was observed that the ChatGPT answers were sufficient and comprehensive, will shed light on many studies to be done on this subject. Developments in technology, and especially in AI, lead individuals to reach accurate and reliable information in a short time in appropriate ways. Many AI applications developed in this direction serve humanity, and it is clear that they will continue to do so. The accuracy and reliability of the answers given by the applications developed with AI are of great importance, and it has been seen that the answers given by ChatGPT to the questions asked about fluoride are sufficient and reliable.

## AUTHOR CONTRIBUTIONS DECLARATION

M.B. and B.S. designed the study; M.B. collected the data; M.B. and B.S. evaluated the data; M.B. and B.S. drafted the manuscript, and all authors critically appraised and revised the manuscript. All authors read and approved the final manuscript.

## ETHICS APPROVAL

Ethics approval was not required for this study.

## CONSENT TO PARTICIPATE

Not Applicable.

## FUNDING

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## CONFLICT OF INTERESTS

The authors declare no competing interests.

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