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A nested case-control analysis of factors influencing preoperative hospitalization fear in pediatric patients and the alleviating effects of child-friendly visual interventions

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Abstract

Background Preoperative fear in pediatric patients can significantly impact their psychological well-being and complicate perioperative care. Traditional hospital environments may exacerbate anxiety in children undergoing elective surgeries, especially given developmental differences across ages 2 to 12.

Methods In a retrospective hospital-based nested case-control study embedded within a cohort, we examined 188 children aged 2 to 12 admitted for elective surgery between March 2023 and March 2024. Participants met specific inclusion criteria and We defined cases as those with a Child Medical Fear Scale (CMFS) score > 30 (High Fear Group) and controls as those with CMFS ≤ 30 (Low Fear Group). Further stratification was based on hospitalization in conventional wards a conventional environment versus specially designed wards featuring "child-friendly visual intervention strategies" (e.g., cartoon themes, interactive toys, multimedia TVs). Standard Routine pre-hospital care (Treatment as Usual) and detailed procedural explanations were provided. Fear Preoperative fear was assessed using the CMFS at admission and before surgery, while parental satisfaction was evaluated with the Patient Satisfaction Questionnaire Short Form (PSQ-18).

Results Among 188 children (mean age 7.57 ± 2.15 years; 64/124 male), 74 cases (high fear) and 71 controls (low fear) were analyzed. No significant demographic differences were observed between groups. Key correlates of higher fear included lower educational status (OR = 0.400, 95% CI = 0.200-0.801; $P = 0.010$) and higher ASA status (OR = 2.273, 95% CI = 1.035–4.989; $P = 0.041$). Environmental stressors such as visibility of sharp instruments (OR = 2.294, 95% CI = 1.048–5.021; $P = 0.038$) and observing injections (OR = 2.565, 95% CI = 1.183–5.557; $P = 0.017$) were significant anxiety factors. The child-friendly intervention group ($n = 43$) exhibited significantly lower fear scores across all dimensions compared to the conventional group ($n = 35$), with a higher proportion achieving CMFS ≤ 30 (76.74% vs. 51.43%; $P = 0.019$) and greater parental satisfaction (79.07% vs. 51.43%; $P = 0.010$).

Conclusion Both individual (e.g., educational status, past hospital experiences) and environmental factors (e.g., visibility of needles) play critical roles in pediatric preoperative fear. Implementing child-friendly visual interventions

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significantly alleviates reduces anxiety and improves parental satisfaction. These findings Our results support the adoption of such strategies in pediatric surgical care and highlight the importance of age-appropriate interventions.

Keywords Pediatric anxiety, Preoperative fear, Child-friendly intervention, Elective surgery, Child development, Patient satisfaction

Introduction

Preoperative hospitalization can be a daunting an intimidating experience for pediatric patients, often accompanied by significant fear [1, 2]. This fear can negatively affect cooperation, post-surgical recovery, and the overall healthcare experience. In children, fear of medical settings is heightened by developmental constraints, an innate apprehension toward unfamiliar environments and an inability to fully comprehend medical procedures [3–5]. If inadequately addressed, fear can manifest as may trigger physiological stress responses, complicating anesthesia induction and recovery [2, 4].

Hospital environments, typically designed with clinical efficiency in mind, may inadvertently amplify pediatric fear [6, 7]. For younger children (e.g., 2–6 years), the inability to distinguish real from imagined threats can exacerbate anxiety, whereas older children (e.g., 7–12 years) may exhibit more anticipatory worry related to perceived outcomes. Traditional hospital aesthetics, featuring sterile, impersonal settings and intimidating medical equipment, can be particularly unsettling for children [8, 9]. Moreover, the presence of unknown healthcare professionals. can significantly heighten anxiety levels. Moreover, repeated encounters with unfamiliar healthcare providers, particularly in white coats, may reinforce negative associations in pediatric patients [10].

Prior medical experiences and a child's cognitive development level are key determinants of fear levels during hospitalization [11, 12]. Familiarity with medical environments through previous admissions can modulate fear responses by offering predictability. Similarly, older children or those in higher educational levels may have greater capacity to process medical explanations, thereby reducing fear related to the unknown [13, 14]. Despite these insights, the interplay of such developmental, experiential, and environmental factors remains incompletely explored.

Recent advances in pediatric care underscore the importance of psychosocial and environmental interventions [15, 16]. Child-friendly visual enhancements—cartoon decorations, interactive play areas, and age-appropriate audiovisual content—present promising avenues for mitigating fear. Studies have shown that visually engaging surroundings can redirect the child's attention from painful stimuli and foster a sense of control [16, 17]. However, empirical data supporting the distinct benefits of child-friendly designs in reducing preoperative fear are still emerging. Moreover, the wide age range of 2 to 12 demands caution in applying uniform interventions.

Therefore, Hence, this study aims to address these gaps by (1) identify the factors contributing to preoperative fear among pediatric patients, and (2) evaluate the impact of child-friendly visual interventions tailored to this wide developmental span.

Methods

Study design

This retrospective case-control study, embedded within a cohort, study employed a hospital-based nested case-control design. The cohort was identified through our hospital's electronic medical records system, including all eligible children admitted for elective surgery between March 2023 and March 2024. We screened 188 children aged 2 to 12 years who were admitted for elective surgery at the Children's Hospital affiliated to Zhejiang University School of Medicine between March 2023 and March 2024.

Sample Size Consideration. Given the retrospective nature of data collection, we used convenience sampling. In future prospective research, a formal sample size calculation by age subgroup is recommended to accommodate developmental differences.In September 2023, our hospital completed… child-friendly visual intervention strategy. As this retrospective study employed de-identified data… informed consent was waived.

Ethical approval

The study was approved by the Ethics Committee of Children's Hospital affiliated to Zhejiang University School of Medicine (2024-ZJ-0128). We confirm that the study strictly adheres to the Declaration of Helsinki.

Inclusion and exclusion criteria

Inclusion Criteria: (1) Age 2–12 years; (2) Elective surgery requiring pre-hospitalization; (3) American Society of Anesthesiologists (ASA) Physical Status Classification I – II; (4) Primary caregiver able to complete study questionnaires in Mandarin.Exclusion Criteria: (1) Children diagnosed with developmental delays or mood anxiety disorders; (2) Children requiring sedative medications; (3) Language barrier precluding questionnaire completion; (4) Children in a comatose state during before the preoperative monitoring period.

Intervention and grouping

From March 2023 to December 2023, children admitted to the conventional wards ($n = 145$) had their CMFS scores assessed via electronic medical records. Although there is no universal consensus on the exact cutoff, we selected 30 based on the natural distribution of scores in our sample, allowing a clear division between lower and higher levels of fear. Children scoring ≤ 30 were categorized as the Low Fear Group (controls), while those scoring > 30 were categorized as the High Fear Group (cases).

Child-Friendly Visual Intervention Group. In September 2023, new wards featuring "child-friendly visual intervention strategies" (e.g., cartoon stickers, colorful foam mats, toys, multimedia TVs) were made available. Using stratified sampling, A subset of 35 patients was selected from the conventional environment, whereas 43 children admitted to the newly designed wards formed the "Child-Friendly Visual Group."

All children received routine pre-hospital care (Treatment as Usual): nursing staff provided basic procedural information, sedation guidelines (if applicable), and ward orientation. The difference was that the Child-Friendly Visual Group experienced additional visual environmental stimuli, potentially offering distraction and emotional comfort.

Outcomes and instruments

General information of pediatric patients

Surgeries classified as levels one or two minor in the pediatric catalog (including day-case surgeries or those requiring ≤ 6 h of postoperative monitoring) were grouped as minor, while the rest were deemed major [18]. ASA (American Society of Anesthesiologists) classification was used to evaluate overall health status [19].

Ward environmental factors

This section examines several environmental factors within the ward, including the presence of visible medical instruments, the observation of others receiving injections, and the frequency of interactions with healthcare providers(categorized as < 1 time/hour vs. ≥1 time/hour). The presence of sharp medical instruments refers to whether such items were visible to children in the ward. The observation of others receiving injections indicates whether children saw other patients being injected during their stay. The frequency of interactions with healthcare providers is categorized based on how often children saw healthcare providers wearing white coats, either less than once per hour or once per hour or more.

Fear level of pediatric patients

We used the Child Medical Fear Scale (CMFS) developed by Broome (1988) to assess fear at admission and before surgery. For younger children (particularly ages 2–5), the caregiver's report and the child's behavioral cues were considered. The CMFS has four dimensions: fear of the medical environment, fear of medical procedures, fear of interpersonal relationships, and self-fear, with 17 items scored 1 (no fear), 2 (some fear), or 3 (extreme fear). Higher total scores reflect greater fear. In this study, Cronbach's α was 0.87 [20].

Patient satisfaction questionnaire (PSQ-18)

The PSQ-18 (Patient Satisfaction Questionnaire Short Form) [Marshall GN, Hays RD, RAND Corp, 1994] was administered to the child's primary caregiver at the end of pre-hospitalization. This 18-item tool uses a 5-point Likert scale, 1="very dissatisfied" to 5="very satisfied" with total scores ranging 18–90, higher scores indicating greater overall satisfaction. Cronbach's α was 0.834 in our sample [21].

Statistical methods

The measurement data are presented as either mean ± standard deviation or median interquartile range, depending on conformity to a normal distribution as determined by Shapiro-Wilk tests. Categorical data are expressed as frequency and percentage. Unpaired t-tests were utilized to compare continuous variables between the two groups. Chi-square tests or Fisher's exact tests were used for categorical variables.Both univariate and multivariate logistic regression models examined factors (demographic: age, gender, education, prior admission, ASA status; environmental: visible instruments, injection observations, provider encounters) contributing to high fear (CMFS > 30) versus low fear (CMFS ≤ 30), with odds ratios (OR) and 95% confidence intervals (CI) reported. Variables showing significance ($P < 0.10$) in univariate analysis were included in the multivariate model. Multicollinearity among variables was assessed using variance inflation factors.A statistical significance level was set at $P < 0.05$. All statistical analyses were performed using SPSS version 22 (SPSS Inc., Chicago, IL, USA) and the R software package version 3.0.2 (Free Software Foundation, Inc., Boston, MA, USA).

Results

General information related influencing factors of fear of pre-hospitalization in children

In this study, we analyzed factors influencing preoperative hospitalization fear in pediatric patients and the effect of child-friendly visual interventions. No significant differences were observed between the Low Fear Group ($n = 71$) and the High Fear Group ($n = 74$) regarding age, body mass index, gender, ethnicity, only child status, residency, parental education level, family monthly income, type of surgery, and pre-hospitalization days ($P > 0.05$ for all). However, there were significant differences in

educational status ($P = 0.003$), previous hospital admission ($P = 0.038$), history of surgery ($P = 0.018$), and ASA status ($P = 0.024$) between the two groups. Children in the High Fear Group were more likely to have primary school education (66.22% vs. 39.44%), fewer previous hospital admissions (29.73% vs. 46.48%), a lower incidence of prior surgery (13.51% vs. 29.58%), and were more commonly classified as ASA I (72.97% vs. 54.93%) compared to the Low Fear Group. These findings suggest that certain demographic and clinical factors may influence levels of preoperative fear in pediatric patients.(See Table 1).

Table 1 General information of pediatric patients

Parameters	Low Fear Group ($n = 71$)	High Fear Group ($n = 74$)	t/χ2	*P*
Age (years)	7.63 ± 2.14	7.52 ± 2.17	0.315	0.753
Body Mass Index (kg/m^2)	16.53 ± 2.04	16.62 ± 2.09	0.237	0.813
Gender (male/female)	31/40	33/41	0.013	0.91
Ethnicity [n (%)]			0.007	0.935
- Han	64 (90.14%)	67 (90.54%)	0.315	0.753
- Other	7 (9.86%)	7 (9.46%)		
Educational Status [n (%)]			11.498	0.003
- Not enrolled (2)	5 (%)	1 (1.35%)		
- Kindergarten	38 (39.44%)	24 (32.43%)		
- Primary school	28 (%)	49 (66.22%)		
Only child [n (%)]	34 (47.90%)	36 (48.65%)	0.008	0.927
Residency [n (%)]			0.216	0.642
- Rural	28 (39.44%)	32 (43.24%)		
- Urban	43 (60.56%)	42 (56.76%)		
Parental education level [n (%)]			0.248	0.969
- College and above	27 (38.03%)	31 (41.89%)		
- High school	22 (29.58%)	22 (29.73%)		
- Elementary school	15 (19.72%)	14 (18.92%)		
- Illiterate	7 (9.86%)	7 (9.46%)		
Family monthly income [n (%)]			0.071	0.965
- <3000 CNY	9 (12.68%)	10 (13.51%)		
– 3000–5000 CNY	24 (33.80%)	26 (35.14%)		
- >5000 CNY	38 (53.52%)	38 (51.35%)		
Previous hospital admission [n (%)]	33 (46.48%)	22 (29.73%)	4.318	0.038
History of surgery [n (%)]	21 (29.58%)	10 (13.51%)	5.563	0.018
Type of Surgery [n (%)]			0.211	0.646
- Major Surgery	15 (21.13%)	18 (24.32%)		
- Minor Surgery	56 (78.87%)	56 (75.68%)		
ASA-status [n (%)]			5.129	0.024
- I	39 (54.93%)	54 (72.97%)		
- II	32 (45.07%)	20 (27.03%)		
Pre-hospitalization days (days)	3.21 ± 1.04	3.24 ± 1.07	0.195	0.846

ASA = American Society of Anesthesiologists

Environmental factors related influencing factors of fear of pre-hospitalization in children

In our analysis of environmental factors affecting preoperative hospitalization fear in pediatric patients, several significant differences were observed between the Low Fear Group and the High Fear Group. The presence of sharp medical instruments was more frequently reported in the High Fear Group (60.81%) compared to the Low Fear Group (38.03%) (χ^2=7.523, $P = 0.006$) (Fig. 1). Additionally, children in the High Fear Group were more likely to observe others receiving injections (55.41% vs. 30.99%; χ^2=8.794, $P = 0.003$). Furthermore, the frequency of seeing healthcare providers varied significantly between groups, with the High Fear Group more often encountering providers once per hour or more (43.24% vs. 25.35%; χ^2=5.134, $P = 0.023$). These results suggest that certain ward environmental factors may contribute to heightened levels of preoperative fear in pediatric patients.

Correlation analysis of each variable with high fear of pre-hospitalization in children

The analysis of factors influencing preoperative hospitalization fear in pediatric patients revealed several significant correlations. Educational status demonstrated a negative correlation with preoperative fear (rho = -0.279, $P < 0.001$), indicating that higher educational status is associated with lower levels of fear. Similarly, previous hospital admissions (rho = -0.173, $P = 0.038$) and history of surgery (rho = -0.196, $P = 0.018$) were negatively correlated, suggesting that prior medical experiences may mitigate fear. Conversely, ASA status showed a positive correlation with fear (rho = 0.188, $P = 0.023$), implying that children in higher ASA categories tend to experience greater fear. Environmental factors, including the presence of sharp medical instruments (rho = 0.228, $P = 0.006$), observing others receiving injections (rho = 0.246, $P = 0.003$), and frequency of seeing healthcare providers (rho = 0.188, $P = 0.023$) (Table 2), also presented positive correlations, indicating these aspects contribute to increased anxiety. Overall, both individual and environmental variables significantly impact preoperative fear in pediatric patients.

Logistic regression analysis of influencing factors and high fear of pre-hospitalization in children

The univariate logistic regression analysis identified several significant risk factors influencing preoperative hospitalization fear in pediatric patients. Educational status emerged as a protective factor, with an odds ratio (OR) of 0.355 (95% CI, 0.188–0.646; $P < 0.001$), indicating lower fear among children with higher educational status. Previous hospital admissions (OR, 0.487; 95% CI, 0.244–0.959; $P = 0.039$) and history of surgery (OR, 0.372; 95% CI, 0.155–0.843; $P = 0.021$) were also associated

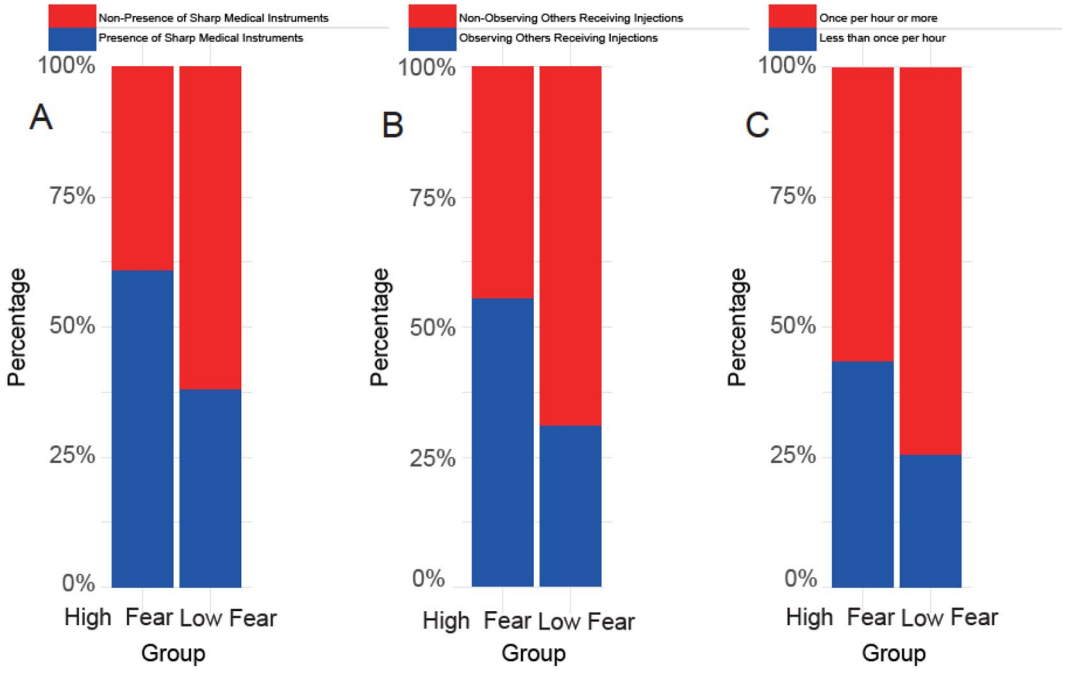

Fig. 1 Difference analysis of environmental factors in the ward between the two groups. **A**: Presence of Sharp Medical Instruments. **B**: Observing Others Receiving Injections. **C**: Frequency of Seeing Healthcare Providers

Table 2 Correlation analysis of each variable with high fear of pre-hospitalization in children

Variable	rho	*P* value
Educational Status	-0.279	$p < 0.001$
Previous hospital admission	-0.173	0.038
History of surgery	-0.196	0.018
ASA-status	0.188	0.023
Presence of Sharp Medical Instruments	0.228	0.006
Observing Others Receiving Injections	0.246	0.003
Frequency of Seeing Healthcare Providers	0.188	0.023

ASA = American Society of Anesthesiologists

with reduced fear levels. Conversely, higher ASA status was linked to increased fear (OR, 2.215; 95% CI, 1.115–4.487; $P = 0.025$), as was the presence of sharp medical instruments (OR, 2.529; 95% CI, 1.304–4.987; $P = 0.007$), observing others receiving injections (OR, 2.767; 95% CI, 1.413–5.533; $P = 0.003$), and frequent encounters with healthcare providers (OR, 2.243; 95% CI, 1.118–4.607; $P = 0.025$).(See Table 3).

In the multivariate logistic regression analysis, educational status continued to show a significant protective effect (OR, 0.400; 95% CI, 0.200-0.801; $P = 0.010$). While previous hospital admissions were not statistically significant (OR, 0.604; 95% CI, 0.273–1.336; $P = 0.213$), a history of surgery remained a significant factor in reducing fear (OR, 0.359; 95% CI, 0.142–0.913; $P = 0.031$). Increased odds of fear were confirmed for higher ASA status (OR, 2.273; 95% CI, 1.035–4.989; $P = 0.041$), the presence of sharp medical instruments (OR, 2.294; 95% CI, 1.048–5.021; $P = 0.038$), observing others receiving injections (OR, 2.565; 95% CI, 1.183–5.557; $P = 0.017$), and frequent interaction with healthcare providers (OR, 2.321; 95% CI, 1.040–5.180; $P = 0.040$). These findings suggest that both individual and environmental factors

Table 3 Single factor logistic regression analysis of influencing factors and high fear of pre-hospitalization in children

Risk Factors	Coefficient	SE	Wald	OR (95% CI)	*P* value
Educational Status	-1.036	0.314	3.296	0.355 (0.188–0.646)	< 0.001
Previous hospital admission	-0.719	0.348	2.065	0.487 (0.244–0.959)	0.039
History of surgery	-0.989	0.428	2.310	0.372 (0.155–0.843)	0.021
ASA-status	0.795	0.354	2.246	2.215 (1.115–4.487)	0.025
Presence of Sharp Medical Instruments	0.928	0.341	2.718	2.529 (1.304–4.987)	0.007
Observing Others Receiving Injections	1.018	0.347	2.931	2.767 (1.413–5.533)	0.003
Frequency of Seeing Healthcare Providers	0.808	0.360	2.245	2.243 (1.118–4.607)	0.025

ASA = American Society of Anesthesiologists

contribute significantly to preoperative fear in pediatric patients.(See Table 4).

Alleviating effect of child-friendly visual intervention strategy of fear of pre-hospitalization

Given the significant role that visual stimuli play in shaping children's perceptions and emotions, particularly in clinical settings, it is logical to hypothesize that targeted visual interventions could mitigate preoperative fear. Our study aimed to explore this hypothesis by comparing the effectiveness of a child-friendly visual intervention strategy against conventional hospital environments.

In our study of the alleviating effects of child-friendly visual interventions on preoperative hospitalization fear in pediatric patients, both the intervention and control groups showed no significant differences in demographic characteristics, including age, BMI, gender, ethnicity, educational status, residency, parental education level, family income, previous hospital admissions, surgical history, type of surgery, ASA status, or pre-hospitalization days ($P > 0.05$ for all)(Table 5). Baseline fear levels, as assessed by the Child Medical Fear Scale (CMFS), were similar across groups, with no significant differences in any fear category or total scores ($P > 0.05$ for all)(Table 6). However, at the conclusion of the pre-hospitalization period, the Child-Friendly Visual Group exhibited significantly lower fear scores across all dimensions: fear of the medical environment ($P = 0.024$), fear of medical procedures ($P = 0.006$), fear of interpersonal relationships ($P = 0.014$), and self-fear ($P = 0.007$), as well as a lower total fear score, with a greater proportion of patients scoring ≤ 30 (76.74% vs. 51.43%; $P = 0.019$)(Table 7). Furthermore, parent satisfaction was notably higher in the intervention group, with an overall satisfaction rate of 79.07% compared to 51.43% in the conventional group ($P = 0.010$) (Table 8). These findings suggest that child-friendly visual interventions significantly reduce preoperative fear and enhance parental satisfaction.

Table 4 Multivariate logistic regression analysis of influencing factors and high fear of pre-hospitalization in children

Risk Factors	Coefficient	SE	Wald	OR (95% CI)	*P* value
Educational Status	-0.916	0.354	-2.588	0.400 (0.200-0.801)	0.010
Previous hospital admission	-0.504	0.405	-1.244	0.604 (0.273–1.336)	0.213
History of surgery	-1.023	0.476	-2.152	0.359 (0.142–0.913)	0.031
ASA-status	0.821	0.401	2.047	2.273 (1.035–4.989)	0.041
Presence of Sharp Medical Instruments	0.830	0.400	2.078	2.294 (1.048–5.021)	0.038
Observing Others Receiving Injections	0.942	0.395	2.387	2.565 (1.183–5.557)	0.017
Frequency of Seeing Healthcare Providers	0.842	0.410	2.055	2.321 (1.040-5.0-180)	0.040

ASA = American Society of Anesthesiologists

Discussion

Our findings shed light on the complex interplay between developmental, experiential, and environmental factors influencing preoperative fear in children aged 2 to 12. First, educational maturity and prior hospital experiences proved crucial in lessening fear, suggesting that familiarity and a child's cognitive abilities moderate anxieties about the unknown. This aligns with cognitive-behavioral theories proposing that repeated, controlled exposure to anxiety-provoking stimuli can reduce fear over time [22, 23].

Second, environmental elements—visible sharp instruments, observing injections, and frequent encounters with providers in white coats—amplified fear. These results resonate with the Fear-Avoidance Model, where stimuli associated with pain or threat become potent cues for anxiety [24, 25]. Minimizing or masking these elements in pediatric wards could mitigate negative emotional responses, particularly in younger or less cognitively advanced children. This indicates an alignment with the Fear-Avoidance Model, where fear of pain leads to avoidance behaviors, which are maladaptive in the hospital setting [26].

The presence of sharp instruments and witnessing invasive procedures may invoke a visceral fear response, especially in children who naturally lack mature coping mechanisms. This suggests the potential benefit of minimizing visible medical paraphernalia in pediatric spaces and creating more comforting, non-clinical visual cues. The frequency of seeing healthcare providers dressed in clinical attire was also associated with heightened fear, possibly due to the association of such attire with medical procedures, reinforcing that interactions in non-threatening appearances or attire might mitigate anxiety [27–29].

Understanding the significant impact of visual stimuli on children's emotional states in clinical settings, it is reasonable to consider that targeted visual interventions could effectively reduce preoperative fear. Our study explored this concept by comparing the effectiveness of a child-friendly visual intervention strategy with conventional hospital environments. The results of our analysis provide empirical evidence that altering the visual environment to be more child-friendly can significantly

Table 5 General data between the two groups

Parameters	Conventional Group (*n* = 35)	Child-Friendly Visual Group (*n* = 43)	t/χ2	*P*
Age (years)	7.54 ± 2.12	7.56 ± 2.04	0.042	0.967
Body Mass Index (kg/m^2)	16.45 ± 2.31	16.67 ± 2.23	0.424	0.673
Gender (male/female)	21/14	23/20	0.333	0.564
Ethnicity [n (%)]			0.000	1.000
- Han	32 (91.43%)	39 (90.70%)		
- Other	3 (8.57%)	4 (9.30%)		
Educational Status [n (%)]			0.168	0.919
- Not enrolled (2)	2 (5.71%)	3 (6.98%)		
- Kindergarten	17 (48.57%)	19 (44.19%)		
- Primary school	16 (45.71%)	21 (48.84%)		
Only child [n (%)]	20 (57.14%)	24 (55.81%)	0.014	0.906
Residency [n (%)]			0.014	0.906
- Rural	15 (42.86%)	19 (44.19%)		
- Urban	20 (57.14%)	24 (55.81%)		
Parental education level [n (%)]			0.027	0.999
- College and above	10 (28.57%)	12 (27.91%)		
- High school	15 (42.86%)	18 (41.86%)		
- Elementary school	7 (20.00%)	9 (20.93%)		
- Illiterate	3 (8.57%)	4 (9.30%)		
Family monthly income [n (%)]			0.089	0.957
- <3000 CNY	7 (20.00%)	9 (20.93%)		
– 3000–5000 CNY	15 (28.57%)	17 (39.53%)		
- >5000 CNY	13 (31.43%)	17 (39.53%)		
Previous hospital admission [n (%)]	19 (54.29%)	21 (48.84%)	0.229	0.632
History of surgery [n (%)]	13 (37.14%)	14 (32.56%)	0.179	0.672
Type of Surgery [n (%)]			0.026	0.872
- Major Surgery	12 (34.29%)	14 (32.56%)		
- Minor Surgery	23 (65.71%)	29 (67.44%)		
ASA-status [n (%)]			0.059	0.808
- I	30 (85.71%)	36 (83.72%)		
- II	5 (14.29%)	7 (16.28%)		
Pre-hospitalization days (days)	3.21 ± 1.23	3.28 ± 1.21	0.228	0.820

CNY = Chinese Yuan

Table 8 Analysis on the difference of parents' satisfaction with treatment between two groups

Parameters	Conventional Group (*n* = 35)	Child-Friendly Visual Group (*n* = 43)	t/χ2	*P*
Very Satisfied	6 (17.14%)	12 (27.91%)		
Satisfied	12 (34.29%)	22 (51.16%)		
Neutral	11 (31.43%)	5 (11.63%)		
Dissatisfied	6 (17.14%)	4 (9.30%)		
Overall satisfaction rate	18 (51.43%)	34 (79.07%)	6.634	0.010

Table 6 Baseline fear level CMFS between the two groups

Parameters	Conventional Group (*n* = 35)	Child-Friendly Visual Group (*n* = 43)	t/χ2	*P*
Fear of Medical Environment (Scores)	7.64 ± 2.31	7.52 ± 2.98	0.195	0.846
Fear of Medical Procedures (Scores)	7.22 ± 2.13	7.14 ± 2.26	0.15	0.881
Fear of Interpersonal Relationships (Scores)	6.42 ± 2.84	6.39 ± 2.53	0.056	0.955
Self-fear (Scores)	6.71 ± 2.05	6.64 ± 2.09	0.162	0.872
Total Score [n (%)]				
-≤30	16 (45.71%)	18 (41.86%)		
->30	19 (54.29%)	25 (58.14%)		

Table 7 CMFS of fear level between the two groups at the end of pre-hospitalization

Parameters	Conventional Group (*n* = 35)	Child-FriendlyVisualGroup (*n* = 43)	t/χ2	*P*
Fear of Medical Environment	7.21 ± 2.29	6.04 ± 2.18	2.304	0.024
Fear of Medical Procedures	6.83 ± 2.01	5.48 ± 2.17	2.827	0.006
Fear of Interpersonal Relationships	6.28 ± 2.24	5.02 ± 2.19	2.51	0.014
Self-fear	6.52 ± 2.04	5.27 ± 1.91	2.791	0.007
Total Score [n (%)]			5.464	0.019
-≤30	18 (51.43%)	33 (76.74%)		
->30	17 (48.57%)	10 (23.26%)		

CMFS: Child Medical Fear Scale

reduce preoperative fear and enhance the overall hospital experience for pediatric patients and their families.

The introduction of child-friendly visual interventions indeed resulted in a marked reduction in preoperative fear levels across all measured dimensions. These interventions, characterized by vibrant, visually stimulating environments featuring cartoon-themed aesthetics and interactive elements, appear to engage children's attention and imagination in positive ways, providing distraction and reducing the psychological distance from the clinical realities of hospitalization.

Child-friendly visual intervention strategies significantly reduced fear and improved caregiver satisfaction. This aligns with prior research emphasizing distraction, engagement, and positive visual cues in alleviating pediatric distress [15, 30]. Although our interventions targeted a broad age range (2–12 years), our data suggest that multi-sensory, interactive environments can benefit children at varying developmental stages. However, tailoring the content and complexity of such interventions to specific age groups might yield even stronger effects, which future research can clarify.

Comparison With Other Studies. Similar interventions worldwide (e.g., specialized play therapy, cartoon-based anesthesia orientation) have reported parallel decreases in preoperative and perioperative anxiety [31, 32]. However, some studies emphasize the importance of subdividing children into narrower age brackets (e.g., 2–5 vs. 6–12) for more developmentally attuned interventions [2, 25]. Our study's single-center design and convenience sampling limit generalizability, yet consistent findings with the broader literature bolster confidence in our conclusions. The interactive nature of the environment may contribute to a sense of autonomy and control, further reducing fear as children are empowered to engage with their surroundings actively [33].

Limitations

The retrospective nature and the wide age range raise concerns about grouping children uniformly with the same instrument (CMFS). Future investigations, ideally prospective and multicentric, should use validated measures tailored to narrower developmental stages. Additionally, the potential temporal bias introduced by implementing the child-friendly wards at a specific point in time could impact results, although we have acknowledged and controlled for the difference in baseline variables.

Conclusion

This hospital-based nested case-control study highlights the multifactorial nature of pediatric preoperative fear, spanning a child's developmental level, prior medical experiences, and ward environmental factors. By integrating child-friendly visual interventions, healthcare facilities may significantly reduce fear and increase parental satisfaction across a wide pediatric age range. While our findings are promising, we encourage further age-stratified studies with rigorous prospective designs to refine and optimize these interventions.

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Author contributions
LXB and TTZ were involved in the conception and design, or analysis and interpretation of the data; XMS and YSW the drafting of the paper, revising it critically for intellectual content; LXB and XMS the final approval of the version to be published; and that all authors agree to be accountable for all aspects of the work.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics statement
This study adhered to the Declaration of Helsinki. Informed consent was waived due to the retrospective, de-identified data collection.

Consent for publication
All authors have agreed to publish.

Competing interests
The authors declare no competing interests.

Clinical trial number
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