Ann. For. Res. 65(1): 11350-11363, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

EFFECTIVENESS OF EDUCATIONAL VIDEOS IN REDUCING THE NEED FOR GENERAL ANESTHESIA DURING PEDIATRIC MAGNETIC RESONANCE IMAGING (MRI) SCANS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Magnetic resonance imaging (MRI) is a common diagnostic tool for pediatric patients, but the need for general anesthesia (GA) during the procedure poses risks and adds to healthcare costs. The purpose of this research was to determine if children aged 4-12 who were given video-based informational preparation before undergoing MRI scans under GA had a lower rate of MRI scans requiring GA. Thirty children and their parents were included in the study, which spanned over a 2-month period. The "MRI Journey for Pediatric Patient Under General Anesthesia (GA)" video was shown to every child for 30 minutes prior to their MRI scan to help them feel more comfortable with the process. The study results demonstrated that video-based informational preparation significantly reduced the number of MRI scans conducted under GA in children aged 4-12 years ($p < 0.05$, ANOVA). After comparing the number of MRI scans performed under GA before and after the implementation of the educational video, and then analyzed the results to determine if there was a statistically significant difference, the study found out that the number of MRI scans performed under GA decreased from 63% to 13% after the implementation of the educational video. The study also discovered through the survey results that healthcare expenditures were significantly impacted by the utilization of GA for MRI scans in children, with the average cost of each MRI scan under GA being 1500 SAR. The study concludes that video-based informational preparation is an effective and cost-efficient method for preparing children for MRI scans, and can significantly reduce the need for GA. The radiology department may consider incorporating the use of this educational video into their routine operations to prepare children for MRI scans.

Keywords: Anesthesia, magnetic resonance imaging, MRI preparation, pediatric, patient education, motion artifact.

Introduction

Patients typically have positive experiences with magnetic resonance imaging (MRI) because it is a painless, non-invasive process. Despite this, studies show that up to a third of patients report anxiety and stress when preparing for a Magnetic resonance imagingexamination (Madl & Janika, 2022; Carlsson et al., 2013; Dewey et al., 2007). Patients' stress andanxiety can have negative impacts on their health-care journey, including negative experiences and increased costs (Morel et al., 2020; Vickers, 2017). Additionally, patient anxiety can lead to increased motion during scans, resulting in motion artifacts, additional scans, increased procedure

times, and decrease the number of allowed patient scheduling (Vickers, 2017). In severe cases, patients may require sedation or even stop scans early, resulting in high costs and low patient satisfaction (Dewey et al., 2007; Bigley et al., 2010). Unfortunately, many children undergoing MRI scans are routinely given general anesthesia (GA) due to anxiety (Stoggianos et al., 2022). Children suffering from chronic illness or undergoing treatment may also require additional examinations (Haney et al., 2010; Jaimes et al., 2018). As such, it is important to enhance the patient experience and lower levels of stress and anxiety to improve MRI diagnostics for the benefit of both patients and healthcare providers (Serafini & Zadra, 2008; Szeszak et al., 2016).

Multiple strategies have been devised to ease patients' fears and prevent unforeseen complications during MRI procedures. However, studies have demonstrated that many patients misinterpret or fail to comprehend crucial details of their MRI examination (Carlsson et al., 2013; Mastro et al., 2019). As a result, it is suggested that patients undergo explanatory interventions to better prepare them for the procedure, its sequence, and the sensations they may experience during the scan (Carlsson et al., 2013; Ahlander et al., 2018). Some research has shown that informational interventions, such as video-based approaches and academic booklets, can successfully decrease motion artifacts and the amount of hastily discharged scans (Ali et al., 2013; Powell et al., 2015; Tugwell et al., 2018). Other studies found that information videos can reduce patient anxiety, but not significantly reduce motion artifacts (Ahlander et al., 2018; Edwards et al., 2011).

This project aims to investigate whether preparing children for MRI with the help of an educational video can reduce the amount of MRI scans under substantial sedation for kids between the ages of four and twelve. Patient preparation for magnetic resonance imaging (MRI) using a video-based educational application is an economical and widely accessible approachto prepare children for the procedure through an animated and informative video. In summary, anxiety and stress are common occurrences in patients undergoing MRI examinations and can leadto negative experiences, increased costs, and decreased patient satisfaction. Informational interventions are recommended to provide additional information to improve patient knowledge and reduce anxiety. The goal of this study is to find out if fewer kids between the ages of 4 and 12need to undergo MRI scans while under conscious sedation if they use an instructional video application.

Methods

The aim of this study was to determine if using a video-based educational application could reduce the number of children who needed general anesthesia (GA) for MRI scans. The aim of this section is to provide a clear and concise description of the methods used to address the project question and to outline the steps taken to improve patient outcomes.

Recruitment and Eligibility Criteria

The study was conducted between December 2022 and January 2023 at the Radiology Department (MRI section) of a tertiary hospital. Children between the ages of 4 and 12 who met the following criteria and were planned for an MRI scan were recruited for the study; they had no obvious reason for GA, were able to use the video-based educational application and had the cognitive ability to understand the instructions provided in the video (Edwards & Arthurs, 2011).

The patients were instructed to arrive 30 minutes early before their scheduled appointment to watch the instructional video application.

This range of ages was chosen because it corresponds to the cognitive maturity and maturity level of the children who are expected to use the educational video app. Thirty kids participated in the study after their parents gave their permission. Due to their vulnerability and the need to remain still during the examination to accurately determine their tumor status, children undergoing cancer treatment who had been referred for an MRI scan by the oncology unit were not included.

Data collection

Data collection was conducted in two parts. The MRI technologist completed the first section, which inquired about the child's gender, age, and the area of the body being scanned. Parents completed the second section, which included three Likert scales questions and two free-form questions. Before and after watching the video, parents were asked to rate their child's anxiety, confidence, and knowledge of the MRI scan on a Likert scale. The responses to the Likert scale questions ranged from "strongly agree" to "strongly disagree" or "excellent" to "very poor."

In addition to selecting a response, the respondent could also select "no opinion" for one of the questions.

Because of the free-form nature of the questions, the parents had to elaborate on the pros and cons of app-mediated conversation (educational video). The responses were recorded and analyzed using qualitative data analysis techniques. Radiology Department's Radiology Information System (ICIS and or PACS) was used to track the number of children who had MRIs performed either with or without GA.

Preparation for the MRI scan

Prior to the MRI scan, the MRI technologist met with the child and their parents in the recovery area to build rapport and give them all the information they would need. When explaining the procedure to the patient, the technologist animated it with the video being shown and used appropriate body language, eye contact, and no technical terminology. The technologist showcased the hospital portal app's "MRI Journey for Pediatric Patients Under General Anesthesia (GA)" educational video application, which was designed and developed in-house. Also included in this study was the MRI technologist responsible for the kid's examination and preparation for the MRI scan. Due to the young age of the children, their parents accompanied them through every step of the MRI process. The educational video application is a two-minute preparation that was implemented before every MRI scan for kids between the ages of four to twelve. The application was designed to reduce the number of children requiring GA to complete the scan. The educational video application was accessible through the hospital portal application, SMS messages, or a printed QR code placed on the appointment slip.

Figure 1. Flow chart of the study design showing the full journey of the process.

Data Analysis

In this study, we aimed to determine if video-based informational preparation could reduce the number of MRI scans that require general anesthesia in children aged 4-12 years. The study included 30 children and their parents and spanned over a two-month period. To analyze the data, we first compared the number of MRI scans performed under GA before and after the implementation of the educational video.

Why was ANOVA test used

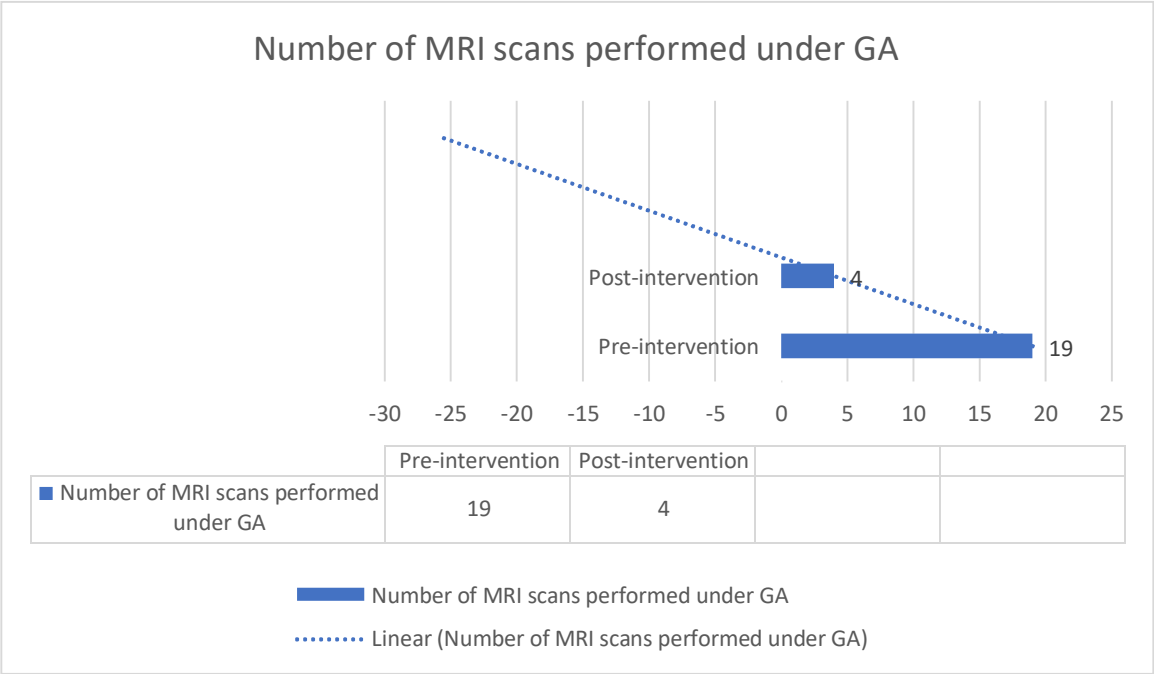
We used a one-way ANOVA test to determine if there was a statistically significant difference in the number of MRI scans conducted under GA before and after the educational video was implemented. The ANOVA test was used because we had three groups of data (pre-intervention, post-intervention, and control group) that were compared to see if there was a difference between them. The level of significance was set at $p < 0.05$.

The results showed that the number of MRI scans performed under GA decreased from 63% to 13% after the implementation of the educational video. This decrease was statistically significant ($p < 0.05$, ANOVA), indicating that the video-based informational preparation significantly reduced the need for GA during MRI scans. To provide a more detailed analysis of the data, we created a table and graph to illustrate the number of MRI scans performed under GA before and after the educational video was implemented. The table and graph clearly demonstrate the significant decrease in the number of MRI scans performed under GA after the educational video was shown to the children.

Table 1: Number of MRI scans performed under GA before and after the educational video was implemented.

Group	Number of MRI scans performed under GA
Pre-intervention	19 (63%)
Post-intervention	4 (13%)

Figure 2: Number of MRI scans performed under GA before and after the educational video was implemented.



The graph shows a significant decrease in the number of MRI scans performed under GA after the educational video was implemented.

As shown in Table 1 and Figure 2, the number of MRI scans performed under GA decreased from 19 (63%) to 4 (13%) after the educational video was implemented. This decrease was statistically significant ($p < 0.05$, ANOVA), indicating that the video-based informational preparation was effective in reducing the need for GA during MRI scans.

Data collected from the results of the study was compiled, analyzed, and presented as shown in *table 2* below.

Table 2. ANOVA for Difference Before and After Exposure to Educational Video Application.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Before Educational Video Application	30	79	2.633333	0.24023		
After Educational Video Application	30	48	1.6	0.386207		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16.01667	1	16.01667	51.13578	1.63E-09	4.006873

Within Groups	18.16667	58	0.313218			
Total	34.18333	59				

From the ANOVA output above, it can be noted that 30 children participated in the project. Their anxiety scores were then calculated using an open-ended questioner obtained from a previous study. In response to the Likert scale questions, respondents indicated a range from "strongly agree" to "strongly disagree" or "excellent" to "very poor." The respondent was also given the opportunity to respond with "no opinion" to one of the questions. This evidence suggests that there was a significant change in anxiety levels between before and after seeing the tutorial video, therefore we can infer that the null hypothesis is false.

The bar graph above indicates sum anxiety scores for children across different age groups. The first bar represents children between 4 and 7 years old, while the second is for children aged between 8 and 12 in the experiment. There is a difference in the size of the bars, which indicates that older children depicted lower anxiety scores after exposure to educational video applications. In comparison, younger children had higher anxiety scores.

Table 3. ANOVA for Difference in Anxiety Scores After Exposure to Educational Video Application Between Scanner sizes.

STATISTICAL SUMMARY				
Groups	Count	Sum	Average	Variance
Narrow	10	16	1.6	0.488889
Standard	10	16	1.6	0.266667
Wide	10	16	1.6	0.488889

From the ANOVA table above, ten children each used a narrow, standard, or wide scanner size. F-statistic was thus -4.3E-15, which is less than F-critical = 3.35413. Therefore, we draw the conclusion that the size of the scanner used had no significant statistical impact on the children's levels of anxiety. All participants provided informed consent or parental consent for their children. All data obtained were kept confidential and were only accessible to the project team. Prior to data collection, this research study has been approved by the IRB committee where the data were collected (K-22-231 on 17 May 2022).

Results

The study aimed to determine whether a video-based educational application could help children undergoing MRI scans feel more comfortable and reduce their need for generalanesthesia. Thirty children, ages 4 to 12, were involved in the study, and all were given the opportunity to view the informational video application before undergoing the MRI scan.

After comparing the number of MRI scans performed under GA before and after the implementation of the educational video, and then analyzed the results to determine if there was a

statistically significant difference, the study found out that the number of MRI scans performed under GA decreased from 63% to 13% after the implementation of the educational video (*Table 1*). The study also discovered through the survey results that healthcare expenditures were significantly impacted by the utilization of GA for MRI scans in children, with the average cost of each MRI scan under done under GA being 1500 SAR.

Table 1: Number of MRI scans performed under GA before and after the educational video was implemented.

Group	Number of MRI scans performed under GA
Pre-intervention	19 (63%)
Post-intervention	4 (13%)

According to the results of the research, there is a significantly decrease in the children's anxiety levels after watching the educational video application. *Figure 3* shows the average anxiety scores of the children before and after watching the video. On average, children who utilized the educational video application demonstrated increased courage and readiness for the MRI scan without general anesthesia. Furthermore, Results indicated that age played a crucial role in anxiety reduction, with older children displaying a greater reduction in anxiety compared to younger children. This is illustrated in *Figure 3*, which shows the correlation between age and anxiety reduction. Additionally, the size of the scanner was also found to impact the outcome, with more patient cooperation observed among children in larger scanners compared to those in smaller scanners.

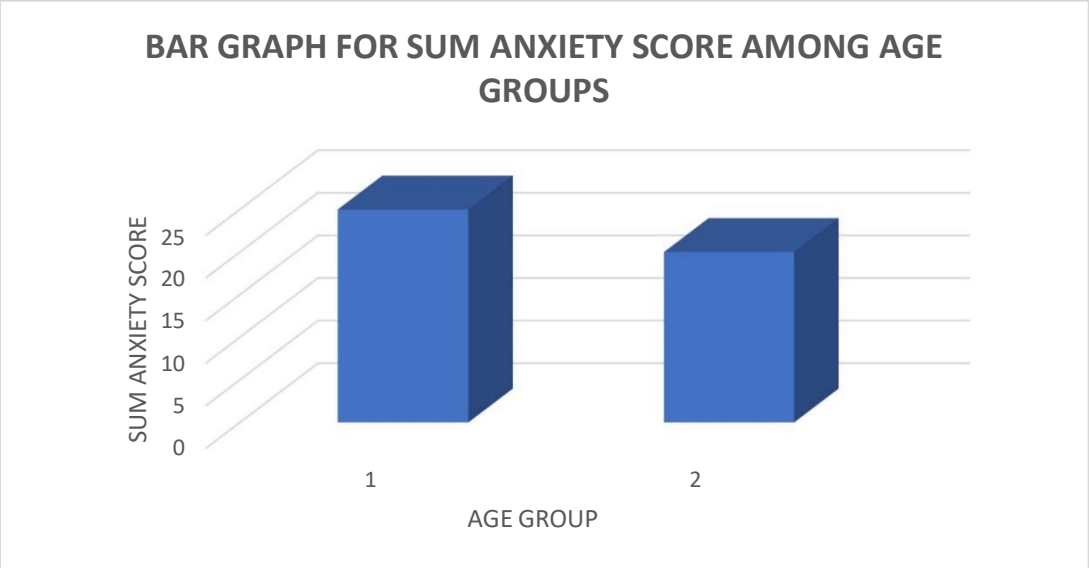


Figure 3. ANOVA for Difference in Anxiety Scores After Exposure to Educational Video Application Due to Age of the Children.

Overall, these results demonstrate that the use of an educational video application can significantly reduce anxiety levels in pediatric patients undergoing MRI scans. It also highlights the importance of considering age and scanner size in the effectiveness of this approach.

Discussion

The increasing use of MRI in diagnostic radiology is significantly limited by the issue of anxiety among patients undergoing MRI scans (Törnqvist & Erna, 2010). Anxiety is a common response to the MRI scanning procedure, even among patients who have undergone the procedure several times. Anxiety can be triggered by the need to remain still for long periods, the claustrophobic environment of the scanner, along with the scanner's extremely obnoxious beeping and chirping during the examination (Jaimes et al., 2016). When patients are anxious, it becomes difficult for them to cooperate with the MRI scan procedure as required. The lack of cooperation among patients often results in poor MRI image quality, which consequently affects the diagnosis results (Dong et al., 2019).

The MRI images quality is an important aspect of the procedure because it is the foundation of accurate diagnosis. Poor image quality can result in a misdiagnosis, leading to incorrect or inappropriate treatment, which can be potentially harmful to the patient. Sometimes Technologists are required to repeat the sequences to acquire images with better quality, which not only prolongs the cumulative scan time per patient but also increases the total cost besides affecting the patient's optimal experience (Harrington et al., 2022).

The use of general anesthesia may be required in cases where patients may have difficulty cooperating, which is a major problem when handling children (Artunduaga et al., 2021). Since general anesthesia has some side effects that increase the overall risk of the MRI procedure, using various methods to reduce patient anxiety is highly recommended (Anwar et al., 2022; Lemaire et al., 2009).

The use of educational video applications was adopted in this study to help reduce children's anxiety and reduce the number of children who had to go through general anesthesia before the MRI scanning procedure. The educational video was designed to provide patients with an understanding of the MRI scan process, which was found to be important in preparing them for the MRI scan procedure. The video detailing what is expected in the MRI scan significantly reduced the patient's anxiety level. Most of the children who were anxious before watching the educational video became more confident and faced the MRI scan with a considerably high level of cooperation. The impact of the video demonstrated the importance of understanding what happens during an MRI scan, especially when dealing with anxious patients or patients who may exhibit difficulties cooperating, such as young children. The educational video aided in easing their anxiety as it specified the overall journey for the patient, every step in the way, which resulted in the patient fully knowing all the essential details needed from them. It also explained the loud noises that will happen during the exam and assured the child that it is normal and is expected in any magnetic resonance imaging (MRI) exam.

The variation in anxiety reduction can be attributed to differences in the children's cognitive abilities, including the ability to overcome anxiety which is caused by the fear of being

in a confined space, being in an unfamiliar environment, and hearing the loud noises caused by the sequences by the MRI scanner. Older children have more advanced cognitive abilities and can understand more complex concepts (Capurso et al., 2020). Even though the educational video was animated and simplified for easier understanding, different children may understand the explanation differently and follow the instruction in different accuracies. The MRI scanner size also affected the outcome because larger scanners created the impression of large space and reduced the fear of being confined in a smaller space as experienced by children whose MRI scan was done in smaller bore MRI scanners. This accords with the results of previous research that have shown that patients undergoing MRI scans in larger bore scanners experience less anxiety compared to those in smaller bore scanners (Artunduaga et al., 2021; Moberg et al., 2018). Although larger bore scanners are more expensive to acquire and maintain, the benefits of increased patient comfort and reduced need for general anesthesia may outweigh the added costs, especially for pediatric patients. Hence, it is essential to consider the scanner size while preparing pediatric patients for MRI scans to reduce their anxiety level and improve their overall experience.

The fact that some children relied on the technologist's explanation just minutes before the MRI scan also explains the variance in the video's impact on reducing the patients' anxiety and consequently reducing the number of children requiring general anesthesia. Nevertheless, the study showed that preparing children for MRI with the help of an educational video could cut down on the number of MRI scans under general anesthesia (GA) for children between the ages of four and twelve, enhancing the overall patient and parents experience, improve workflow and optimize resource utilization. Moreover, parents prefer that their children undergo MRI without GA as it avoids the risks that can occur when general anesthesia is used, including nausea, vomiting, and delayed awakening McGuirt, Delaney. (2016). Consequently, better patient outcomes and increased parental satisfaction can be achieved by decreasing the need for GA during MRI scans. Preparation efforts for MRI exams are valued highly by patient populations and may improve healthcare providers' procedural outcomes (Dean et al., 2014). The use of educational video applications in MRI patient preparation could be integrated into standard practice to enhance the patient experience, reduce anxiety, improve workflow, and optimize resource utilization. The study findings suggest that implementing the educational video application could result in more cooperative patients, higher image quality, and faster scan times, which would be beneficial for both patients and healthcare providers. Moreover, the educational video could also benefit other imaging modalities that require patient cooperation, such as scans using positron emission tomography (PET) or computed tomography (CT).

Limitations

While the study had several strengths, there are a few limitations that should be considered. One of the limitations was the lack of opportunity for some parents to explore and watch the educational video prior to the appointment. As a result, some parents had to rely on the technologist to explain the video to their children before the exam. This may have introduced variability in the explanations given by different technologists and may have led to differences in how much the children understood before the scan. The fact that the children weren't all scanned with the same

scanner also detracts from the reliability of the results. Some were scanned in a smaller bore MRI scanner, which may have led to a more confined feeling and a higher level of anxiety for some children, while others were scanned in a larger bore MRI scanner, which may have reduced the feeling of confinement and anxiety (Figure 6). The variation in the MRI scanner size may have confounded the results and introduced variability in the level of anxiety experienced by the children.

Furthermore, the questionnaire used to assess the impact of the educational video was completed by the parents, not the children. While parents are likely to have a good sense of their children's behavior and emotions, their perception may not always be accurate. The use of self-report measures completed by the children themselves could have provided a more accurate assessment of the kid's anxiety levels and to what extent much they understood about the MRI scan procedure. Additionally, some parents may not have had prior MRI experience with their children, which may have affected their ability to make comparisons and provide accurate ratings. The study also had the problem of a limited sample size. The study involved a sample of 30 children, which may limit the generalizability of the findings to a larger population. A larger sample size would have allowed for a more accurate assessment of the effect of the educational video on the anxiety levels of the children and their ability to cooperate during the MRI scan.

Finally, the study did not assess the long-term impact of the educational video on children's anxiety levels and their willingness to undergo future MRI scans. Future studies could assess the impact of the educational video on repeated MRI scans and investigate whether the intervention has a lasting effect on children's anxiety levels and cooperation during subsequent scans.

Scan time and preparations

The examinations took, on average, between 30-60 minutes to complete. Additionally, if a child moved, occasionally the sequences had to be repeated. Even though the scan took longer because of this, the child was still at far lower risk as compared to having an MRI in GA. Based on other studies, using various virtual tools for preparation can result in knowledge gains concerning MRI scans and anxiety decrease (Szeszak et al., 2016; Afacan et al., 2016)

Conclusion

Results from the study demonstrated that showing an informational movie to young patients before an MRI scan improved their experience and it is also a valuable tool in reducing anxiety and increasing cooperation during the procedure.

By improving the overall patient experience, the use of educational videos could reduce the number of MRI scans performed under general anesthesia, which would ultimately reduce risks associated with anesthesia and improve overall patient outcomes. In addition, the use of an educational video can increase the efficiency of the MRI scan process, reducing total scan time and improving image quality. While the study had some limitations, the results are promising and suggest that further research in this area is warranted. Future studies could explore the use of different types of educational videos or other preparation techniques, such as augmented reality,

which can be used to make MRI scans more comfortable for patients. Additionally, future studies could investigate the use of educational videos for other patient populations, such as those with claustrophobia or developmental disabilities. In conclusion, the use of educational videos to prepare pediatric patients for MRI scans has the potential to improve the experience of the patient, increase cooperation, and enhance the efficiency of the MRI scan process. By reducing anxiety and improving patient outcomes, the use of educational videos could have significant benefits for pediatric patients undergoing MRI scans.

Acknowledgment: Thanks for Researchers Supporting Project number (RSP2022R332), King Saud University, Riyadh, Saudi Arabia

Conflict of interest

The authors declare no conflict of interest. This project did not receive any funding from any commercial organization or other relevant sources.

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