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Original Article

Pediatric rheumatologists' perspective on next-generation: virtual reality revolution

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ABSTRACT

Objective: This study assessed pediatric rheumatologists' (PRs) knowledge, attitudes, and experiences regarding virtual reality (VR) technology in medical education, clinical management, patient education, and research.

Material and Methods: A web-based survey was conducted among pediatric rheumatologists (PRs) in Türkiye. Participants were categorised based on self-reported VR knowledge. Group 1 included participants who considered themselves knowledgeable about VR, while Group 2 included those who did not perceive themselves as knowledgeable about the technology. Demographics, attitudes, and behaviors related to VR were compared. The influence of social media and telemedicine experience on VR awareness was also evaluated.

Results: Eight one participants, 49.3% were pediatric rheumatology (PR) fellows, 27.1% faculty members, and 23.6% PR specialists. Overall, 67.9% had VR knowledge (Group 1), while 32.1% did not (Group 2). Group 1 demonstrated significantly greater awareness of telemedicine and health technologies ($p=0.003$, $p<0.001$). VR equipment knowledge ($p<0.001$) and prior experience ($p<0.001$) were also higher in Group 1. Awareness of VR applications in pain management was more prevalent in Group 1 (43.6%) than in Group 2 (15.3%, $p=0.018$). Hesitancy towards clinical VR implementation was reported by 90.9% of Group 1 and 61.5% of Group 2 ($p=0.199$).

Conclusion: PRs show an increasing interest in VR technology, indicating a promising trajectory for its integration into clinical and educational settings.

Keywords: Autoimmune diseases, Digital health technologies, Rheumatology, Social media, Telemedicine, Virtual reality

INTRODUCTION

Pediatric rheumatology is a subspecialty of pediatrics focusing on inflammatory and non-inflammatory disorders of the connective tissues, joints, muscles, and vessels. Although it is a relatively new branch of pediatrics, there have been great advances in the diagnosis and treatment of pediatric rheumatic diseases in the last two decades. With the emergence of biologics as therapeutic agents, the goal of complete recovery and total well-being for children with rheumatic conditions are not far away.

In addition to the developments in diagnostics and pharmaceuticals, new technologies to improve the quality of care (patient education, exercise, and pain management) and for education and professional networking are endorsed and being used with increasing enthusiasm.

Virtual reality (VR) is a significant development, initially used for entertainment and gaming. However, over the last 20 years, the accessibility and applicability of VR technology have increased (1). The technology allows users to experience real-world sensations in a virtual world created with special equipment. A head-mounted display connected to a mobile phone or computer is the most essential piece of equipment (2). Hand controllers, sensory detectors, gloves, and clothing are also used to enhance reality. This creates a three-dimensional, multi-sensory, and immersive environment.

Virtual reality technology appears to be emerging as a game changer in medical education and practical training, clinical

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management, patient education, training, and research (3). Since pain is one of the most important symptoms in patients with rheumatic diseases, this comprehensive technology could be a new tool for pain relief. Although limited data is available, the beneficial effects of VR technology in managing pain and anxiety in patients with rheumatic diseases have been demonstrated (4). Few applications using VR technologies are being developed for the training of healthcare professionals and medical students about inflammatory arthritis (3,5). However, there may be some negative aspects, when immersed in the virtual environment, the line between the virtual and the real may become blurred as the virtual and the real become intertwined. In addition, all information about people can be accessed through the inputs and outputs of VR devices. Therefore, ethical issues such as confidentiality of personal information, personal freedom and privacy may arise as their use becomes more widespread (6).

Due to the lack of data on the use of VR, today's new but essential technology, we aimed to evaluate the knowledge, attitudes, usage trends, and experiences of pediatric rheumatologists regarding virtual reality technology in clinical practice.

MATERIALS and METHODS

The present study was conducted between June and August 2024, targeting pediatric rheumatologists (PRs) practicing in Türkiye. A web-based survey was prepared by the Google Forms software (Google Forms, Albuquerque, New Mexico, USA) and conducted to all 143 PRs in Türkiye via a WhatsApp link by mobile smartphones and e-mail addresses. After removing the pilot responses, we found that 81 physicians gave informed consent by opening the questionnaire and completing the survey anonymously, resulting in a response rate of 56.64%.

The electronic survey consisted of 27 questions, divided into three sections. The first section collected demographic information, including age, gender, academic title, center of affiliation, and experience in pediatric rheumatology.

The second section assessed participants' use of technology, including social media, internet, and telemedicine, as well as their knowledge, attitudes, and behaviors towards these technologies. Participants were asked about the frequency of social media use, their knowledge of telemedicine, whether they had assessed patients via telemedicine, their familiarity with health technologies, the proportion of literature searches related to health technologies, and their frequency of internet use related to rheumatology.

The third section focused on participants' knowledge, experience, and opinions regarding VR and its potential applications in medical practice. In this section, participants were asked whether they considered themselves to be knowledgeable about VR, with a binary response option. This section then explored their knowledge and training in VR technologies, sources of information, experiences and opinions regarding the use of VR in pain management, treatment, and exercise therapy, and their likelihood of prescribing VR technologies. It also assessed concerns about the suitability and applicability of VR technology in the hospital setting and the reasons for these concerns. The full set of survey questions can be found in the supplementary document.

Participants were categorized into two groups based on their self-assessment of knowledge regarding VR technology. Group 1 included participants who considered themselves knowledgeable about VR, while Group 2 included those who did not perceive themselves as knowledgeable about the technology. First, comparisons were made between the two groups on factors that might indirectly influence VR knowledge, such as demographic characteristics, technology use, and internet and telemedicine use. Subsequently, comparisons were made regarding factors that could directly influence VR knowledge, including participants' experiences with VR, their sources of information, and their understanding of VR applications in medical practice, in order to identify the underlying sub-factors that determine the overall knowledge of VR and their contribution to the differences between the groups.

Statistical analysis

Survey data were collected using Microsoft Excel (Microsoft Corporation, Redmond, WA) and analyzed using SPSS 29.0 (IBM Corp., Armonk, NY, USA). Minimum, maximum, and median descriptive statistics were calculated according to the distribution of numerical variables. Categorical variables were analyzed as frequency and proportion. The normality of the baseline data was examined using the Kolmogorov Smirnov test. The Mann-Whitney U test was used to compare non-normally distributed numerical variables, and the Chi-square test was used to compare categorical variables. A p-value <0.050 was considered statistically significant.

RESULTS

The survey was completed by 81 clinicians working in pediatric rheumatology in Türkiye. Sixty-seven of the PRs (82.7%) were female. The median (min-max) age of the PRs was 37 years (31-64). The study group consisted of 40 PR fellows (49.3%), 22 faculty members (27.1%), and 19 PR specialists (23.6%). Of the participants, 73 PRs (90.1%) work in an academic institution (university or training and research hospital), 7 PRs (8.6%) in a state hospital, and 1 PR (1.3%) in a private clinic. When assessing the participants' experience in pediatric rheumatology, 53 (65.4%) had 1-5 years, 18 (22.2%) had 6-15 years, and 10 (12.4%) had more than 15 years of experience.

Among the cohort, 55 PRs (67.9%) claimed to be well-versed in VR technology (group 1) and 26 PRs (32.1%) did not consider themselves knowledgeable about this technology (group 2). The

Table I: Comparison of demographic characteristics of the participants in Group 1 and Group 2

	Group 1 (n=55)	Group 2 (n=26)	p
Female*	47 (85.5)	20 (76.9)	0.343‡
Age (years)†	38 (31-64)	36.5 (31-56)	0.206§
Academic title*			
PR fellow	23 (41.8)	17 (65.4)	0.164‡
PR specialist	15 (27.3)	4 (15.4)	**0.048**‡
PR specialist (Faculty)	17 (30.9)	5 (19.2)	
Center of affiliation*			
Academic institution	50 (90.9)	23 (88.5)	0.461‡
State hospital	5 (9.1)	2 (7.7)	
Private clinic	0 (0)	1 (3.8)	
PR experience*			
1-5 years	34 (61.8)	19 (73.1)	0.333‡
6-15 years	13 (23.6)	5 (19.2)	
>15 years	8 (14.6)	2 (7.7)	

***:** n(%),**†:** median (min-max),**‡:** Chi-square,**§:** Mann-Whitney U test **PR:** Pediatric rheumatology, Bold p value for the comparison between fellows and all specialists (including specialists and faculty members)*

Table II: Comparison of social media, telemedicine, and health technology knowledge and use of participants in Group 1 and Group 2

	Group 1 (n= 55)	Group 2 (n= 26)	p*
Social media†			
Usage	53 (96.4)	24 (92.3)	0.590
Frequency			
Everyday	43 (81.1)	22 (91.7)	
2-3 days/week	5 (9.4)	0 (0)	
<2-3 days/week	5 (9.4)	2 (8.3)	0.403
Telemedicine†			
Knowledge	48 (87.3)	15 (57.7)	0.003
Experience	14 (25.5)	6 (23.41)	0.817
Knowledge about health technology*	51 (92.7)	16 (61.5)	<0.001
Frequency of internet use in their speciality†			0.730
Everyday	50 (90.9)	23 (88.5)	
2-3 days/week	5 (9.1)	3 (11.5)	
The percentage of literature reviews on health technologies in total literature reviews†			
≤20%	30 (54.5)	23 (88.5)	0.003
>20%	25 (45.5)	3 (11.5)	

***:** Chi-square,**†:** n(%)*

gender distribution between the two groups was similar, with 47 females (85.5%) in Group 1 and 20 females (76.9%) in Group 2, showing no statistically significant difference (p=0.343). The median (min-max) age of group 1 was 38 (31-64) years and that of group 2 was 36.5 (31-56) years and both groups were similar in terms of age (p=0.206). Detailed demographic data are shown in Table I.

When the participants were categorized according to academic title as PR fellows and specialists (including both practicing specialists and faculty members), the proportion of specialists was significantly higher in Group 1 (n=32, 58.2%) than in Group 2 (n=9, 34.6%) (p=0.048). When asked about the frequency of internet use in rheumatology, 50 PRs (90.9%) in Group 1 and 23 PRs (88.5%) in Group 2 reported using the internet every day (p=0.730). PRs who reported good knowledge of VR technology were significantly more informed about telemedicine (n=48, 87.3%) and health technologies (n=51, 92.7%) compared to those who felt less knowledgeable about VR technology. The differences were statistically significant for both telemedicine and health technologies (p=0.003 and p < 0.001, respectively) (Table II).

When the entire cohort was divided into fellows and specialists (including faculty members) based on academic title, 25 fellows (62.5%) and 38 specialists (92.7%) had knowledge about telemedicine (p=0.001), while 4 fellows (10.0%) and 16 specialists (39.0%) had evaluated patients via telemedicine (p=0.002).

The groups were asked to indicate the proportion of health technology reviews among their total literature reviews. In Group 1, 30 PRs (54.5%) reported this proportion as ≤20%, whereas in Group 2, 23 PRs (88.5%) reported the same. This difference was statistically significant (p=0.003) (Table II). Participants in group 1 had more knowledge of VR equipment (n=49 89.1%) compared to group 2 (n=8, 30.7%) (p<0.001). In group 1, 29 PRs (52.7%) had experience with VR technology, whereas no PRs in group 2 had such an experience. Table III provides a detailed assessment of the source of VR experience, knowledge of technology, and knowledge of VR equipment.

Table III: Comparison of the information sources and experiences of the examined PRs on VR according to groups

	Group 1 (n:55)	Group 2 (n:26)	p*
VR experience†	29 (52.7)	0(0)	<0.001
Source of VR experience†			
Educational application	19 (34.5)		
Medical congress	8 (14.5)		
Patient treatment	5 (9)		
Tecnology fairs	4 (7.3)		
Knowledge of VR equipment†	49 (89.1)	8 (30.7)	<0.001
VR equipment†			
Smartphones	36 (65.5)	6 (23.1)	
Computer	39 (70.9)	7 (26.9)	
Hand controller	6 (10.9)	6 (23.1)	
Head-monted display	39 (70.9)	5 (19.2)	
Source of information for VR technologies†			
Other healthcare professional	27 (49.1)	7 (26.9)	
Medical congress	16 (29.1)	7 (26.9)	
Scientific articles	23 (41.8)	5 (19.2)	
Technology fairs	5 (9)	2 (7.7)	
Social media	20 (36.4)	6 (23.1)	

***:** Chi-square,**†:** n(%), **VR:** Virtual reality*

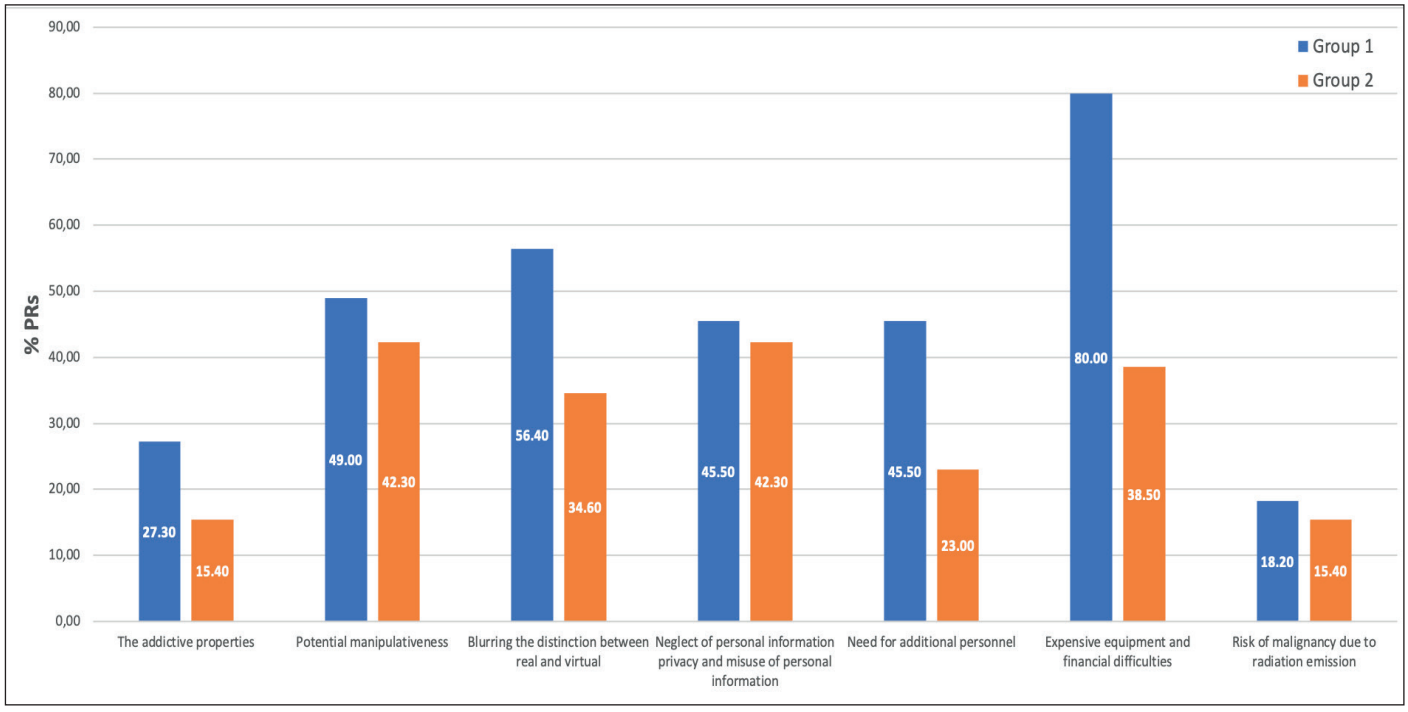

Figure 1: Percentage distribution of reasons for hesitation regarding the application of virtual reality techniques in Group 1 and Group 2

Among the participants in group 1, 47 PRs (85.4%) stated that they could use VR technology for patient education, 44 PRs (80.0%) for practical applications, 39 PRs (70.9%) for theoretical education, 37 PRs (67.3%) as a treatment method, and 1 PR (1.8%) for remote consultation. One PR (1.8%) in group 1 stated that he would not use VR technology in his practice. In group 2, 17 PRs (65.4%) stated that they could use VR technologies for patient education, 15 PRs (57.7%) for practical applications, 12 PRs (46.2%) as a treatment method, and 11 PRs (42.3%) for theoretical education. Twenty-four PRs (43.6%) in group 1 and 4 PRs (15.3%) in group 2 were aware that virtual reality applications are in use for pain management (p=0.018). Forty-six PRs (83.6%) in group 1 and 17 PRs (65.4%) in group 2 believed that virtual reality applications would be effective in pain management (p=0.887). There were 54 PRs (98.2%) in group 1 and 19 PRs (73%) in group 2 who believed that VR applications could be used in exercise therapy (p=0.743).

Twenty-eight PRs (50.9%) from group 1 and 10 PRs (38.4%) from group 2 thought that VR applications could be prescribed as a treatment (p=0.897). Similarly, 36 PRs (65.5%) in group 1 and 12 PRs (46.2%) in group 2 said they could prescribe virtual reality applications in a clinical setting (p=0.782) when asked if they would prefer to prescribe virtual reality applications as a treatment. Forty-four PRs (80.0%) in group 1 and 18 PRs (69.2%) in group 2 agreed that VR applications could be used in a hospital setting.

Similarly, 50 PRs (90.9%) in group 1 and 16 PRs (61.5%) in group 2 reported concerns about issues related to the VR techniques (p=0.199). In Group 1, the main concerns about VR technology were the high cost of equipment and associated financial challenges, the risk of blurring the distinction between real and virtual experiences, and the potential for manipulation and in Group 2, the main concerns were the risk of neglecting the privacy of personal data and misuse of personal information, the potential for manipulation, and issues related to the high cost of equipment and financial challenges. Figure 1 shows the percentage distribution of reasons for hesitation for both groups.

DISCUSSION

This study is the first to describe the knowledge and attitudes related to VR technology. Approximately two-thirds of the cohort indicated that they were knowledgeable about VR technology. Those who reported having such knowledge also had more information about telemedicine, health technologies, and VR equipment; they conducted more literature reviews on health technology and had more experience with VR.

There was no significant difference in age, gender, or center of affiliation between participants who considered themselves knowledgeable about VR technology and those who did not. However, the specialists and the faculty members had higher levels of knowledge about VR technology, which we attribute to the correlation between increasing professional experience and the increased likelihood of learning about new technologies through professional networks and conferences. Similarly, when physicians' perspectives on the metaverse were assessed among allergy-immunology physicians, it was found

that perspectives did not change with age, gender and place of work, but changed with increasing years of professional experience (7).

The use of social media has increased in recent years with the development of technology and the widespread use of the internet. When social media first appeared, it was for personal life and entertainment. Over time, it began to offer networking and information sharing in professional life. Medical professionals began to use social media to connect with peers, share research, discuss clinical cases, collaborate on medical projects, collect data, provide medical education, disseminate health information and educate patients about diseases, treatments and preventive measures. An international survey conducted by the Emerging EULAR Network (EMEUNET) showed that 71% of rheumatologists use social media for professional purposes, including professional networking, education, and clinical and research updates. It has been observed that those who use social media for professional purposes also use these platforms for longer periods in professional and non-professional ways (8). It is thought that the use of social media and the internet will enable people to learn more about new and widely used technologies, such as VR, through the rapid transfer of information. In our study, although not statistically significant, use of social media, frequency of use of social media, and frequency of use of the internet related to the field were higher among those who reported being more knowledgeable about VR technology.

Telemedicine has emerged with the spread of high-speed internet and portable technological devices. During the SARS-CoV-2 pandemic, the use of telemedicine has increased mainly due to the need for remote visits. Telemedicine in pediatric rheumatology practice has the potential to visit patients remotely, view patient examinations, facilitate multidisciplinary approaches, identify suspicious cases and call for face-to-face visits, and avoid problems due to social difficulties (9). Another study from our group showed that parents of pediatric rheumatology patients were quite accepting telemedicine visits (10). The convenience of telemedicine and the rapid adoption of innovations have paved the way for digital transformation in rheumatology. The ability to communicate between patients and physicians through online platforms has enabled the digitalisation of several medical practices. In our study, participants who were more familiar with VR were also more likely to be familiar with telemedicine. Specialists and faculty members were also more familiar with telemedicine and treated more patients via telemedicine.

Over the past decade, the field of rheumatology has seen significant advances through the integration of a variety of digital health technologies. These innovations enable the regular maintenance of electronic health records, enhance patient data collection through wearable technologies and mobile applications, prevent delays in diagnosis and treatment through virtual visits, use digital therapeutics, and apply artificial intelligence to make informed assumptions about patient diagnosis, treatment outcomes, and mortality (11). In our study, those who felt more knowledgeable about VR were more familiar with health technology and were more likely to include health technology topics in their clinical literature searches. It seems inevitable that the interrelationship between new developments will be overlooked. Therefore, the integration of digital technologies may open new horizons in rheumatology in the future. With the increasing use of health technologies, the use of VR in rheumatology has become more widespread and the number of people who have experienced these applications has increased. As shown in our study, knowledge about VR is growing as more people engage with it.

VR technologies have significant potential benefits for patients and rheumatologists in several areas of patient care. In pediatric rheumatology, a relatively new field compared to other pediatric subspecialties, the use of VR in education is valuable due to the current global shortage of experts. In our study, rheumatologists who were more familiar with virtual reality had more experience using it in education. VR applications are already being used for educational purposes in fields such as plastic surgery, orthopedics, and neurosurgery where manual dexterity and attention are required, as well as for the learning of anatomy and clinical ultrasound (12-16). In the field of rheumatology, an educational study was conducted in Germany where 125 participants, including healthcare professionals and medical students, were taught about inflammatory arthritis with the help of a VR application called Rheumality (3). Almost all the participants reported that the VR presentation had improved their understanding of inflammatory arthritis and expressed a desire for further training, including new case studies and information on other rheumatic diseases.

Pain management is another area where the use of VR is growing and could provide significant benefits in rheumatology. To date, it has been used in children for pain relief during dental procedures, for elective day surgery, for intravenous cannulation, and for the treatment of burns (17-20). Interestingly, in a rheumatology clinic, the application of VR-based meditation and biofeedback treatments involving 20 patients with lupus, rheumatoid arthritis, and fibromyalgia led to a reduction in pain, as evidenced by decreased Visual Analog Scale (VAS) scores (4). In our cohort, participants with a higher levels of knowledge about VR were more likely to be aware of its applications in pain management. Although the difference was not statistically significant, these participants were also more likely to believe in the effectiveness of VR for pain management. Given that pain is a prevalent symptom in rheumatic diseases, this finding underscores the potential value of VR as a tool for enhancing patient care. Despite the lack of statistical significance, the trend suggests that familiarity with VR technology may influence perceptions of its utility in clinical settings.

Digital therapeutics, another application of VR, is a subset of digital health technologies that provide evidence-based

therapeutic interventions to patients (21). These interventions are powered by advanced software programs and are designed to prevent, manage, or treat a broad spectrum of medical conditions and diseases. Many digital therapeutics undergo rigorous review and approval by regulatory agencies, such as the Food and Drug Administration (FDA), to ensure their efficacy and safety (22). In the United States, some of these products are available by prescription, and reimbursement for these treatments is anticipated to be available within a few years (22). In our study, participants who were more knowledgeable about VR were also more likely to be aware that virtual reality applications could be prescribed and were more confident in their ability to prescribe such applications. This increased awareness and confidence suggests that informed practitioners are ready to integrate digital therapeutics into clinical practice. As digital therapeutics continue to evolve, they have the potential to become a more widespread and integral part of the global healthcare system, providing innovative solutions for patient care and management.

In addition to its many potential benefits, VR applications may have some drawbacks. They may pose several potential risks, including addiction, immersive effects, and dissociative symptoms such as depersonalization, desensitization, and derealization. There are also concerns that addiction to VR applications could lead to a decrease in daily activity levels (6). Another problem is the unequal accessibility of these methods for patients and clinicians. In our study, participants' most common concerns about VR were the high cost of equipment and financial difficulties, the potential blurring of lines between reality and virtual experiences, concerns about manipulation capabilities, and the misuse of privacy and personal information. Additionally, the digital footprint, which refers to the data trail individuals leave behind while using digital devices and interacting with online services, poses a privacy risk and can make individuals susceptible to manipulation for various purposes. Therefore, it is crucial to establish comprehensive legal regulations and guidelines for virtual reality technologies and applications.

The main limitation of our study is the response rate, with approximately half of pediatric rheumatologists participating in the survey. This limited response rate limits the generalizability of our findings, as the perspectives of the non-responding half may differ. Secondly, participants who considered themselves knowledgeable about virtual reality expressed many reservations about its use. It remains unclear whether these reservations are based primarily on personal opinion or on not having experienced virtual reality first hand. Further research is needed to explore the underlying reasons for these reservations, as understanding their root causes may inform strategies to address concerns and improve the acceptance and integration of VR applications in clinical practice.

CONCLUSION

The findings suggest varying levels of familiarity with VR technology among pediatric rheumatologists, with certain demographic factors influencing comfort and knowledge regarding its use. The potential for VR to enhance both patient care and professional education in pediatric rheumatology remains promising, though further research is required to better understand its practical applications and impact on clinical practice. As VR technology evolves, it may hold considerable promise for improving the management of pediatric rheumatic diseases, depending on its integration into the field.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. Approval was obtained for the study protocol from the Ethics Committee of Istanbul University, Istanbul Faculty of Medicine (approved 02.05.2024-2541508).

Contribution of the authors

Doğru A: Constructing the hypothesis or idea of research and/or article, Taking responsibility in the writing of the whole or important parts of the study. ***Kavrul Kayaalp G:*** Planning methodology to reach the conclusions, Taking responsibility in the writing of the whole or important parts of the study. ***Arık SD:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***Demirkan FG:*** Taking responsibility in logical interpretation and conclusion of the results, Reviewing the article before submission scientifically besides spelling and grammar. ***Özlem Akgün:*** Taking responsibility in necessary literature review for the study. ***Menentoğlu B:*** Taking responsibility in necessary literature review for the study. ***Başer Taşkın B:*** Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments. ***Aktay Ayaz N:*** Constructing the hypothesis or idea of research and/or article, Planning methodology to reach the conclusions, Reviewing the article before submission scientifically besides spelling and grammar.

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Conflict of interest

The authors declare that there is no conflict of interest.

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