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REVIEW

Effect of a game-based intervention on preoperative pain and anxiety in children: A systematic review and meta-analysis

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Abstract

Background: Games are increasingly being used as a means of alleviating pain and anxiety in paediatric patients, in the view that this form of distraction is effective, non-invasive and non-pharmacological.

Aims: To determine whether a game-based intervention (via gamification or virtual reality) during the induction of anaesthesia reduces preoperative pain and anxiety in paediatric patients.

Methods: A systematic review with meta-analysis of randomised controlled trials was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and using RevMan software. The review was based on a search of the EMBASE, CINAHL, Medline, SciELO and Scopus databases, conducted in July 2021. No restriction was placed on the year of publication.

Results: 26 studies were found, with a total study population of 2525 children. Regarding pain reduction, no significant differences were reported. For anxiety during anaesthesia induction, however, a mean difference of −10.62 (95% CI −13.85, −7.39) on the Modified Yale Preoperative Anxiety Scale, in favour of game-based intervention, was recorded.

Conclusions: Game-based interventions alleviate preoperative anxiety during the induction of anaesthesia in children. This innovative and pleasurable approach can be helpful in the care of paediatric surgical patients.

Relevance to clinical practice: In children, preoperative management is a challenging task for healthcare professionals, and game-based strategies could enhance results, improving patients' emotional health and boosting post-surgery recovery. Distractive games-based procedures should be considered for incorporation in the pre-surgery clinical workflow in order to optimise healthcare.

KEYWORDS

anxiety, children, game, pain, perioperative care, virtual reality

1 | INTRODUCTION

Surgery is often a highly stressful experience for children, during which the induction of anaesthesia is a critical period (Kain et al., 2006; Walther-Larsen et al., 2016). At this time, up to 30% of children experience moderate to severe levels of pain and up to 60%, high levels of anxiety (Gates et al., 2020; Perrott et al., 2018). Preoperative anxiety begins when the patient first learns of the need for surgery and can peak at any moment before the actual surgery (Fortier et al., 2010). Furthermore, apprehension regarding the surgical intervention may be heightened by related factors, such as an unfamiliar environment, separation from parents or the fear of needles or other procedures (Drasković et al., 2015).

What does this paper contribute to the wider global clinical community?

- Game-based distraction is an effective non-pharmacological resource in paediatric preoperative care.
- Such interventions reduce preoperative anxiety levels in children undergoing painful procedures.
- This innovative and pleasurable approach can enhance the care of paediatric surgical patients during the induction of anaesthesia.

1.1 | Background

Intense anxiety can affect children's physical and psychological health, provoke adverse postoperative outcomes that delay recovery and rehabilitation, and negatively affect a child's cooperation in self-care (Drasković et al., 2015; Fortier et al., 2011). Up to 20% of children undergoing surgery may present signs of stress and psychological pressure (delirium and negative behavioural changes), which in some cases persist for months after surgery (Aytekin et al., 2016; Beringer et al., 2014). In addition, preoperative anxiety is associated with higher levels of postoperative pain (Caumo et al., 2000), and may even triple the consumption of analgesics (Wollin et al., 2003).

Both pharmacological and non-pharmacological treatments can be used to combat preoperative anxiety and pain (Manyande et al., 2015; Perry et al., 2012). The approach most commonly adopted is that of premedication, but this frequently has adverse effects such as nausea and vomiting. Sedatives, too, can have undesirable consequences, sometimes producing delirium, agitation or even pain (Manyande et al., 2015). However, an alternative approach is available, in the form of non-pharmacological interventions based on pleasurable activities such as music, painting, games, movies, tablet apps, video games or virtual reality (Gómez-Urquiza et al., 2016; Manyande et al., 2015).

Game-based interventions (via gamification or virtual reality) can provide distraction and effectively complement traditional pain and anxiety-reducing methods (Alqudimat et al., 2021). This non-pharmacological approach can enhance social and communication skills, help project fears, feelings and emotions and foster cooperation with health professionals during medical procedures (Lestari et al., 2017).

Some recent studies in this context have focused on game-based learning, or 'serious games', that include game mechanics aimed at helping children and parents cope with the preparation for a surgical intervention (Vrancken et al., 2021). Other researchers have conducted systematic reviews to investigate the clinical application of virtual reality to reduce anxiety in paediatric and burn patients (Ang et al., 2021) or during dentistry (Cunningham et al., 2021). Similarly, immersive technologies have been used to alleviate anxiety and assist chronic pain management in adolescents (Alqudimat et al., 2021). Other studies have analysed the use of audio-visual distraction techniques (based on cartoons, video clips, interactive games, virtual reality or humanoid robots) for children subjected to painful procedures such as venous access, cancer therapy or treatment for burns (Chen et al., 2020; Chow et al., 2016; Eijlers, Utens, et al., 2019; Gates et al., 2020; Gerçeker et al., 2020). The use of smart-technology interventions, such as games or videos streamed from mobile phones or tablets, or immersive video headsets for paediatric patients, has also been investigated (Rantala et al., 2020).

The use of games-based and audio-visual interventions as distractive resources is a new concept that could effectively reduce perioperative pain and anxiety. However, the effect produced in a preoperative setting remains controversial. Some studies have focused on the effect of non-pharmacological interventions on children during the preoperative period (Caruso et al., 2020; Won et al., 2017), and meta-analyses have been conducted of virtual reality interventions, although not specifically focused on children (Kenney & Milling, 2016). Nevertheless, to the best of our knowledge, no previous studies have been undertaken to analyse the specific effect produced by these novel interventions during the induction of anaesthesia, with respect to the possible alleviation of pain and/or anxiety.

Although game-based interventions are increasingly being employed in the preoperative period for children, their development and adaptation to different settings and types of surgery are still a challenging problem. In our opinion, an analysis of randomised clinical trials conducted in different settings would provide valuable evidence of the effects of game-based interventions in this context.

2 | AIM

The objective of this systematic review and meta-analysis is to determine the effect of game-based interventions (via gamification or virtual reality) during the induction of anaesthesia to reduce pain and anxiety in paediatric patients.

3 | METHODS

3.1 | Design

This systematic review and meta-analysis were performed following the PRISMA recommendations (Page et al., 2021). The study is registered in the PROSPERO database (International Prospective Register of Systematic Reviews) with number CRD42021270072.

3.2 | Search strategy

The following databases were consulted: EMBASE (Ovid), CINAHL (Ebsco), Medline (Ovid), SciELO (BIREME Virtual Health Library) and Scopus (Elsevier). Grey literature was also consulted, but no relevant studies were found. The Mesh terms employed in the search strategy were '(game OR gamification OR virtual reality) AND (preoperative OR perioperative) AND (anxiety OR pain) AND child*'. The search was conducted in July 2021 in accordance with the PICOS (Population, Intervention, Comparison, Outcome and Study) strategy (see Table 1). The search question was as follows: What effect does a game-based intervention programme have on the pain and anxiety felt during anaesthesia induction by children aged up to 12 years?

3.3 | Search outcomes

Articles meeting the following criteria were included: (1) randomised controlled trials; (2) sample composed exclusively of children; (3) evaluation of an intervention compared with a control group; (4) game, gamification or virtual reality-based intervention; (5) analysis of the impact of the intervention on pain and anxiety levels, measured before and at the time of anaesthesia induction (with no time restriction on time before induction) and (6) use of a validated measurement tool (Table 2). No restriction was placed on the language or year of publication.

The following types of study were excluded: (1) protocol studies; (2) studies without randomisation and a control group; (3) studies with an adult sample and (4) studies including a non-games-based intervention.

The studies were selected for inclusion by two independent reviewers, according to the following process: first, the studies were assessed by title and abstract against the eligibility criteria, after which a full-text assessment was performed (see Figure 1). If the reviewers disagreed, a third reviewer was requested to make the final decision.

3.4 | Quality appraisal

For quality assessment of randomised controlled trials, the levels of evidence and grades of recommendation stipulated by the OCEBM (Oxford Centre for Evidence-Based Medicine) were used (Howick et al., 2011; see Table 2). The risk of bias was analysed using the 'Risk of Bias Assessment' (RoB 2.0; Sterne et al., 2019). The risk of bias and quality of evidence assessment were performed independently and in duplicates by two reviewers.

3.5 | Data extraction

All data were extracted and collated in a spreadsheet by two of the authors. In case of disagreement, a third author reviewed this process. For each of the studies found, the following variables were obtained: (1) author, year, country of publication; (2) study design; (3) sample characteristics; (4) study aim; (5) characteristics of the intervention; (6) type of surgery performed; (7) measuring instruments used and (8) main results obtained (see Table 2).

The reliability of the researchers' data coding was checked by calculating the intraclass correlation coefficient, obtained as 0.97 (minimum = 0.94; maximum = 1). Cohen's Kappa coefficient of the categorical variables was 0.96 (minimum = 0.93; maximum = 1).

3.6 | Synthesis

The results of the systematic review and data extraction were subjected to a descriptive analysis and data table classification. The studies presenting sufficient statistical data were used to perform a meta-analysis. Heterogeneity was analysed using the I^2 index, which represents the percentage of variation attributable to statistical heterogeneity. Fixed or random-effects analysis was employed according to the heterogeneity of the sample. Thus, if the I^2 value was greater than 50%, a random-effects analysis was used. Two random-effects meta-analyses were performed to estimate the effect size of game-based interventions, one for preoperative anxiety measured with mYPAS (the modified Yale Preoperative Anxiety Scale) and the other with mYPAS-SF (the modified Yale Preoperative Anxiety-Short Form). The effect size was estimated from the sample size of the intervention and control groups, and the means and standard deviations were calculated for each group during anaesthesia induction. Publication bias was assessed using funnel plots, and sensitivity analysis was also performed. Cochrane RevMan Web software was used for all statistical calculations.

TABLE 1 PICOS search strategy

Participants	Intervention	Comparison	Outcomes	Study
Children (up to 12 years of age)	Interactive game, gamification or virtual game before surgery	Control group (traditional intervention, usual medication, no distraction aids or other intervention)	Anxiety Pain	Randomised controlled trials

TABLE 2 Characteristics of the included studies ($n = 26$)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results *M* (SD)/median (IQR)	EL/RG
Al-Nerabieah et al. (2020), Syria	RCT	*N* = 64 Age 6–10 years n CG = 32 n IG = 32	To evaluate VR glasses in the dental waiting room	CG: no intervention IG: a cartoon shows through VR eyeglasses in the waiting room (5 min play) Time before anaesthesia 20 min	Dental surgery	mYPAS-SF WBFPRS	**Baseline** *mYPAS-SF* CG: 57.02 (7.53) IG: 37.31 (15.39) **Induction** *mYPAS-SF* CG: 78.96 (8.24) IG: 45.89 (12.96) $p \leq .001$ *WBFPRS* CG: 4.09 (0.85) IG: 1.56 (1.16) $p \leq .001$	1b/A
Buffel et al. (2019), Belgium	RCT	*N* = 20 Age 6–10 years n CG = 8 n IG = 12	To evaluate perioperative anxiety	CG: no intervention IG: a serious game-CliniPup® (2 days play prior to surgery)	Ambulatory surgery (dental and ENT)	mYPAS	**Induction** CG: 51.88 (15.57) IG: 31.67 (7.79) $p = .01$	1b/A
Buyuk et al. (2021), Turkey	RCT	*N* = 78 Age 5–10 years n CG = 38 n IG = 40	To examine the effects of VR intervention on anxiety levels	CG: no intervention IG: VR glasses (5 min play)	Circumcision	CAM-S	VR interventions were effective in reducing anxiety in the preoperative period	1b/A
Chaurasia et al. (2019), India	RCT	*N* = 80 Age 4–8 years n CG = 40 n IG = 40	To evaluate the efficacy of an incentive-based game therapy in reducing preoperative anxiety	CG: no intervention IG: incentive-based game Time before anaesthesia 1 day	Elective surgery (ophthalmology, urology, orthopaedic, general)	mYPAS	**Baseline** CG: 27.1 (3.4) IG: 26.6 (3.5) **Induction** CG: 52.6 (11.4) IG: 32.4 (6.5) $p < .001$	1b/A
Clausen et al. (2021), Denmark	RCT	*N* = 60 Age 3–6 years n CG = 30 n IG = 30	To evaluate anxiety level after a game on a tablet computer	CG: no intervention IG: game on a tablet computer Time before anaesthesia 20 min	Elective minor (abdominal and urologic surgery)	mYPAS	**Baseline** CG: 39.0 (2.3) IG: 39.2 (3.0) **Induction** CG: 65.8 (3.4) IG: 55.7 (4.2) [95% CI, −0.63 to 20.8; $p = .066$]	1b/A

(Continues)

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results M (SD)/median (IQR)	EL/RG
Dehghan et al. (2019), Iran	RCT	$N = 40$ Age 6–12 years n CG = 20 n IG = 20	To investigate the effect of VR technology on preoperative anxiety	CG: no intervention IG: VR (5 min play)	Abdominal surgery	YPAS	Intervention showed significant reduction in the preoperative anxiety score after therapeutic exposure using VR	1b/A
Dwairej et al. (2020), Jordan	RCT	$N = 128$ Age 5–11 years n CG = 64 n IG = 64	To evaluate the effectiveness of video game distraction on the preoperative anxiety	CG: no intervention IG: videogame Time before anaesthesia 20 min	Elective surgery (ENT, orthopaedic, dental, genital surgery)	mYPAS	**Baseline** CG: 43.93 (12.04) IG: 43.49 (11.24) **Induction** CG: 63 (15.66) IG: 42.67 (13.91) $p < .001$	1b/A
Eijlers, Dierckx, et al. (2019), Netherlands	RCT	$N = 191$ Age 4–12 years n CG = 97 n IG = 94	To investigate if VR exposure is associated with lower levels of anxiety	CG: no intervention IG: VR (15 min play) Time before anaesthesia 30–60 min	Elective maxillofacial, dental or ENT	mYPAS	**Baseline Median (IQR)** CG: 26.7 [23.3–32.5] IG: 28.3 [23.3–31.7] **Induction** CG: 38.3 [28.3–53.3] IG: 40.0 [28.3–58.3] $p = .862$	1b/A
Forouzandeh et al. (2020), Iran	RCT	$N = 172$ Age 3–12 years n CG = 53 n IG1 = 64 n IG2 = 55	To analyse the effect of interactive games and painting on preoperative anxiety	CG: no intervention IG1: interactive games IG2: painting Time before anaesthesia 20–30 min	Elective surgery	mYPAS	**Baseline** CG: 57.45 (17.93) IG1: 57.72 (17.60) IG2: 50.76 (19.20) **Induction** CG: 56.50 (15.63) IG1: 49.91 (13.21) $p < .001$ IG2: 42.21 (15.86) $p < .001$	1b/A

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results *M* (SD)/median (IQR)	EL/RG
Gao et al. (2014), China	RCT	*N* = 59 Age 3–6 years n CG = 30 n IG = 29	To evaluate the effect of games on reducing preoperative anxiety	CG: no intervention IG: cartoons game Time before anaesthesia 15–20 min	Elective surgery	mYPAS	**Baseline** CG: 30.43 (3.27) IG: 30.81 (3.64) **Induction** CG: 58.89 (13.39) IG: 51.32 (11.34) $p = .023$	1b/A
Hashimoto et al. (2020), Japan	RCT	*N* = 58 Age 4–12 years n CG = 29 n IG = 29	To determine the anxiolytic effect during the preoperative period in children	CG: portable multimedia player IG: VR glasses Time before anaesthesia 1 day	Elective surgery (ENT, ophthalmology, plastic/ dermatology, orthopaedic, oral, digestive)	mYPAS	**Induction** CG: 33.3 [23.3–44.2] IG: 23.3 [23.3–25.0] $p = .001$	
Hosseinpour and Memarzadeh (2010), Iran	RCT	*N* = 200 Mean age 4.33 years n CG = 100 n IG = 100	To evaluate the efficacy of a playroom next to the operating room to reduce preoperative anxiety	CG: no intervention IG: cartoons game Time before anaesthesia 30 min	Elective surgery	mYPAS	Preoperative anxiety was significantly decreased for all categories of the anxiety score as assessed by mYPAS questionnaire	1b/A

(Continues)

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results M (SD)/median (IQR)	EL/RG
Huntington et al. (2018), England	RCT	$N = 176$ Age 5–7 years n CG = 59 n IG1 = 60 n IG2 = 57	To evaluate if games improved children's anxiety	CG: no intervention IG1: video game IG2: placebo-video	Dental surgery	mYPAS VAS-anxiety	**Baseline** *mYPAS* CG: 45.1 (20.5) IG1: 47.6 (22.2) IG2: 43.2 (20.7) **Induction** *mYPAS* CG: 45.1 (20.5) IG1: 47.6 (22.2) [OR 1.02, 95% CI 0.61 to 2.6, $p = .97$] IG2: 43.2 (20.7) [OR 1.38, 95% CI 0.87 to 3.81; $p = .49$] *VAS* CG: 3.5 (2.5) IG1: 3.5 (2.6) [OR 2.0, 95% CI −0.6 to 1.3 $p = .42$] IG2: 3.7 (2.4) [OR 1.53, 95% CI −0.8 to 1.1; $p = .65$]	1b/A
Jung et al. (2021), USA	RCT	$N = 70$ Age 5–12 years n CG = 37 n IG = 33	To evaluate VR to reduce preoperative anxiety	CG: no intervention IG: VR (5 min play)	Elective surgery	mYPAS	**Baseline Median (IQR)** CG: 28.3 [23.3–28.3] IG: 28.3 [23.3–28.3] **Induction** CG: 45.0 [33.3–56.7] IG: 28.3 [23.3–33.3] $p < .0001$	1b/A

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results M (SD)/median (IQR)	EL/RG
Lee et al. (2012), South Korea	RCT	$N = 130$ Age 3–7 years n CG = 44 n IG1 = 44 n IG2 = 42	To determine the effects of gamification on preoperative anxiety in children	CG: no intervention IG1: game IG2: cartoon	Elective surgery (ENT, ophthalmology, orthopaedic)	mYPAS	**Baseline** CG: 27.3 (8.4) IG1: 27.3 (7.6) IG2: 25.8 (4.2) **Induction** CG: 57.4 (18.1) IG1: 43.6 (16.1) $p < .05$ IG2: 31.8 (8.8) $p < .05$	1b/A
Marechal et al. (2017), France	RCT	$N = 115$ Age 4–11 years n CG = 55 n IG = 60	To compare the effects of midazolam with tablet-games for children anxiety	CG: midazolam IG: tablet-game Time before anaesthesia 20 min	Ambulatory surgery (urology, ENT, orthopaedic, ophthalmology)	mYPAS	**Baseline** CG: 37.1 (14.0) IG: 34.6 (13.6) **Induction** CG: 40.5 (18.6) IG: 41.8 (20.7) $p = .99$	1b/A
Matthyssens et al. (2020), Belgium	RCT	$N = 72$ Age 5–11 years n CG = 25 n IG1 = 25 n IG2 = 22	To evaluate the effectiveness of the serious game on anxiety and pain	CG: no intervention IG1: serious game-CliniPup® IG2: empty game without educational information	Ambulatory surgery (dental, ENT or urologic)	VAS-anxiety and pain	**Baseline** *Anxiety* CG: 4.5 IG1: 2.8 IG2: 2.5 *Pain* CG: 1.6 IG1: 0.5 IG2: 1.4 **Induction** *Anxiety* CG: 4.5 IG1: 1.9 $p = .044$ IG2: 2.7 *Pain* CG: 1.12 IG1: 0.4 $p = .09$ IG2: 1.1	1b/A

(Continues)

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results M (SD)/median (IQR)	EL/RG
Park et al. (2019), South Korea	RCT	$N = 80$ Age 4–10 years n CG = 40 n IG = 40	To evaluate the effect of VR on preoperative anxiety of children	CG: VR video + parents watching the same video via the mirroring display IG: VR video (4 min)	Elective surgery (ENT, ophthalmology, orthopaedic, dental)	mYPAS	**Baseline** CG: 36.7 (23.3–47.5) IG: 32.5 (23.3–47.5) **Induction** CG: 38.3 (23.3–44.2) IG: 28.3 (23.3–36.7) $p = .025$	1b/A
Patel et al. (2006), USA	RCT	$N = 112$ Age 4–12 years n CG =38 n IG1 = 38 n IG1 = 36	To evaluate the efficacy of a video game in reducing preoperative anxiety in children	CG: midazolam IG1: parent presence + hand-held video game IG2: parent presence	Outpatient surgery	mYPAS	**Baseline** CG: 45.2 (3.1) IG1: 37.4 (2.3) IG2: 34.3 (2.0) **Induction** CG: 53.9 (2.7) IG1: 41.7 (4.1) $p = .04$ IG2: 51.5 (4.0)	1b/A
Rodriguez et al. (2019), USA	RCT	$N = 52$ Age 4–10 years n CG = 25 n IG = 27	To determine if a large projection-based video screen mounted to a patient's bed decreased anxiety when compared to a tablet	CG: bedside entertainment and relaxation theatre IG: tablet game (1.17–7.64 min play)	Outpatient surgery (ENT, plastics, urology, ophthalmology, orthopaedics, rheumatology, general)	mYPAS	**Baseline** CG: 26.3 (6.5) IG: 25.5 (5.7) **Induction** CG: 35.0 (14.3) $p = .001$ IG: 30.6 (14.6) $p = .037$	1b/A

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results *M* (SD)/median (IQR)	EL/RG
Ryu et al. (2019), South Korea	RCT	*N* = 80 Age 4–10 years n CG = 39 n IG = 41	To evaluate whether gamification with VR gaming reduce preoperative anxiety in children	CG: no intervention IG: VR (4 min play)	Elective surgery (ENT, ophthalmology, orthopaedics, dental)	mYPAS	**Baseline** CG: 51.7 (31.7–61.7) IG: 46.7 (32.5–55.9) **Induction** CG: 46.7 (33.3–63.3) IG: 38.3 (23.3–50.9) [Mean difference 95% CI 9.2 (0.3–18.2), $p = .022$]	1b/A
Scarano et al. (2021), Italy	RCT	*N* = 50 Age 4–12 years n CG = 25 n IG = 25	To evaluate how playing can help to reduce preoperative anxiety of children	CG: no intervention IG: playing room Time before anaesthesia 30 min	Elective surgery	mYPAS	**Baseline** CG: 30.86 (16.57) IG: 25.12 (4.3) **Induction** CG: 43.45 (24.30) IG: 28.92 (9.32) $p < .05$	1b/A
Seiden et al. (2014), USA	RCT	*N* = 108 Age 1–11 years n CG = 51 n IG = 57	To compare the effects of a tablet-based interactive distraction tool on perioperative anxiety	CG: midazolam IG: tablet-game	Outpatient surgery (ENT, urology, gastrointestinal, ophthalmology, gynaecologic, dental, orthopaedics, general)	mYPAS	**Baseline Median (IQR)** CG: 28 (23–45) IG: 32 (23–45) **Induction** IG vs CG mean difference (95% CI) (favour intervention): −14.0 (−6.1 to −22.0), $p < .001$	1b/A

(Continues)

TABLE 2 (Continued)

Author, year, country	Design	Sample	Aim	Intervention[a]	Surgery	Anxiety and pain measured	Results *M* (SD)/median (IQR)	EL/RG
Stewart et al. (2019), USA	RCT	*N* = 102 Age 4–12 years n CG = 51 n IG = 51	To compare effects of tablet-based interactive distraction with oral midazolam on preoperative anxiety	CG: midazolam IG: tablet-game Time before anaesthesia 20 min	Ambulatory surgery (urology, ENT, ophthalmology, general)	mYPAS-SF	**Baseline** CG: 24.4 (3.7) IG: 25.3 (5.0) **Induction** CG: 35.7 (16.4) IG: 28.6 (11.6) $p < .001$	1b/A
Ünver et al. (2020), Turkey	RCT	*N* = 94 Age 7–12 years n CG = 47 n IG = 47	To determine the effect of a game intervention on the preoperative anxiety levels	CG: no intervention IG: game Jenga®	Elective minor surgery (circumcision, inguinal hernia repair)	VFAS	**Baseline** CG: 1.48 (0.99) IG: 1.82 (1.27) **Postintervention** CG: 2.42 (1.13) IG: 0.70 (0.80) $p < .001$	1b/A
Uyar et al. (2020), Turkey	RCT	*N* = 134 Age 5–8 years n CG = 46 n IG1 = 43 n IG2 = 45	To analyse the change in children's anxiety levels	CG: midazolam IG1: playing a videogame IG2: watch cartoon Time before anaesthesia 20 min	Elective surgery (ENT)	mYPAS	**Baseline** CG: 40.7 IG1: 40.7 IG2: 42.6 **Induction** CG: 38.3 IG1: 39.5 IG2: 43.7 $p = .224$	1b/A

Abbreviations: CAM-S, Children's Anxiety metre scale; CG, Control group; EL, Evidence level; ENT, Ears, Nose and Throat surgery; IG, Intervention group; IQR, Interquartile range; mYPAS, Modified Yale Preoperative Anxiety Scale; mYPAS-SF, Modified Yale Preoperative Anxiety Scale-Short Form; RG, Recommendation grade; VAS, Visual analogue scale; VFAS, Visual Facial Anxiety Scale; VR, Virtual reality; WBFPRS, Wong–Baker Faces Pain Rating Scale; YPAS, Yale Preoperative Anxiety Scale questionnaire.

[a]No intervention = no distraction aids or usual medication.

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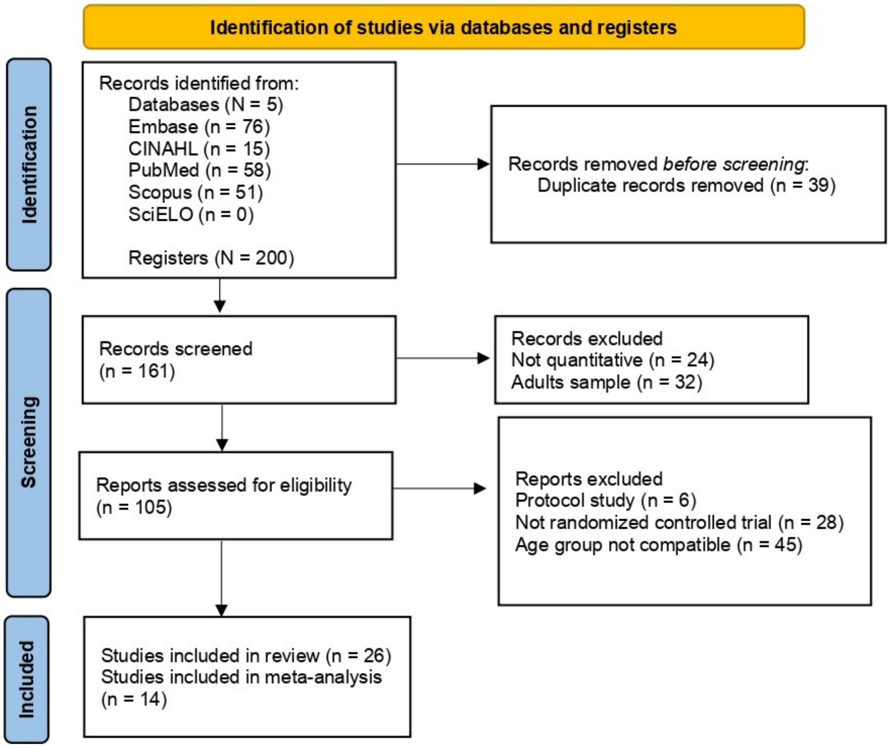

FIGURE 1 Flow diagram of the publication search process [Colour figure can be viewed at wileyonlinelibrary.com]

4 | RESULTS

4.1 | Characteristics of the studies included

In total, 200 studies were found in the five databases. After reviewing the titles and abstracts and removing duplicates, 161 records were remained. The full-text reading then reduced the final sample for analysis to 26 studies. The search and selection process is described in Figure 1.

All of the studies included were randomised controlled trials. The total sample population consisted of 2525 children. One study was published in 2006, but the majority ($n = 18$) were conducted in 2019 or later. The following countries of publication were represented: USA ($n = 5$), Turkey ($n = 3$), Iran ($n = 3$), South Korea ($n = 3$) and Belgium ($n = 2$), together with one study each published in Syria, India, Denmark, Jordan, Netherlands, China, Japan, England, France and Italy (Table 2).

To measure the pain experienced, one study used the Wong–Baker Faces Pain Rating Scale (WBFPRS) and another, the pain dimension of the Visual Analogue Scale (VAS). To evaluate anxiety, most studies ($n = 20$) used the mYPAS, while others used the YPAS-SF ($n = 2$) or the Yale Preoperative Anxiety (YPAS) ($n = 1$). Other anxiety measurement tools used were the Visual Facial Anxiety Scale (VFAS), the anxiety dimension of the VAS and the Children's Anxiety Metre-Scale (CAM-S) (Table 2).

The samples of children were heterogeneous and included various settings (ambulatory and elective) and types of surgery (dental, otorhinolaryngology, genital, urologic, ophthalmological, urological, orthopaedic, abdominal or general) (see Table 2). The durations considered before the induction of anaesthesia ranged from 20 min (Al-Nerabieah et al., 2020; Clausen et al., 2021; Dwairej et al., 2020; Forouzandeh et al., 2020; Gao et al., 2014; Marechal et al., 2017; Stewart et al., 2019; Ünver et al., 2020) to 24 h (Chaurasia et al., 2019; Hashimoto et al., 2020). Most of the interventions lasted between 5 min (Al-Nerabieah et al., 2020; Buyuk et al., 2021; Dehghan et al., 2019; Jung et al., 2021) and 15 min (Eijlers, Dierckx, et al., 2019) (Table 2).

All studies presented an adequate level of quality, according to the quality assessment tools applied, and none were excluded for this reason. The characteristics of the studies included are shown in Table 2, and the risk of bias, in each case, is illustrated in Figure 2.

4.2 | Effect of the game-based intervention on pain and anxiety levels

All 26 studies reported the effect of game-based interventions on anxiety levels, and two also considered the effect on pain levels (Al-Nerabieah et al., 2020; Matthyssens et al., 2020).

4.2.1 | Analysis of pain levels

Two studies reported the effect of the game-based interventions on pain levels (Al-Nerabieah et al., 2020; Matthyssens et al., 2020). One detected no significant differences in this respect between the intervention group and the control group (Matthyssens et al., 2020), while the other recorded a decreased pain score in the intervention group (mean difference −2.53; 95% CI: −3.04, −2.02, $p \leq .001$) (Al-Nerabieah

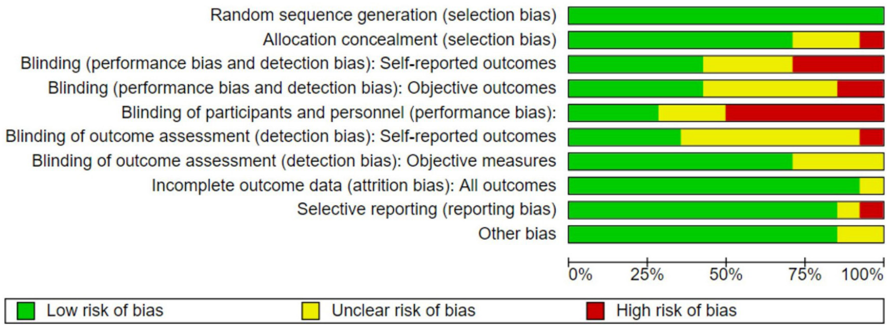

FIGURE 2 Risk of bias across all included studies [Colour figure can be viewed at wileyonlinelibrary.com]

et al., 2020) (Table 2). A meta-analysis could not be performed of these studies due to the different pain scales used (WBFPRS vs. VAS).

4.2.2 | Analysis of anxiety levels

Of the 12 studies not included in the meta-analyses, 10 reported that children experienced a significant reduction in preoperative anxiety after a game-based intervention was employed as a distraction method (Buyuk et al., 2021; Dehghan et al., 2019; Hashimoto et al., 2020; Hosseinpour & Memarzadeh, 2010; Jung et al., 2021; Matthyssens et al., 2020; Park et al., 2019; Ryu et al., 2019; Seiden et al., 2014; Ünver et al., 2020). Only two studies (Eijlers, Dierckx, et al., 2019; Uyar et al., 2020) found no beneficial effect on anxiety from this intervention (Table 2).

4.3 | Meta-analysis of the effect of the game-based intervention on anxiety levels

Studies that provided sufficient statistical information ($n = 14$) were included in the meta-analysis. As they presented considerable heterogeneity, a fixed-effects model was not considered appropriate and only a random-effects model was applied. Two meta-analyses were performed of the effect size of a game-based intervention on anxiety levels. The first, with 12 studies, all of which used the mYPAS questionnaire, had a sample of $n = 493$ children for the intervention group and $n = 471$ for the control group (Table 2). The effect size of the intervention, calculated as the mean difference achieved during anaesthesia induction according to the mYPAS score was −10.62 (95% CI: −13.85, −7.39) in favour of the intervention. The statistical heterogeneity (I^2 value) across these studies was 84%.

The second meta-analysis was conducted of the two studies that used the mYPAS-SF questionnaire, which included $n = 83$ children in each group. This analysis revealed no statistically significant effect on anxiety levels, with an estimated effect size of −20.10 (95% CI: −45.55, −5.35).

A sensitivity analysis was performed for both meta-analyses, revealing no change in effect size when each study was removed from the analysis. The funnel plots did not indicate the presence of publication bias. The forest plot and the risk of bias of each study are shown in Figures 3 and 4.

For the remaining 12 studies, no meta-analysis was performed due to differences in the anxiety measurement scales (VAS and VFAS) (Matthyssens et al., 2020; Ünver et al., 2020), in the measurement units (Eijlers, Dierckx, et al., 2019; Hashimoto et al., 2020; Jung et al., 2021; Park et al., 2019; Ryu et al., 2019; Seiden et al., 2014) or due to insufficient statistical data (Buyuk et al., 2021; Dehghan et al., 2019; Hosseinpour & Memarzadeh, 2010; Uyar et al., 2020).

5 | DISCUSSION

To the best of our knowledge, no previous systematic reviews or meta-analyses have been conducted to determine the effect of games-based interventions on pain and anxiety levels in children during the preoperative induction of anaesthesia.

Our analysis shows that gamification improves preoperative preparation for children, especially by reducing their anxiety. Thus, the children in the gamification group had significantly lower levels of anxiety than those in the control group at the time of anaesthesia induction. We corroborate prior reports that pleasurable activities can alleviate the anxiety felt by children before surgery (Kumar et al., 2019; Weber, 2010), although one study observed no such positive effects in adult patients (Koo et al., 2020).

No significant differences in pain levels were reported, although this may be due to the small number of studies that addressed this question. Nevertheless, digital distraction techniques have been shown to reduce levels of distress and pain in children subjected to painful procedures (Gates et al., 2020).

Distraction techniques and non-pharmacological medical methods provide the basis for simple, readily-applicable interventions that can reduce anxiety and disruptive behaviour in children. Virtual reality devices used for patients undergoing routine blood extraction can reduce acute pain and anxiety and produce high levels of satisfaction (Gold & Mahrer, 2018). In a related study, patients reported that the intervention made them feel more comfortable and less scared during their hospital stay (Gold et al., 2021). Other strategies, too, have been employed to alleviate stress, anxiety and

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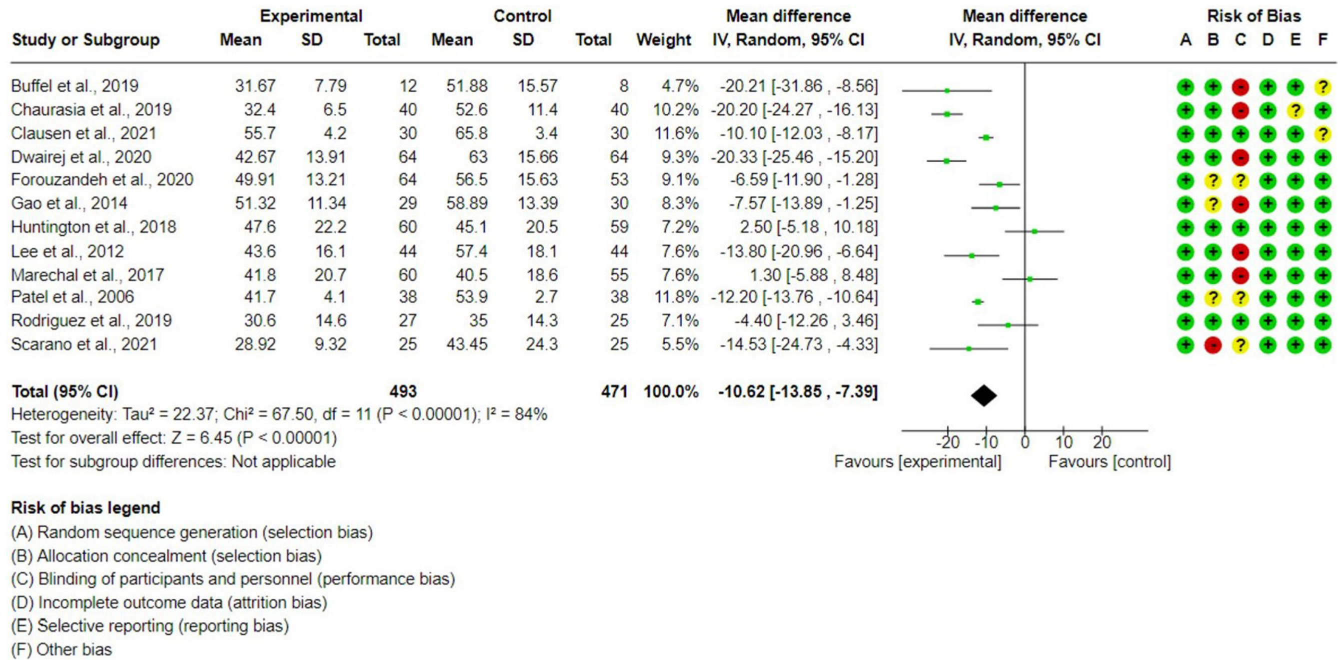

FIGURE 3 Forest plot for anxiety using mYPAS [Colour figure can be viewed at wileyonlinelibrary.com]

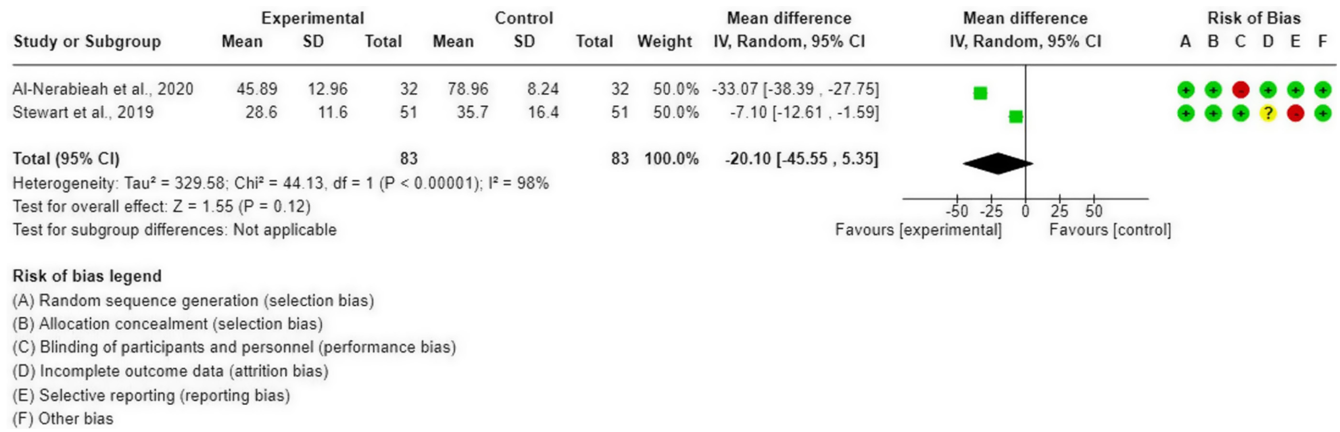

FIGURE 4 Forest plot for anxiety using mYPAS-SF [Colour figure can be viewed at wileyonlinelibrary.com]

pain, such as art therapy or music therapy (Gómez-Urquiza et al., 2016; Nooruzi et al., 2018). In relation to anaesthetic induction, it has been observed that watching cartoons during sleep induction for deep sedation are associated with a shorter sleep onset time (Tschiedel et al., 2019).

Gamification is another pleasurable educational resource that can be useful during preparation for surgery and in postoperative care. Studies have shown that children who receive an educational multimedia intervention are less worried about surgery and other hospital procedures (Fernandes et al., 2014). Moreover, this approach can also reduce parental anxiety (Fernandes et al., 2015; Kumar et al., 2019). However, a recent meta-analysis indicated that virtual reality interventions were potentially more effective in younger children than in adolescents (Eijlers, Utens, et al., 2019).

Despite the considerable pain and anxiety experienced by many children prior to surgery, non-pharmacological methods are still rarely considered as a means of alleviating these problems during the induction of anaesthesia (Rantala et al., 2020). Gamed-based interventions can reduce preoperative anxiety, and at the same time, itprovides the opportunity to educate children about the hospital environment during hospitalisation or even at home before attending for treatment (Rantala et al., 2020). Gamification has been shown to improve the physical, mental and emotional health of the child (Lestari et al., 2017). On the other hand, although the benefits of this type of intervention seem significant, little is known about the longer-term duration of effects (after surgery, during hospitalisation or after discharge). Furthermore, the children included in the studies in our analysis varied in age, in the type of surgery received and in hospital setting, which means that our results should be interpreted with caution. In conclusion, distraction-based interventions need to be further developed to optimise surgical pathways, and thus enhance preoperative and postoperative settings for the paediatric patient.

5.1 | Limitations

The review process described is subject to certain clinical and methodological limitations. First, the studies considered used a wide variety of instruments to measure anxiety and pain, and different forms of results reporting (means and standard deviation / median and interquartile range). Second, there were large differences in the duration of the intervention (from 5 to 15 min) and in the time points before anaesthetic induction (from 20 min to 24 h). This heterogeneity makes it difficult to determine the optimal timing and duration of preoperative intervention. The control groups, too, were heterogeneous with respect to parental presence, type of intervention and medication supplied. In addition, the diverse settings and types of surgery would have affected the pain and anxiety experienced, thus influencing the study results.

Another limitation to our study is that the effect size of the intervention on pain levels could not be analysed due to the small number of studies found. Similarly, the meta-analysis performed with the mYPAS-SF questionnaire was based on just two studies (Al-Nerabieah et al., 2020; Stewart et al., 2019). Accordingly, further randomised clinical trials are essential to analyse the effect size obtained, until when our results should be interpreted with caution.

A more extensive analysis of postoperative pain and anxiety levels would also be desirable, but our review and meta-analysis had no access to follow-up data after surgery. Potential variability in this respect might have contributed to the fact that these questions were not investigated.

5.2 | Implication for practice and research

The meta-analysis presented in this paper shows that gamed-based interventions can have a positive effect, alleviating preoperative anxiety. They are safe and both encourage and educate children about medical procedures. By reducing anxiety, they contribute to earlier hospital discharge, faster recovery and rehabilitation, a reduced need for medication during anaesthesia and better pain tolerance, all of which help lower hospital costs (Moura et al., 2016). However, the management of perioperative pain and anxiety in children continues to pose significant challenges and is often inadequate, due to cost and time-related restrictions (Copanitsanou & Valkeapää, 2014; Fortier & Kain, 2015). Since reducing pain and anxiety is among the main tasks performed by nursing professionals, it is necessary to develop interventions to better address perioperative management. An important preoperative responsibility of nurses is to optimise physiological and psychological health and to help patients adapt to stressors. The method we describe could usefully be included as a nursing function to help alleviate anxiety in children and thus optimise surgical care. Further research is needed to determine the ideal type and duration of preoperative preparation and intervention.

6 | CONCLUSIONS

Game-based interventions have a positive impact, reducing preoperative anxiety in children before and during the induction of anaesthesia, although our analysis detected no significant impact on pain levels. This innovative and pleasurable type of intervention can be helpful in the care of paediatric surgical patients, alleviating pain and anxiety during preoperative care. This task is often challenging for nursing professionals, and game-based strategies could help them provide positive attention in paediatric care, benefiting children's emotional health and post-surgery recovery. However, such distraction-based interventions need further development to optimise surgical pathways in preoperative and postoperative settings for the paediatric patient.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors have agreed on the final version and meet all four following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]: Have made substantial contributions to conception and design, analysis and interpretation of data. Been involved in drafting the manuscript or revising it critically for important intellectual content. Given final approval of the version to be published. Each author has participated sufficiently in the work to take public responsibility for appropriate portions of the content. N. S.-M. and J.L. G.-U. involved in study design. J.L. R.-B., R.A. G.-L., L. P.-H., M.J. M.-J. and G. D.-V. involved in literature search and data analysis. N. S.-M., J.L. R.-B., M.J. M.-J. and R.A. G.-L. involved in manuscript preparation.: N. S.-M. and J.L. G.-U. involved in supervision.

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