

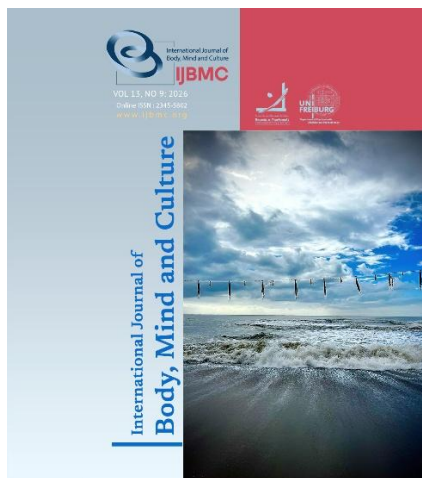
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Arabic-Language Immersive Virtual Reality Preparation for Children Undergoing MRI: Associations With Anxiety, Preparation Time, and Parental Satisfaction

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ABSTRACT

Objective: To evaluate an Arabic-language, nurse-administered immersive virtual reality preparation program (VRPP) for children undergoing elective MRI, with anxiety as the primary outcome and preparation time and parental satisfaction as secondary outcomes.

Methods and Materials: A quasi-experimental pre-test/post-test study was conducted in two pediatric radiology departments in Baghdad, Iraq. Site determined study arm; 120 children aged 5–12 years were included (60 per group). The VR arm received three Arabic-language modules delivered in a single supervised session of approximately 10–15 minutes; controls received routine nurse-led preparation. Anxiety was assessed with the Venham Anxiety Clinical Scale (VACS), preparation time was recorded by the attending research nurse, and parental satisfaction was measured using an adapted 8-item scale (8–40; Cronbach's $\alpha = .91$).

Findings: Baseline VACS distributions were similar between groups ($U = 1731$, $p = .675$). After preparation, 98.3% of children in the VR group were rated relaxed, compared with none in the control group; post-preparation VACS distributions differed markedly ($U = 0$, $p < .001$). The intervention-group mean VACS score changed from 2.40 ± 0.53 to 0.02 ± 0.13 . Preparation time was lower in the VR group ($U = 218.00$, $Z = -8.341$, $p < .001$). Parental satisfaction was higher with VR (37.83 ± 1.43) than routine preparation (17.75 ± 4.08), with a significant difference in satisfaction categories ($\chi^2(2) = 120.00$, $p < .001$).

Conclusion: Arabic-language immersive VR preparation was associated with lower observed anxiety, shorter recorded preparation time, and higher parental satisfaction. Because study arm was determined by hospital site, the findings should be interpreted as associative rather than definitive causal evidence.

Keywords: Pediatric MRI, Virtual reality, Procedural anxiety, Preparation time, Parental satisfaction, Nursing.

Introduction

Magnetic resonance imaging (MRI) is a central non-ionizing imaging modality in pediatric care, but the scanner environment can be challenging for children because it combines unfamiliar equipment, loud acoustic sequences, restricted space, and prolonged immobility requirements (Copeland et al., 2021; Everts et al., 2022). Procedural distress can reduce cooperation and increase the likelihood of motion artefact, repeated sequences, delayed completion, or escalation to sedation in selected patients (Stunden et al., 2021; Hamd et al., 2023).

Preparation therefore has both psychological and operational importance. Conventional approaches typically include verbal explanation, printed material, child-life support, or audiovisual education. These strategies can be helpful, but their effects vary with developmental tailoring, staff communication, parental involvement, and the child's previous experience (Johnson et al., 2025; Nigro et al., 2025). Broader pediatric evidence also supports non-pharmacological preparation and distraction as useful nursing strategies for reducing fear and distress (Atshan et al., 2024; Kalel & Shawq, 2023).

Virtual reality (VR) extends preparation from passive explanation to immersive rehearsal. In pediatric MRI, VR can expose the child in advance to the scanner appearance, room layout, sounds, and procedural sequence, thereby increasing familiarity and predictability before the actual examination (Stunden et al., 2021; Ashmore et al., 2019; Hudson & Heales, 2025a). Randomized and feasibility studies, together with recent meta-analytic evidence, indicate that VR-based MRI preparation can reduce anxiety and improve cooperation in many children (Saliba et al., 2025a; Saliba et al., 2025b; Gardner et al., 2025).

The clinical rationale is also consistent with evidence from other pediatric procedures, where immersive VR and structured distraction have been associated with lower pain, fear, or anxiety and, in some studies, greater caregiver satisfaction (Turgut et al., 2024; Wei et al., 2024; Watheeg Kharbot & Mohammed, 2025). Importantly, most pediatric VR literature has been generated outside Arabic-speaking health systems. Culturally and linguistically adapted preparation may reduce the cognitive burden of unfamiliar

explanations and may improve engagement in children and families.

Accordingly, this study evaluated a nurse-administered, Arabic-language immersive VR preparation program for children undergoing elective MRI in Baghdad, Iraq. The primary outcome was observed procedural anxiety; secondary outcomes were recorded preparation time and parental satisfaction. Because assignment was determined by hospital site rather than individual randomization, the study was designed to estimate associations with the intervention while acknowledging potential site-related confounding.

Methods and Materials

Study Design and Setting

A quasi-experimental pre-test/post-test parallel-group design was used. The study was conducted from April 2025 through February 2026 in the pediatric radiology departments of two tertiary-care teaching hospitals in Baghdad, Iraq. Study arm was determined by hospital site to reduce cross-group contamination. Consequently, hospital site and intervention status were not independently randomized.

Participants and Sample Flow

Children aged 5–12 years who were scheduled for elective MRI without planned sedation were recruited consecutively. A minimum target of 96 participants was calculated using a 95% confidence level and 5% margin of error; the calculation was precision-based rather than an effect-size-based power analysis. A total of 147 children were screened. Twenty-seven did not enter the final main-study sample (4 were ineligible, 11 withdrew or declined, and 12 participated in the pilot study), leaving 120 children, 60 per group. The participant flow is summarized in Figure 1.

Eligibility required age 5–12 years, scheduled elective MRI without sedation, ability to tolerate the VR headset, and parental consent. Exclusion criteria were planned anesthesia or sedation, neurological or psychiatric conditions judged to interfere with participation, visual or hearing impairment that prevented use of the intervention, previous VR-related motion sickness, or an infectious condition that precluded headset use.

Virtual Reality Preparation Program

The VR program comprised three sequential Arabic-language modules delivered during one supervised pre-MRI session lasting approximately 10–15 minutes in total. The modules addressed (1) the physical MRI environment and scanner layout, (2) representative scanner sounds, and (3) the procedural sequence from arrival through completion. Content was developed with pediatric nursing input and reviewed for developmental appropriateness and cultural sensitivity. A standalone Meta Quest 3S head-mounted display was used. A trained research nurse remained with the child throughout, provided reassurance, monitored discomfort, and could pause or terminate the session if necessary. No VR-related discontinuations were recorded.

The control group received routine institutional preparation consisting of nurse-led verbal explanation and available printed information, consistent with common pediatric imaging preparation approaches (Stunden et al., 2021; Johnson et al., 2025). The VR intervention was used as pre-procedural exposure and rehearsal rather than as intra-scan distraction.

Outcome Measures

Sociodemographic and clinical characteristics included child age, sex, MRI indication, and previous MRI experience.

Anxiety was assessed using the Venham Anxiety Clinical Scale (VACS), a behaviorally anchored 0–5 observational scale ranging from relaxed (0) to out of contact (5). The scale was originally developed to rate children's anxiety and uncooperative behavior and has been used subsequently in procedural research (Venham et al., 1980). Ratings were made at baseline and immediately after the assigned preparation by trained research assistants. Complete blinding to study arm could not be guaranteed because the intervention was overt.

Parental satisfaction was measured after the MRI encounter with an adapted 8-item, 5-point Likert scale based on the parent-satisfaction work of Gerkenmeyer and Austin (Gerkenmeyer & Austin, 2005). Total scores ranged from 8 to 40 and were categorized as low (8–18.66), moderate (18.67–29.33), or high (29.34–40). Internal consistency of the 8-item study version was Cronbach's $\alpha = .91$.

Preparation time was recorded in minutes by the attending research nurse and categorized as short (4–6 minutes), usual (8–10 minutes), or longer (10–15 minutes).

The recorded measure did not distinguish consistently whether the VR exposure interval itself was included; therefore, it is interpreted as an operational preparation-time measure rather than total staff or room time.

Data Collection Procedure

Assessments occurred at baseline before preparation, immediately after the assigned preparation, and after MRI for parental satisfaction. The same procedural sequence was used at both sites as far as practicable. Children and parents were free to discontinue participation without affecting clinical care.

Statistical Analysis

Analyses were performed with IBM SPSS Statistics, version 26. Frequencies, percentages, means, and standard deviations summarized the data. Baseline categorical variables were compared with chi-square tests. VACS scores were treated as ordinal; between-group comparisons at baseline and post-preparation used the Mann–Whitney U test, and intervention-group pre/post change was evaluated with the Wilcoxon signed-rank test. Preparation time was compared with the Mann–Whitney U test. Satisfaction categories were compared with chi-square analysis. Two-sided $p < .05$ was considered statistically significant. Where reported, rank-based effect size was calculated as $r = Z/\sqrt{N}$.

Ethical Considerations

The Ethical Research Committee of the College of Nursing, University of Baghdad approved the study (Approval No. 325A, February 2025). Written informed consent was obtained from a parent or legal guardian, and child assent was obtained when developmentally appropriate. Participation was voluntary, withdrawal did not affect clinical care, and data were anonymized and stored according to institutional requirements. No institutional or external funding was received, and no financial or professional relationship with VR technology providers was declared.

Findings and Results

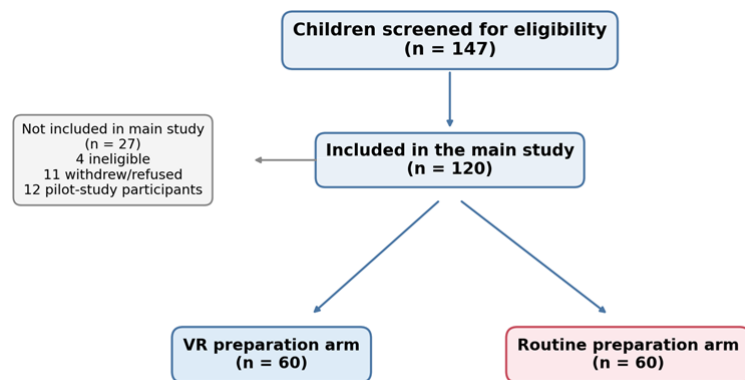
Participant flow and baseline characteristics are summarized in Figure 1 and Table 1. Of 147 screened children, 120 entered the main study (60 per group). The displayed baseline characteristics were similar between groups, including age, sex, MRI indication, and previous MRI experience.

Anxiety findings are presented in Figure 2, Table 2, and Table 3. Baseline VACS distributions were comparable ($U = 1731$, $p = .675$), whereas post-preparation distributions differed markedly ($U = 0$, $p < .001$). The intervention-group mean VACS score decreased from 2.40 ± 0.53 to 0.02 ± 0.13 , with a large within-group rank-based effect ($r = .639$).

Preparation-time findings are reported in Table 4 and Table 5. The VR group had a lower preparation-time mean rank than the routine-preparation group (34.13 vs. 86.87; U

$= 218.00$, $Z = -8.341$, $p < .001$), although the timing interval should be interpreted cautiously because inclusion of VR exposure itself was not consistently distinguished.

Parental satisfaction is summarized in Table 6 and Figure 3. All parents in the VR group were classified as highly satisfied, whereas 63.3% of routine-preparation parents were classified as low and 36.7% as moderate satisfaction ($\chi^2(2) = 120.00$, $p < .001$).



Allocation was determined by hospital site rather than individual randomization.

Figure 1.

Participant flow through screening, exclusion, and site-based allocation

Baseline demographic and clinical characteristics are summarized in Table 1. Mean age was 8.7 ± 2.5 years in both groups. None of the displayed baseline categorical

characteristics differed significantly between groups based on the displayed category counts (all $p > .20$).

Table 1.

Baseline sociodemographic and clinical characteristics by study group

Variable	Category	VR n (%)	Control n (%)	χ^2	P
Sex	Female	34 (56.7)	27 (45.0)	1.634	.201
	Male	26 (43.3)	33 (55.0)		
Age (years)	5–7	19 (31.7)	21 (35.0)	1.906	.385
	8–10	28 (46.7)	21 (35.0)		
	11–12	13 (21.7)	18 (30.0)		
	Mean $\pm$ SD	8.7 ± 2.5	8.7 ± 2.5		
MRI indication	Neurological	46 (76.7)	44 (73.3)	1.389	.708
	Spinal	9 (15.0)	8 (13.3)		
	Musculoskeletal	2 (3.3)	5 (8.3)		
	Body/other	3 (5.0)	3 (5.0)		
Previous MRI	Yes	28 (46.7)	30 (50.0)	0.133	.715
	No	32 (53.3)	30 (50.0)		

Note. χ^2 values are based on the displayed category counts. M = mean; SD = standard deviation.

Anxiety Outcomes

VACS category distributions before and after preparation are displayed in Figure 2 and Table 2. At baseline, both groups were concentrated in the tense and reluctant categories. Following VR preparation, 59 of 60 children

(98.3%) were rated relaxed; the remaining child was rated uneasy. In the control group, no child was rated relaxed post-preparation, and the distribution extended from tense through out of contact.

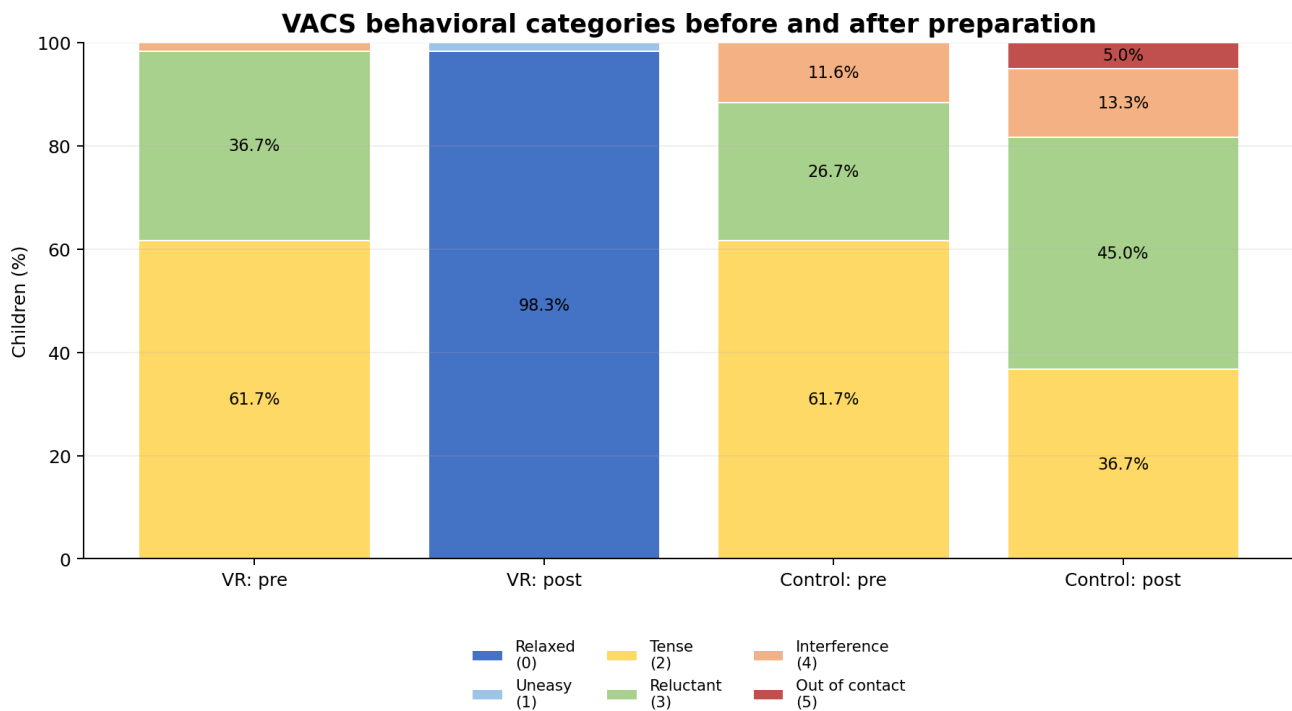


Figure 2.

Distribution of VACS behavioral categories before and after preparation in the VR and routine-preparation groups

Table 2.

VACS behavioral categories before and after preparation

VACS category	Score	VR pre n (%)	VR post n (%)	Control pre n (%)	Control post n (%)
Relaxed	0	0 (0.0)	59 (98.3)	0 (0.0)	0 (0.0)
Uneasy	1	0 (0.0)	1 (1.7)	0 (0.0)	0 (0.0)
Tense	2	37 (61.7)	0 (0.0)	37 (61.7)	22 (36.7)
Reluctant	3	22 (36.7)	0 (0.0)	16 (26.7)	27 (45.0)
Interference	4	1 (1.7)	0 (0.0)	7 (11.7)	8 (13.3)
Out of contact	5	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.0)

Using the displayed category counts, baseline VACS distributions did not differ significantly between groups ($U = 1731$, $p = .675$). Post-preparation distributions differed markedly ($U = 0$, $p < .001$). The intervention-group mean VACS score decreased from 2.40 ± 0.53 to 0.02 ± 0.13 ; the

post-preparation control distribution corresponded to a mean of 2.87 ± 0.83 . The intervention-group Wilcoxon analysis yielded $Z = -6.994$, $p < .001$, with $r = .639$, indicating a large within-group shift. These results are summarized in [Table 3](#).

Table 3.

Summary of VACS score comparisons

Comparison	VR mean $\pm$ SD	Control mean $\pm$ SD	U / Z	p	Interpretation
Baseline between groups	2.40 ± 0.53	2.50 ± 0.70	$U = 1731$	.675	No significant baseline difference
Post-preparation between groups	0.02 ± 0.13	2.87 ± 0.83	$U = 0$	< .001	Marked between-group difference
VR pre–post	$2.40 \pm 0.53 \rightarrow 0.02 \pm 0.13$	—	$Z = -6.994$	< .001	Large effect, $r = .639$

Preparation Time

Preparation-time comparisons are presented in [Table 4](#) and the recorded time-category distribution is shown in [Table 5](#). The VR group had a lower mean rank for preparation time (34.13) than the routine-preparation group (86.87), with $U = 218.00$, $Z = -8.341$, $p < .001$.

Table 4.*Between-group comparison of recorded MRI preparation time*

Outcome	Group	n	Mean rank	U	p
Preparation time	VR preparation	60	34.13	218.00	< .001
	Routine preparation	60	86.87		

Note. Mann–Whitney U test; reported $Z = -8.341$.

Table 5.*Distribution of recorded preparation-time categories*

Time category	Minutes	VR n	VR %	Control n (%)
Short	4–6	16	26.7	1 (1.7)
Usual	8–10	44	73.3	36 (60.0)
Longer	10–15	0	0.0	23 (38.3)
Total	—	60	100.0	60 (100.0)

As Table 5 shows, 26.7% of VR-prepared children were recorded in the 4–6-minute category and 73.3% in the 8–10-minute category; none were recorded in the 10–15-minute category. In the routine-preparation group, 38.3% were recorded in the 10–15-minute category. Interpretation of workflow efficiency should remain cautious because the recorded interval did not consistently distinguish whether VR exposure itself was included.

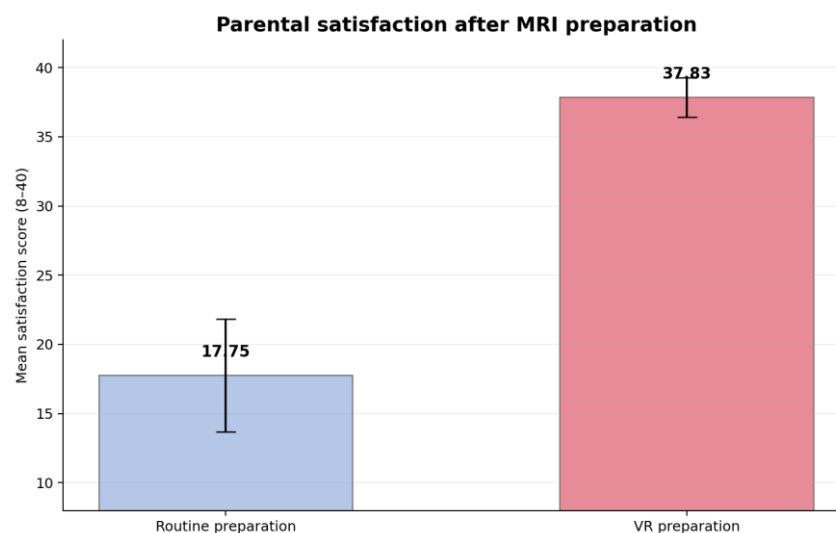
Parental Satisfaction

Parental satisfaction results are summarized in Table 6 and visualized in Figure 3. All 60 parents in the VR group were classified in the high-satisfaction category, whereas the routine-preparation group included 38 parents (63.3%) with low satisfaction and 22 (36.7%) with moderate satisfaction. No routine-preparation parent reached the high-satisfaction category.

Table 6.*Parental satisfaction after MRI preparation*

Satisfaction level	Score range	VR n (%)	Control n (%)	Group mean $\pm$ SD
Low	8–18.66	0 (0.0)	38 (63.3)	VR: 37.83 $\pm$ 1.43
Moderate	18.67–29.33	0 (0.0)	22 (36.7)	Control: 17.75 $\pm$ 4.08
High	29.34–40	60 (100.0)	0 (0.0)	

Note. Satisfaction categories followed the study's predefined cut points. Category distribution: $\chi^2(2) = 120.00$, $p < .001$.

**Figure 3.**

Mean parental satisfaction scores after routine and VR preparation; error bars show ± 1 SD.

Discussion and Conclusion

This quasi-experimental study found a pronounced association between Arabic-language immersive VR preparation and lower observed anxiety before pediatric MRI. The post-preparation distribution shown in [Figure 2](#) was almost completely separated by group, with 98.3% of VR-prepared children rated relaxed. This direction is consistent with randomized and pooled evidence supporting VR-based preparation for pediatric MRI and other anxiety-provoking procedures ([Stunden et al., 2021](#); [Saliba et al., 2025a](#); [Saliba et al., 2025b](#); [Chen et al., 2023](#)).

The magnitude observed here is larger than many effects reported in the broader literature and should therefore be interpreted in light of the study design. Assignment was site-based, not individually randomized, so hospital-specific factors such as staff communication, workflow, environmental familiarity, or patient mix could contribute to the contrast. Nevertheless, the baseline VACS distributions were similar, and the intervention-group shift from tense/reluctant behavior to relaxed behavior is clinically notable.

Interpretation of Anxiety Findings

Immersive preparation can plausibly reduce anticipatory anxiety by increasing predictability and giving children a concrete rehearsal of scanner appearance, sounds, and sequence. Similar mechanisms are emphasized in VR-MRI development and feasibility studies, where familiarity and perceived preparedness emerge as central benefits ([Hudson & Heales, 2025a](#); [Hudson & Heales, 2025b](#); [McCombe et al., 2025](#); [Abd Gani et al., 2023](#)). The use of Arabic-language content may also have increased accessibility for children and parents in the local setting, although language-specific effects were not separately tested.

The findings also align with pediatric evidence outside MRI. Immersive VR has reduced distress in perioperative care and painful procedures, while culturally local nursing studies have reported benefits of non-pharmacological approaches for pediatric fear, anxiety, and pain ([Turgut et al., 2024](#); [Wei et al., 2024](#); [Watheeg Kharbot & Mohammed,](#)

[2025](#); [Atshan et al., 2024](#)). These converging findings support continued evaluation of VR as a preparation tool rather than assuming that benefits are limited to distraction during the procedure itself.

Preparation Time

The lower preparation-time rank in the VR group suggests a potential workflow benefit. Prior MRI-focused work has reported that interactive or immersive rehearsal can improve readiness, reduce repeated explanation, and facilitate cooperation ([Stunden et al., 2021](#); [Johnson et al., 2025](#); [van Spaendonck et al., 2023](#); [Yang et al., 2025](#)). In the present data, 38.3% of routine-preparation children were in the longest recorded category, whereas no VR-prepared child was. However, because the recorded interval did not consistently distinguish whether the VR exposure itself was included, this outcome should be interpreted as recorded operational preparation time rather than a definitive estimate of total staff or room time.

Parental Satisfaction

Parental satisfaction showed complete category separation: every VR-group parent was classified as highly satisfied. This result is directionally consistent with randomized pediatric VR evidence in which caregiver satisfaction or perceived acceptability improved alongside reduced child distress ([Turgut et al., 2024](#); [Ashmore et al., 2019](#)). Qualitative MRI research likewise indicates that parents value preparation that makes the procedure understandable and child-centered ([Johnson et al., 2025](#)). Because satisfaction was measured after parents had observed the preparation experience, the measure may reflect both the intervention and the visible behavioral response of the child.

Strengths and Limitations

Strengths include use of an immersive Arabic-language intervention, a clinically interpretable observational anxiety scale, inclusion of both child and parent outcomes, and recruitment from two tertiary pediatric radiology departments. The study also reports operational preparation-time data, which is relevant to implementation decisions.

Several limitations are important. First, intervention assignment was determined by hospital site, producing potential site-by-treatment confounding and limiting causal inference. Second, the sample-size calculation was precision-based rather than an a priori effect-size power analysis. Third, complete assessor blinding was not feasible. Fourth, the adapted 8-item satisfaction scale had strong internal consistency but was not accompanied by a full construct-validation analysis in this population. Fifth, the preparation-time variable was not documented consistently enough to determine whether VR exposure itself was included. Finally, the study did not assess downstream scan quality, repeat sequences, sedation use, cost-effectiveness, or longer-term acceptance of future MRI.

An Arabic-language, nurse-administered immersive VR preparation program was associated with substantially lower observed anxiety, shorter recorded preparation time, and higher parental satisfaction among children undergoing elective MRI. The consistency of the direction of these findings with prior pediatric VR research is encouraging, but the site-allocated design prevents strong causal conclusions. Future multicenter studies should randomize within sites, use blinded or video-based outcome assessment where possible, define preparation-time measurement prospectively, and evaluate scan quality, sedation avoidance, and cost-effectiveness.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

Ethical Research Committee, College of Nursing, University of Baghdad (Approval No. 325A, February 2025).

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contributed to this study.

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