

SYSTEMATIC REVIEW

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Effectiveness of parental presence during induction of anaesthesia in managing perioperative anxiety in children: a GRADE-assessed systematic review and meta-analysis of randomized controlled trials

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Abstract

Background Preoperative anxiety in children is common and may negatively affect anesthetic management and postoperative recovery. Parental Presence during Induction of Anesthesia (PPIA) is widely used as a non-pharmacological strategy, but its effectiveness remains uncertain. This systematic review and meta-analysis evaluated the effect of PPIA on perioperative anxiety in children.

Methods Randomized and quasi-randomized trials comparing PPIA with no parental presence or alternative interventions for perioperative anxiety in children undergoing elective procedures under general anesthesia were systematically reviewed. Five electronic databases were searched from inception to June 30, 2025. Study quality was assessed using the Cochrane Collaboration's Risk-of-Bias tool and GRADE framework. Data were pooled using a random-effects meta-analysis, with effect sizes reported as Weighted Mean Differences (WMDs) or Standardized Mean Differences (SMDs). The primary outcome was perioperative anxiety assessed at follow-up time points, and the secondary outcome was the change in perioperative anxiety from baseline to each follow-up time point.

Results A total of 24 studies were included, evaluating four intervention comparisons: PPIA versus no parental presence, PPIA versus sedative premedication, PPIA combined with sedative premedication versus sedative premedication alone, and PPIA versus other non-pharmacological interventions. Compared with no parental presence, PPIA was associated with reductions in children's anxiety and heart rate from baseline to induction (SMD = -1.13, $P=0.022$; WMD = -8.74, $P=0.004$). In contrast, PPIA alone was less effective than midazolam in reducing anxiety at induction and from baseline to induction (SMD = 1.06, $P=0.022$; SMD = 2.15, $P=0.004$), and combining PPIA with midazolam offered no additional benefit over midazolam alone at induction (SMD: -0.40, $P=0.402$). One study suggested that video distraction may be more effective than PPIA. The certainty of evidence ranged from low to moderate, and only five studies were rated as high quality.

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Conclusion PPIA modestly reduces perioperative anxiety and heart rate in children compared with no parental presence but is less effective than midazolam and provides no additional benefit when combined with it. Therefore, high-quality studies are needed to clarify the clinical relevance of PPIA and to optimize its implementation in pediatric anesthesia.

Registration number CRD42024596457

Keywords Anesthesia, Parental presence, Perioperative anxiety, Systematic review

Background

Perioperative anxiety is a common and clinically significant problem in pediatric surgical patients, particularly during the induction of general anesthesia [1]. It typically manifests through behavioral signs such as crying, restlessness, or withdrawal [2], and can complicate anesthesia management by provoking resistance, escape behaviors, and adverse physiological reactions [3]. These reactions not only increase the risk of intraoperative complications and the requirement for higher anesthetic doses but also contribute to postoperative challenges, including emergence delirium, intensified pain, delayed recovery, and increased analgesic needs [4, 5]. Consequently, effective strategies to mitigate perioperative anxiety are a core priority in pediatric anesthesia practice.

Both pharmacological and non-pharmacological approaches are used to reduce preoperative anxiety in pediatric anesthesia, but the optimal strategy remains unclear due to limited evidence-based guidance [6]. Sedative premedications, particularly Midazolam (MDZ), are commonly administered and effective in reducing anxiety and facilitating parental separation [7, 8]. However, these drugs may be refused by children or cause adverse effects including agitation, delayed recovery, emergence delirium, cognitive impairment, respiratory depression, and excessive sedation [9]. Additional concerns include safety risks, increased costs, and the need for specialized facilities and staff, particularly in outpatient settings [10].

Non-pharmacological strategies are increasingly preferred for managing pediatric perioperative anxiety due to their minimal side effects and broad psychosocial benefits [11, 12]. Among these approaches, Parental Presence during Induction of Anesthesia (PPIA) provides emotional support, alleviates separation anxiety, and promotes a calmer environment through the parent-child bond [13, 14]. PPIA is a simple, non-invasive, and cost-effective intervention that may reduce children's anxiety, enhance cooperation, improve parental satisfaction, and decrease the need for sedative premedication [15, 16]. However, several concerns have been raised regarding PPIA, including unpredictable parental behavior during emergencies, increased staff anxiety, workflow disruptions, infection risks, medicolegal considerations, prolonged induction times, and the possibility that anxious parents may inadvertently exacerbate the child's distress

[17–19]. Evidence from clinical trials has further contributed to this debate, with mixed findings. Some studies reported no effect of PPIA [20–27], others observed increased anxiety associated with parental presence [28–32], while several demonstrated reduced anxiety in children exposed to PPIA compared with no parental presence or alternative interventions [33–37]. Systematic reviews and meta-analyses have similarly produced inconsistent results [38–42]. Overall, these findings underscore the need for rigorous, high-quality, evidence-based research to determine the clinical utility of PPIA and guide its effective implementation in pediatric anesthesia practice.

Although previous reviews have provided insights into PPIA, methodological limitations, such as heterogeneity in study designs, variability in outcome measures, and differences in synthesis approaches, warrant further investigation. Given the growing interest in PPIA and the increasing number of related publications, an updated and methodologically rigorous review is needed. To address this gap, we conducted a systematic review and meta-analysis of both quasi-randomized and fully randomized trials to evaluate the efficacy of PPIA in reducing pediatric perioperative anxiety. By pooling outcomes from eligible studies, we aimed to provide a robust, evidence-based assessment of PPIA as a standalone intervention, a non-pharmacological adjunct, or a potential alternative to sedative premedication in contemporary pediatric anesthesia practice.

Methods

Ethical approval and study design

The current review was reported in compliance with the most recent statement of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [43]. The review protocol received approval from the Research Ethics Committee of Tehran University of Medical Sciences, Tehran, Iran (No. IR.TUMS.SPH.REC.1403.178). Additionally, the study protocol was prospectively registered with PROSPERO (No. CRD42024596457).

Eligibility criteria

We included Randomized Controlled Trials (RCTs) of any design subtype, published in peer-reviewed journals

in any language. Eligible studies involved children under 18 years of age, of either gender, classified as American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective diagnostic or surgical procedures under general anesthesia via inhalation, intravenous induction, or a combination of both. The intervention of interest was the addition of PPIA to the standard pediatric anesthetic protocol, defined as the physical presence of one or both parents in the Operating Room (OR) during induction until the child lost consciousness. Eligible comparator protocols included No Parental Presence at Induction of Anesthesia (NPPIA), defined as standard pediatric anesthetic care provided alone or in combination with other non-pharmacological approaches.

The outcome of interest was perioperative anxiety in children, operationalized as anxiety scores measured using validated subjective and physiological measures (e.g., Modified Yale Preoperative Anxiety Scale [mYPAS], Heart Rate [HR], and cortisol levels) at the following perioperative time points: T0 (baseline), T1 (preoperative holding area), T2 (transition to the OR), T3 (anesthesia induction), or T4 (post-induction). The primary outcome was perioperative anxiety at follow-up time points (T2, T3, and T4), expressed as mean scores with corresponding Standard Deviations (SDs). The secondary outcome was the change in perioperative anxiety from baseline, operationalized as mean change scores with corresponding SDs from baseline (T0 or T1) to each subsequent perioperative time point (T2, T3, or T4). The inclusion of change scores as a secondary outcome was based on evidence that the choice of time point and outcome metric (i.e., follow-up scores vs. change scores) can substantially influence estimated Mean Differences (MDs), and consequently, the conclusions of a meta-analysis [44].

Studies were excluded if they employed non-randomized designs, were not original research articles, focused exclusively on infants (i.e., under 12 months of age), evaluated parental presence during perioperative phases other than anesthesia induction (e.g., post-anesthesia recovery), or involved co-interventions that confounded the effects of PPIA (i.e., unequal application of additional non-pharmacological interventions between groups or implementation of parental presence in both arms without a true NPPIA control condition). Detailed exclusion criteria are provided in the Supplementary Table 1.

Information sources

A comprehensive systematic search was performed across four key electronic databases: Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, Scopus, and Clarivate Web of Science. To enhance the review's inclusivity and minimize the risk of publication bias, grey literature was also explored through Google Scholar. Additionally, the World Health Organization's

International Clinical Trials Registry Platform was searched to identify any unpublished data related to the included studies. Finally, to ensure maximal retrieval of relevant literature, the reference lists of all included articles, as well as those from relevant previously published reviews, were manually screened to identify any additional eligible articles that may have been overlooked in the electronic search.

Search strategy

A comprehensive search strategy was developed with the support of an experienced research librarian, using Medical Subject Headings (MeSH) and relevant keywords related to parental presence, anesthesia, pediatrics, and anxiety. Database-specific search strategies were applied using Boolean operators (Supplementary Table 2). Two independent reviewers conducted the searches from inception to July 2024, with an update on June 30, 2025, to capture newly published studies. Any discrepancies arising during the search process were resolved through collaborative discussion and consensus, ensuring transparency and methodological rigor.

Study selection and data management

All records were imported into EndNote X8 for deduplication, followed by title/abstract screening and full-text assessment against the eligibility criteria. Data were extracted using a structured, pilot-tested Microsoft Excel form developed for this review. Duplicate publications were handled by retaining the report with the largest sample size or the most comprehensive methodological information. When required, means and SDs were estimated from medians and Interquartile Ranges (IQRs) using established methods [45], and mean change scores with corresponding SDs were calculated when not directly reported. Additional information was obtained from trial registries or by contacting corresponding authors when necessary.

The Risk of Bias (RoB) of the included RCTs was assessed using the Cochrane Risk of Bias 2 (RoB-2) tool [46], and studies were categorized according to methodological quality to support subgroup analyses, following a previously published approach [47]. The certainty of the evidence for each outcome was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework [48].

Study selection, data extraction, and RoB-2 and GRADE assessments were conducted independently by two reviewers, with disagreements resolved by consensus. Inter-rater agreement was substantial to almost perfect (Cohen's $\kappa = 0.81$ – 0.92), indicating a high level of agreement between two reviewers [49].

Data synthesis and analysis

Data synthesis was conducted concurrently with data extraction by two independent reviewers using a qualitative meta-summary approach [50]. Intervention comparisons were categorized into four groups: PPIA versus NPPIA, PPIA versus sedative premedication, PPIA combined with sedative premedication versus sedative premedication alone, and PPIA versus other non-pharmacological interventions. For multi-arm trials, data were reorganized into pairwise comparisons according to these categories. To enhance comparability of anxiety outcomes across studies, assessment time points were harmonized into five predefined perioperative time points, as specified in the Outcomes section of the eligibility criteria.

When at least three methodologically comparable studies reported the same intervention comparisons at identical time points, meta-analyses were conducted using random-effects models in Stata (version 11.2; StataCorp, College Station, TX), with a P -value < 0.05 considered statistically significant. Analyses were performed using both follow-up mean scores and mean change scores from baseline to each follow-up time point. Effect Sizes (ESs) were expressed as Weighted Mean Differences (WMDs) or Standardized Mean Differences (SMDs), as appropriate, with corresponding 95% Confidence Intervals (CIs) [51].

Between-study heterogeneity and potential publication bias were evaluated using standard methods (I^2 , Cochran's Q , funnel plots, Begg's and Egger's tests, and trim-and-fill procedures), with subgroup analyses, meta-regression, and sensitivity analyses conducted when substantial heterogeneity was detected [52].

Results

Characteristics of included studies

A detailed flow diagram of the study selection process is presented in Supplementary Fig. 1. A total of 5,423 records were identified through database searches and reference screening. Following removal of duplicates and title/abstract screening, 62 articles underwent full-text assessment; four could not be retrieved [53–56], and 33 were excluded based on the eligibility criteria (Supplementary Table 3). Six studies conducted by the same primary author were retained, as each addressed a distinct objective [23, 25, 31, 32, 57, 58], and two publications from the same dataset were included for reporting unique outcomes [59, 60]. The final review therefore included data from 24 studies reported across 25 publications from 1989 to 2025, comprising data from 2,033 child-parent dyads (941 in intervention groups and 1,092 in comparison groups).

A summary of study design, countries of origin, types of surgery, children's age and gender, and sample sizes is

presented in Table 1. A detailed overview of participants, interventions, and outcome measurements is provided in Supplementary Table 4. Most studies were published in English, with two in Persian [59, 60] and one in Chinese [61]. The studies were conducted in multiple countries, most frequently the United States, China, and Iran. The majority were parallel-group fully RCTs, while three were Quasi-Randomized Control Trials (qRCT) [20, 27, 62]. Most trials employed a two-arm design, whereas eight implemented multi-arm designs [23, 28, 29, 31, 32, 36, 37, 57]. Surgical procedures primarily involved day-case operations, particularly ear, nose, and throat surgeries and hernia repairs. Children aged 1–15 years were included across studies, with no significant differences in age or sex distribution between intervention and comparison groups. Both mothers and fathers accompanied children in most trials, although four studies included only mothers [22, 27, 62, 63].

Effects of interventions

A summary of anxiety outcome measures, categorized by the four types of intervention comparisons, is presented in Table 2.

PPIA vs. NPPIA

Fifteen trials assessed subjective anxiety in non-sedated children comparing PPIA with NPPIA [20, 21, 23, 25, 27, 31–33, 35–37, 57, 59, 62, 64]. Two studies lacked numerical data [27, 32], and in one study, conversion from median to mean and SD was not possible [64]. Consequently, 12 studies were deemed suitable for the pooled analysis, comprising five ESs for anxiety during the transition to the OR and eleven ESs for anxiety at induction. The meta-analysis found no significant difference in anxiety between PPIA and NPPIA groups during the transition to the OR (k : 5, SMD: -0.53, 95% CI: -1.10 to 0.04; $P = 0.069$; Fig. 1a), from baseline to OR transition (k : 4, SMD: -1.37, 95% CI: -2.81 to 0.07; $P = 0.061$; Fig. 1b), or at induction (k : 11, SMD: -0.71, 95% CI: -1.46 to 0.03; $P = 0.060$; Fig. 2a). However, PPIA was associated with a significantly greater reduction in anxiety from baseline to induction (k : 8, SMD: -1.13, 95% CI: -2.10 to -0.16; $P = 0.022$; Fig. 2b). Sensitivity analyses suggested that these findings were influenced by the exclusion of certain studies (Supplementary Figs. 2 and 3). Clinically, these results suggest that while PPIA alone may not significantly reduce anxiety at discrete time points such as OR transition or induction, it may help attenuate overall anxiety progression from baseline to induction, although sensitivity analyses indicate that this effect should be interpreted with caution due to variability across studies.

Furthermore, five studies evaluated physiological indicators of anxiety, including serum or salivary cortisol [20, 25], HR [35, 61, 65], or Blood Pressure (BP) [35,

Table 1 Characteristics of the included trials investigating the effect of PPIA on children's perioperative anxiety (ordered chronologically by year of publication)

Study ID (country)	Study design	Characteristics of the children		RoB**
		Type of procedure	Sample size (age, year; gender, female/male ^a)	
Fatima et al., 2025 [64] (Pakistan)	Two-arm RCT	Mostly hernia repair	IG: 35 (nr.; 23/12) CG: 35 (nr.; 18/17)	Some concern
Silveira et al., 2024 [20] (Brazil)	Two-arm qRCT	nr.	IG: 22 (3.6 ± 2.1; 7/15) CG: 24 (3.0 ± 2.4; 7/17)	High
Jain et al., 2023 [30] (India)	Two-arm RCT	nr.	IG: 30 (nr.; 8/22) CG: 30 (nr.; 12/18)	Some concern
Li et al., 2023 [35] (China)	Two-arm RCT	ENT surgeries	IG: 80 (6.3 ± 3.1; 37/43) CG: 80 (5.0 ± 3.9; 38/42)	Some concern
Yao et al., 2022 [36] (China)	Four-arm RCT	ENT surgeries	IG: 30 (4.6 ± 1.2; 12/18) CG: 30 (4.3 ± 1.1; 10/20)	Low
Talabi et al., 2021 [21] (Nigeria)	Two-arm RCT	Mostly hernia repair	IG: 50 (7.1 ± 3.6; 12/38) CG: 50 (6.4 ± 3.3; 11/39)	High
Lao et al., 2019 [61] (China)	Two-arm RCT	ENT surgeries	IG: 60 (3.2 ± 2.5; 26/34) CG: 60 (2.9 ± 2.8; 32/28)	High
Hussain & Khan, 2018 [37] (Pakistan)	Three-arm RCT	Mostly hernia repair	IG: 41 (3.0, 3.0; 13/28) CG: 41 (2.0, 3.0; 7/34)	Low
Sadeghi et al., 2017 [66] (Iran)	Two-arm RCT	Mostly hernia repair	IG: 48 (6.2 ± 7.1; 1/47) CG: 48 (5.5 ± 8.1; 8/40)	High
Rastegarian et al., 2016 [62] (Iran)	Two-arm qRCT	ENT surgeries	IG: 19 (nr.; 7/12) CG: 18 (nr.; 6/12)	High
Soenarto et al., 2016 [63] (Indonesia)	Two-arm RCT	Cardiac invasive procedures	IG: 22 (3.6, 2-5.8; 13/9) CG: 23 (3.4, 2-5.8; 15/8)	Some concern
Kim et al., 2015 [29] (Korea)	Three-arm RCT	Mostly eye surgeries	IG: 34 (5.3 ± 1.4; 21/13) CG: 33 (5.5 ± 1.0; 19/14)	High
Rasti-Emad-Abadi et al., 2014 [59] (Iran)	Two-arm RCT	Mostly ENT	IG: 30 (5.1 ± 2.3; 22/8) CG: 30 (5.8 ± 2.3; 19/11)	High
Kazak et al., 2010 [28] (Turkey)	Three-arm RCT	Mostly circumcision	IG: 20 (37.0 ± 27.0; 9/11) CG: 20 (39.0 ± 28.0; 5/15)	Low
Wright et al., 2010 [33] (Canada)	Two-arm RCT	Mostly ENT	IG: 30 (nr.; nr.) CG: 31 (nr.; nr.)	Low
Akinci et al., 2008 [22] (Turkey)	Two-arm RCT	nr.	IG: 50 (4.0 ± 2.0; 11/39) CG: 50 (5.0 ± 2.0; 18/32)	High
Kain et al., 2007 [31] (USA)	Four-arm RCT	Mostly ENT	IG: 94 (5.5 ± 2.0; 29/65) CG: 99 (5.4 ± 2.0; 40/59)	Low
Kain et al., 2003, a [32] (USA)	Four-arm RCT	nr.	IG: 27 (4.3 ± 2.3; 15/12) CG: 33 (5.5 ± 2.0; 16/17)	High
Kain et al., 2003, b [57] (USA)	Three-arm RCT	nr.	IG: 29 (5.5 ± 3.0; 11/18) CG: 24 (4.8 ± 3.0; 6/18)	High
Amanor-Boadu, 2002 [65] (Nigeria)	Two-arm RCT	Inguinal surgeries	IG: 52 (n/a; n/a) CG: 66 (n/a; n/a)	High
Kain et al., 2000 [58] (USA)	Two-arm RCT	Mostly ENT	IG: nr. (3.3 ± 1.7; 40.4/59.6) CG: nr. (3.6 ± 1.6; 30.4/69.6)	High
Kain et al., 1998, a [23] (USA)	Three-arm RCT	nr.	IG: 29 (4.3 ± 1.8; 11/18) CG: 26 (4.5 ± 1.5; 12/14)	High
Kain et al., 1996 [25] (USA)	Two-arm RCT	nr.	IG: 43 (3.5, 2.5-5.0; 17/26) CG: 41 (3.1, 1.8-5.6; 14/27)	Some concern
Hickmott et al., 1989 [27] (UK)	Two-arm qRCT	nr.	IG: 26 (n/a; n/a) CG: 23 (n/a; n/a)	High

Abbreviations: CG Comparison group, ENT Ear, nose, and throat, IG Intervention group, n/a Not available, nr Not reported, qRCT Quasi-randomized control trial, RCT Full randomized control trial, RoB Risk of bias, UK United Kingdom, USA United States

^aAge is reported as mean ± standard deviation or median with interquartile range, whereas gender is presented as number or percentage

^{**}The modified version of Cochrane Collaboration's Risk of Bias assessment tool for RCT (RoB-2): (1) Low: low RoB across all domains, (2) Some concern: some concerns in at least one domain, but no domain rated as high RoB, and (3) High: high RoB in at least one domain, or multiple domains with some concerns that collectively reduce confidence in the results

Table 2 Summary of anxiety outcome measures across included trials investigating the effect of PPIA on children's perioperative anxiety, stratified by type of intervention

Intervention type	Study ID	Measurement		Findings**
		Tools/Indicators	Times*	
PPIA vs. NPPIA	Fatima et al., 2025	mYPAS	T3	Sig. ↓
	Silveira et al., 2024	mYPAS	T3	Sig. ↑
		Cortisol	T3	N/S
	Li et al., 2023	mYPAS	T0, T1, T3	Sig. ↓ at T1, T3
		BP, HR	T0, T3	Sig. ↓ [‡] : T0 vs. T3
	Yao et al., 2022	mYPAS-SF	T0, T1, T3	Sig. ↓ at T3
	Talabi et al., 2021	mYPAS	T0, T1, T3	N/S
	Lao et al., 2019	HR	T0, T3	Sig. ↓ at T3
		BP	T0, T3	N/S
	Hussain & Khan, 2018	mYPAS	T1, T3	Sig. ↓ at T3
	Rastegarian et al., 2016	mYPAS	T3	Sig. ↓
	Rasti-Emad-Abadi et al., 2014	mYPAS	T0, T4	Sig. ↓ at T4
	Wright et al., 2010	mYPAS	T0, T2, T3, T4	Sig. ↓ at T2
	Kain et al., 2007	mYPAS	T0, T1, T3	N/S
	Kain et al., 2003, a	mYPAS	T1, T2, T3	nr.
	Kain et al., 2003, b	mYPAS	T1, T2, T3	nr.
	Amanor-Boadu, 2002	HR	T0, T3	Sig. ↓ at T3
	Kain et al., 1998	mYPAS	T1, T2, T3	N/S
	Kain et al., 1996	YPAS, CARS	T2, T3	N/S
		VAS	T1, T2, T3	N/S
		Cortisol	T3	N/S
	Hickmott et al., 1989	CAS	T1, T3	N/S
PPIA vs. premedication	Jain et al., 2023	mYPAS	T1, T3	Sig. ↑ at T3
	Yao et al., 2022	mYPAS-SF	T0, T1, T3	nr.
	Soenarto et al., 2016	mYPAS	T0, T2, T3	N/S
	Kazak et al., 2010	CAS	T1 (1.1: before premedication, 1.2: 10 min after premedication, 1.3: 20 min after premedication), T3, T4	Sig. ↑ at T1.3, T3
		BP	T1, T3	N/S
		HR	T1, T3	nr.
	Kain et al., 2007	mYPAS	T0, T1, T3	Sig. ↑ at T3
	Kain et al., 2003, a	mYPAS	T0, T1, T3	nr.
	Kain et al., 1998	mYPAS	T1, T2, T3	N/S
PPIA plus premedication vs. premedication alone	Yao et al., 2022	mYPAS-SF	T0, T1, T3	Sig. ↓ at T3
	Sadeghi et al., 2017	mYPAS	T0, T1, T3	Sig. ↓ at T3
	Akinci et al., 2008	CAS	T3	N/S
	Kain et al., 2003, a	mYPAS	T0, T1, T3	nr.
	Kain et al., 2000	mYPAS	T1, T2, T3	N/S
PPIA vs. VD	Kim et al., 2015	mYPAS	T1, T2, T3	Sig. ↑ at T2, T3

Abbreviations: BP Blood pressure, CARS Clinical Anxiety Rating Scale, CAS Child Anxiety Scale, HR Heart rate, min minutes, mYPAS Modified Yale Preoperative Anxiety Scale, mYPAS-SF Modified Yale Preoperative Anxiety Scale-Short Form, nr Not reported, N/S Not significant, NPPIA No parental presence at induction of anesthesia, PPIA Parental presence during induction of anesthesia, Sig Significantly, T Timepoint, VAS Visual Analog Scale, VD Video distraction, YPAS Yale Preoperative Anxiety Scale

↑: Higher or [‡] more increased (mean change); ↓: Lower or [‡] less increased (mean change).

*Assessments were conducted at the following time points: T0) Baseline: in the surgical ward or prior to hospital admission, T1: Preoperative holding area: within the designated preoperative waiting room, T2) Transition to the operating room: typically during parental separation in the comparison group, or at a comparable time in the PPIA group when no separation occurred, T3) Anesthesia induction: from wearing an anesthetic mask to loss of consciousness or starting intravenous anesthetic agents to loss of consciousness, and T4) Post-induction: following induction of anesthesia, either in the post-anesthesia care unit, postoperative waiting room, or the post-surgical ward

**Intervention group vs. comparison group

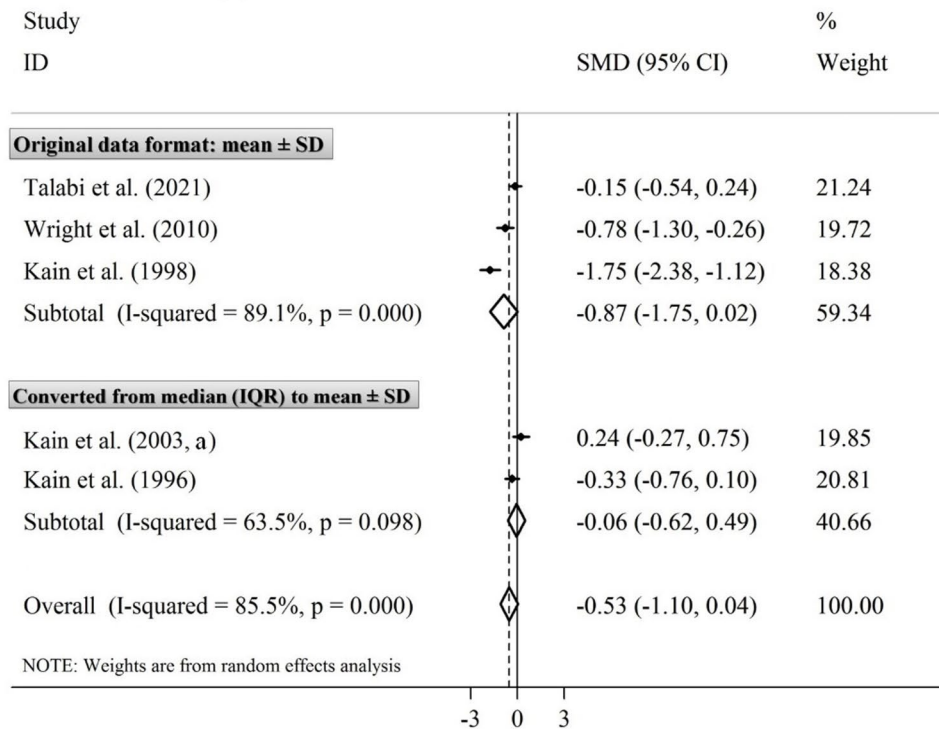
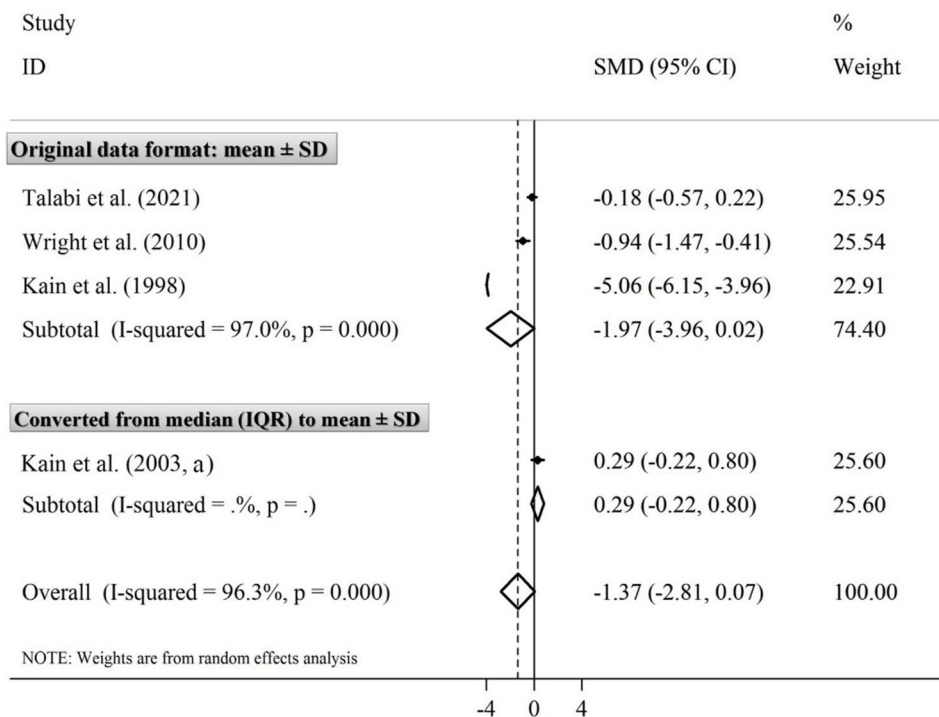
(a) at the transition to the OR**(b) from baseline to transition to the OR**

Fig. 1 Forest plots comparing the effect of PPIA versus NPPIA on children's perioperative anxiety during the transition to the OR and from baseline to OR transition (data are stratified by the method of anxiety assessment reporting)

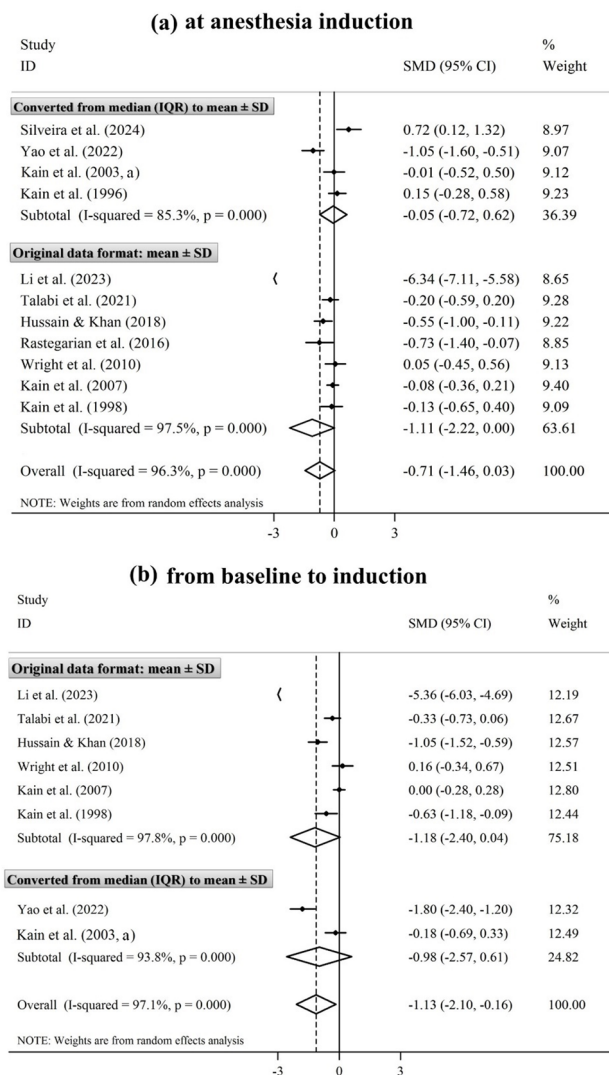


Fig. 2 Forest plots comparing the effect of PPIA versus NPPIA on children's perioperative anxiety at induction and from baseline to induction (data are stratified by the method of anxiety assessment reporting)

61]. Among these, three studies reporting changes in children's HR from baseline to induction met the criteria for inclusion in the meta-analysis [35, 61, 65]. Pooled analysis showed a significantly greater reduction in HR in the PPIA group compared with the NPPIA group (k : 3, WMD: -8.74, 95% CI: -14.64 to -2.84; P = 0.004; Fig. 3). Sensitivity analysis indicated that the exclusion of certain studies influenced the results of the primary meta-analysis (Supplementary Fig. 4). These findings suggest that PPIA may help reduce physiological anxiety responses, as reflected by HR, although the results should be interpreted cautiously due to sensitivity to specific studies.

PPIA vs. sedative premedication

Seven trials evaluated children's anxiety comparing PPIA without premedication to sedative premedication

without parental presence [23, 28, 30, 31, 36, 57, 63]. Only one study reported physiological outcomes [28], preventing pooled analysis. All seven trials assessing subjective anxiety were eligible for meta-analysis, although data from one study could not be converted to mean and SD due to ambiguous IQR values [28], and the single study using dexmedetomidine (DEX) [36] was excluded. Ultimately, three ESs for anxiety during OR transition and five ESs at induction were included in the pooled analysis.

The meta-analysis showed no significant difference between PPIA and MDZ groups during OR transition (k : 3, SMD: 0.95, 95% CI: -0.57 to 2.46; P = 0.221; Fig. 4a) or from baseline to OR transition (k : 3, SMD: 2.03, 95% CI: -0.67 to 4.74; P = 0.141; Fig. 4b). In contrast, anxiety at induction was significantly higher in the PPIA group compared with the MDZ group (k : 5, SMD: 1.06, 95% CI: 0.15 to 1.96; P = 0.022; Fig. 5a), with a corresponding greater increase from baseline to induction (k : 5, SMD: 2.15, 95% CI: 0.71 to 3.60; P = 0.004; Fig. 5b). Sensitivity analyses indicated that the pooled estimate for anxiety at induction was influenced by the exclusion of certain studies (Supplementary Figs. 5 and 6). These findings suggest that PPIA alone may be less effective than MDZ premedication in reducing anxiety at induction, while having no significant effect during OR transition; sensitivity analyses also indicate that the induction result should be interpreted with caution.

PPIA plus sedative premedication vs. sedative premedication alone

Five trials compared children's subjective anxiety between PPIA combined with sedative premedication and sedative premedication alone [22, 36, 57, 58, 66]. One study was excluded due to missing numerical data [58], and another using DEX [36] was also excluded. The meta-analysis of the remaining three ESs at induction showed no significant difference between groups (SMD: -0.40, 95% CI: -1.33 to 0.53; P = 0.402; Fig. 6). Sensitivity analysis confirmed that exclusion of any single study did not substantially affect the pooled estimate (Supplementary Fig. 7). These findings suggest that adding PPIA to sedative premedication does not significantly reduce anxiety at induction compared with sedative premedication alone.

PPIA vs. other non-pharmacological interventions

One study comparing PPIA with Video Distraction (VD) found that children in the PPIA group exhibited significantly higher anxiety during both OR transition and induction [29].

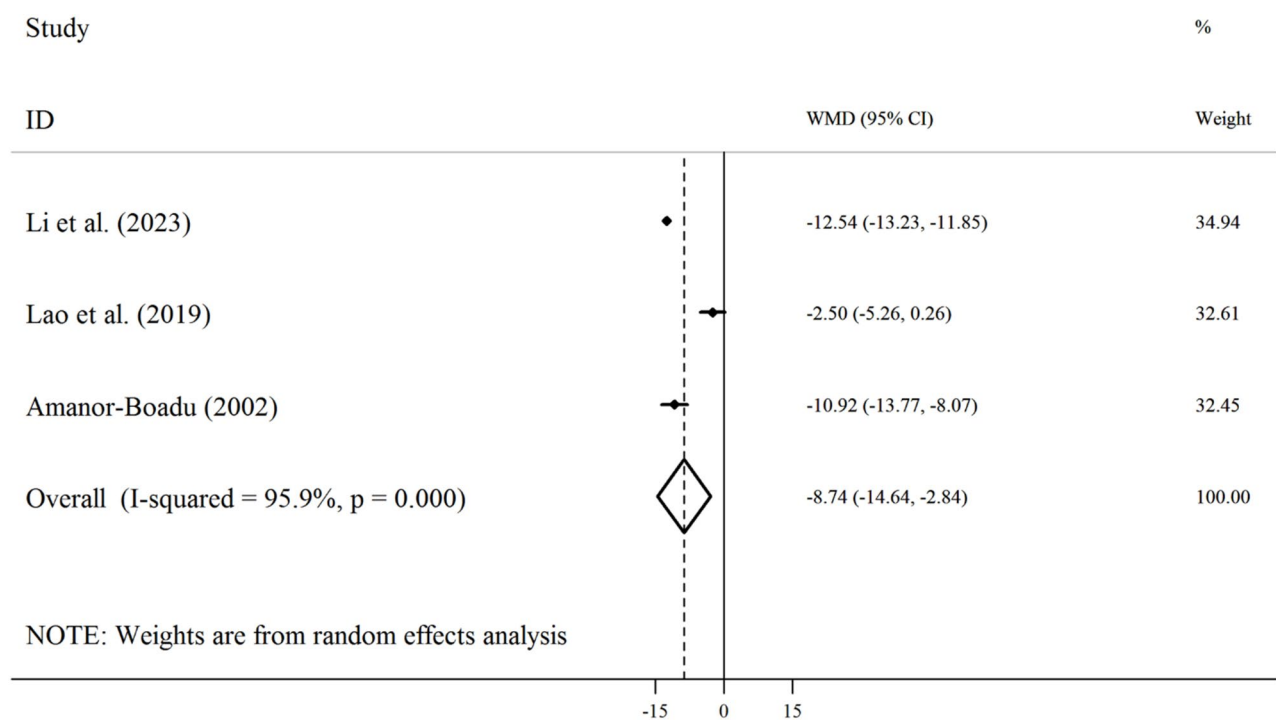


Fig. 3 Forest plot comparing the effect of PPIA versus NPPIA on children’s heart rate from baseline to induction

Adverse events
Among the seven studies that evaluated the safety of the intervention methods, no significant adverse events were reported [23, 25, 28, 32, 36, 58, 63].

Subgroup and meta-regression analyses
Moderate to high heterogeneity was observed across studies. Meta-regression indicated that none of the continuous variables significantly explained this heterogeneity (Supplementary Table 5). Subgroup analyses by study design, country, type of surgery, gender distribution, routine PPIA use, and methodological quality reduced heterogeneity in some cases (Supplementary Table 6).

Publication bias
Visual inspection of the funnel plot showed no apparent asymmetry for the pooled ES of PPIA versus NPPIA on anxiety at induction (Supplementary Fig. 8), which was confirmed by non-significant Begg’s and Egger’s tests. No publication bias was detected for other outcomes, except for the comparison of PPIA versus NPPIA on anxiety change from baseline to induction (Supplementary Table 7). However, the trim-and-fill method did not alter the pooled ES, indicating that this bias did not meaningfully affect the overall results.

Quality of studies
Using the Cochrane RoB-2 tool, five studies were rated as high quality [23, 31, 33, 36, 37], while the remaining

studies were moderate ($n = 5$) or low ($n = 14$) quality. The main sources of bias were related to randomization and selective outcome reporting (Supplementary Figs. 9 and 10; full judgments in Supplementary Table 8).

GRADE assessment rated the evidence as high for PPIA versus premedication in reducing anxiety at induction and from baseline to induction. For other outcomes, evidence quality ranged from very low to moderate, primarily due to study inconsistency and serious RoB (Table 3).

Discussion
This meta-analysis provides an evidence-based evaluation of the efficacy of PPIA as a potential alternative to pharmacological premedication or as a non-pharmacological adjunct in contemporary pediatric anesthesia. Our findings indicate that PPIA alone, when compared with MDZ, was associated with higher levels of anxiety in children both at the time of induction and from baseline to induction. This suggests that PPIA alone may be insufficient to adequately alleviate children’s preoperative anxiety and could therefore be less effective than pharmacological interventions. Furthermore, the combination of PPIA with MDZ was associated with lower anxiety levels at induction compared with MDZ alone; however, this difference was not statistically significant. Although the addition of PPIA may show a favorable trend, it does not appear to confer a clear additive benefit beyond that achieved by MDZ alone. These findings are

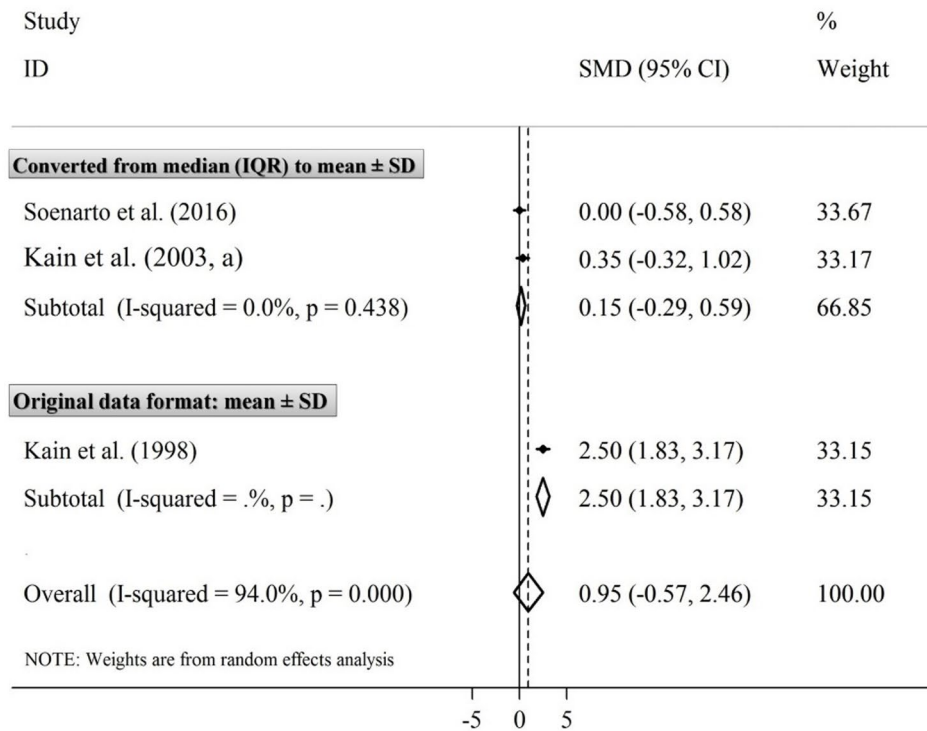
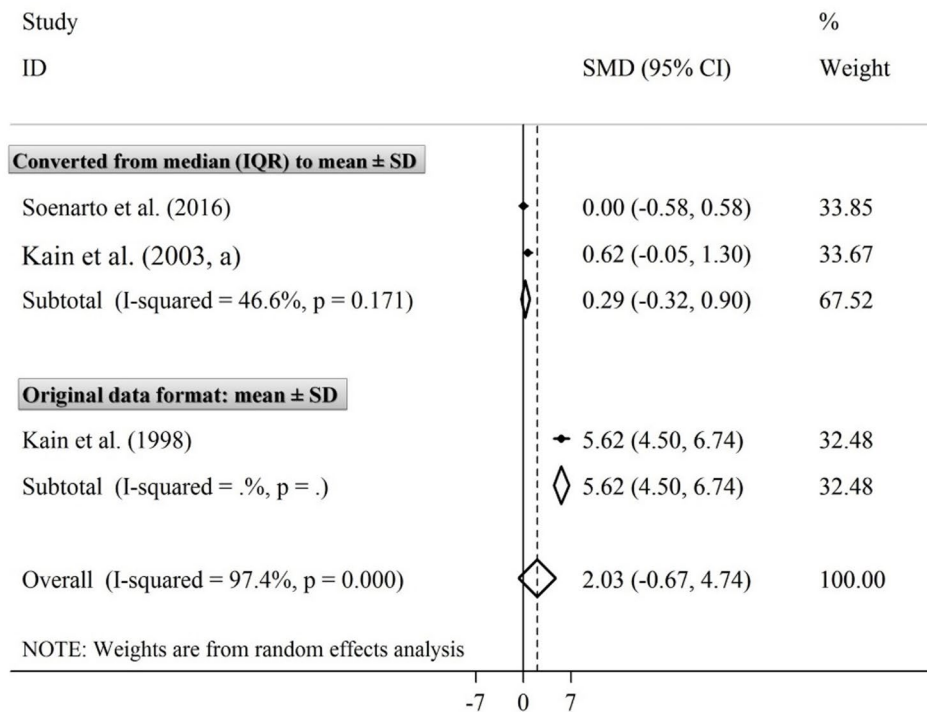
(a) at the transition to the OR**(b) from baseline to transition to the OR**

Fig. 4 Forest plots comparing the effect of PPIA versus MDZ premedication on children's perioperative anxiety during the transition to the OR and from baseline to OR transition (data are stratified by the method of anxiety assessment reporting)

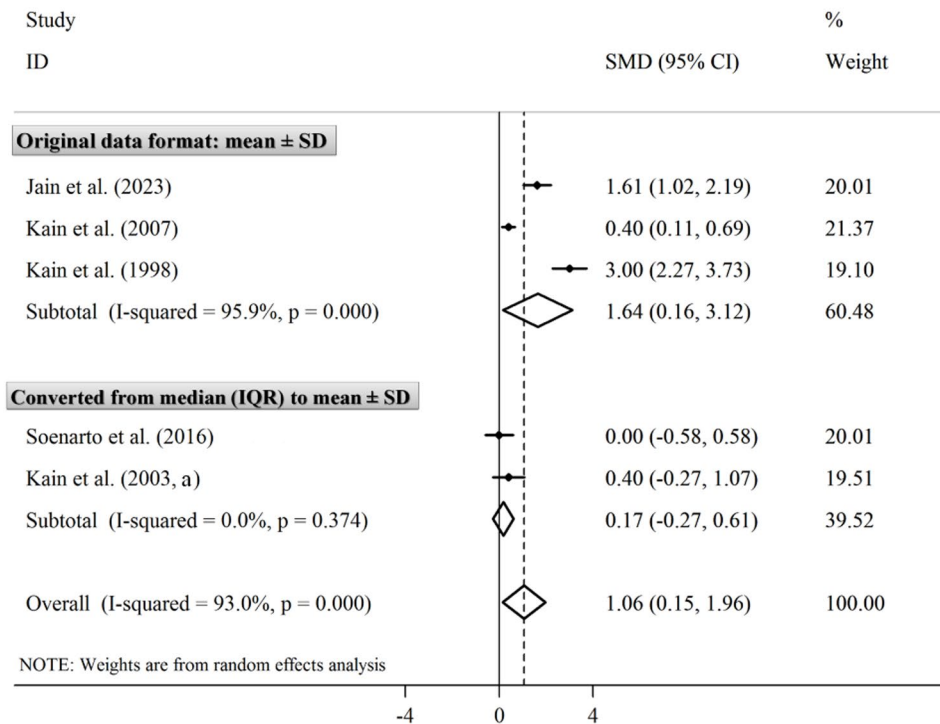
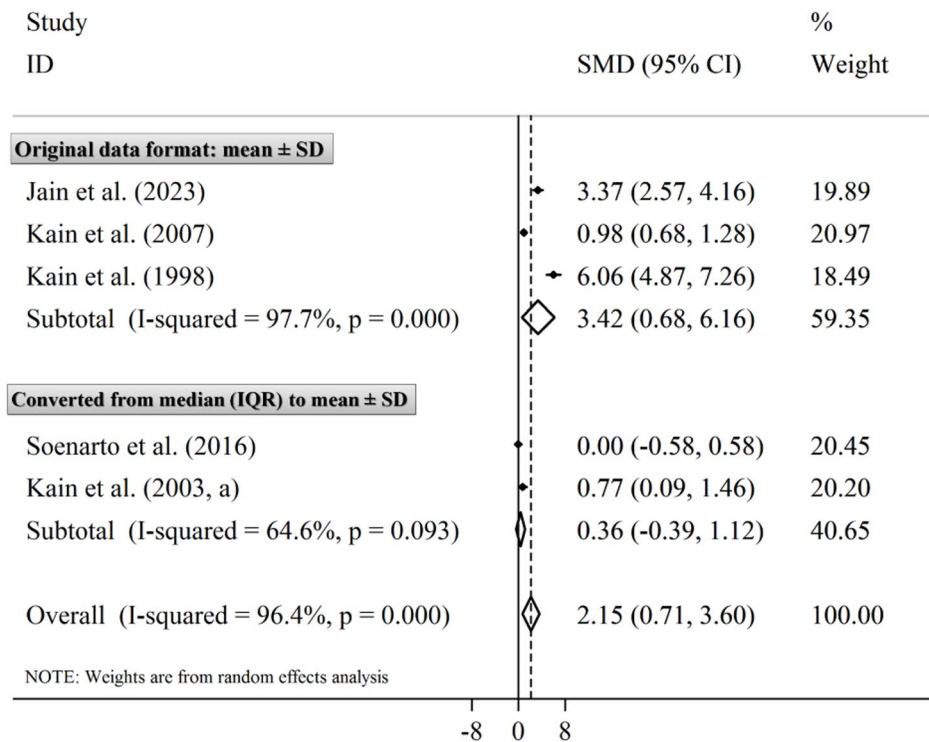
(a) at anesthesia induction**(b) from baseline to induction**

Fig. 5 Forest plots comparing the effect of PPIA versus MDZ premedication on children's perioperative anxiety at induction and from baseline to induction (data are stratified by the method of anxiety assessment reporting)

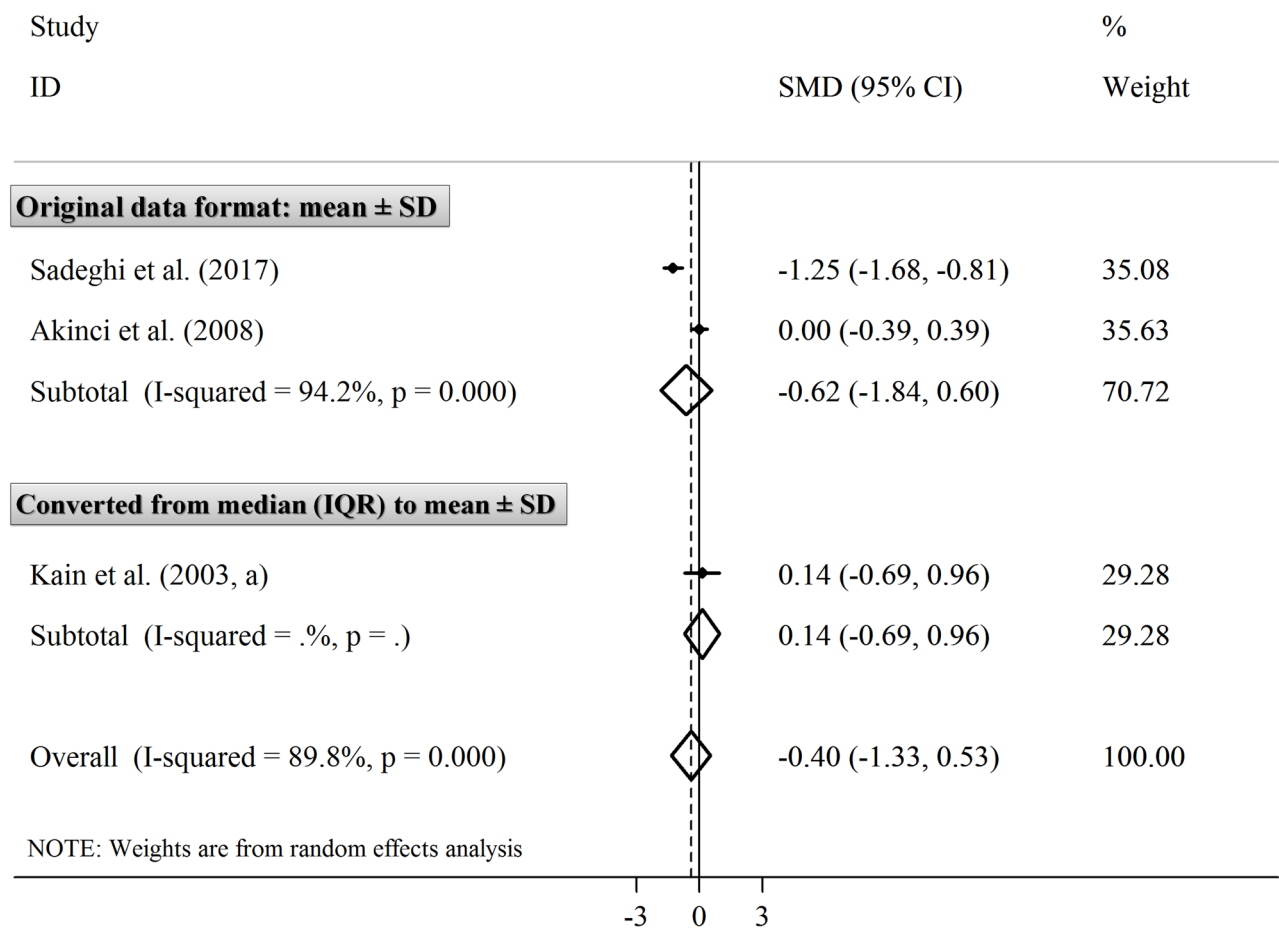


Fig. 6 Forest plot comparing the effect of PPIA combined with MDZ premedication versus MDZ premedication alone on children’s perioperative anxiety at induction (data are stratified by the method of anxiety assessment reporting)

generally consistent with previous systematic reviews, which have similarly reported limited or no additional benefit of PPIA over sedative premedication alone, and have identified PPIA alone as less effective than pharmacological or behavioral distraction strategies [38, 39].

The present meta-analysis further clarifies and extends previous evidence syntheses by providing updated insights into the comparative effects of PPIA versus NPPIA on reducing children’s perioperative anxiety. Our findings indicate that children’s anxiety levels varied considerably across different perioperative time points. Specifically, the reduction in anxiety from baseline to induction was significantly greater among children who received PPIA without premedication compared to those who received neither premedication nor PPIA. Additionally, children in the PPIA-only group demonstrated a substantially greater reduction in HR from baseline to induction than their counterparts in the NPPIA group, suggesting a potential physiological calming effect associated with PPIA. Sensitivity analyses underscored the influence of individual trials on the overall outcomes. Excluding the study by Kain et al. [57] yielded a

statistically significant reduction in anxiety during the OR transition in favor of PPIA over NPPIA, whereas the primary analysis had shown no significant difference. Likewise, excluding a qRCT by Silveira et al. [20] revealed a statistically significant reduction in children’s anxiety at induction, consistently favoring PPIA over NPPIA.

Our findings reveal some inconsistencies relative to previous meta-analyses that specifically targeted PPIA. Consistent with Erhaze et al. [40], who reported no statistically significant differences in anxiety levels between PPIA and NPPIA groups at either OR transition (MD= -0.26; $P = 0.08$) or induction (MD = 0.04; $P = 0.69$), we also observed no significant differences at these time points. However, unlike their review, our analysis demonstrated a trend toward reduced anxiety at both induction and OR transition, likely reflecting the larger number of ESs included in our study. In contrast, Liang et al. [41] reported that PPIA significantly reduced perioperative anxiety compared with controls (MD= -0.85; $P < 0.001$). This discrepancy may be attributed to differences in eligibility criteria, as only three of their nine included studies met our inclusion criteria [23, 25, 66]. These differences

Table 3 GRADE evidence profile: the effect of PPIA on children's perioperative anxiety, stratified by type of intervention

Outcomes (number of studies)	Quality assessment						Summary of findings		
	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Number of participants	Effect (95% CI)	Quality of evidence	
PPIA vs. NPPIA	Subjective anxiety at the transition to the OR (5 RCTs)	Serious ¹	Serious ²	No serious ⁴	Undetected ⁵	179	181	SMD: 0.53 lower (1.10 lower to 0.04 higher) ⁶	⊕⊕⊕⊕ Low ⁷
	Subjective anxiety from baseline to OR transition (4 RCTs)	Serious ¹	Serious ²	No serious ⁴	Undetected ⁵	136	140	SMD: 1.37 lower (2.81 lower to 0.07 higher) ⁸	⊕⊕⊕⊕ Moderate ⁹
	Subjective anxiety at induction (10 RCTs, 1 qRCT)	Serious ¹	Serious ²	No serious ⁴	Undetected ⁵	465	473	SMD: 0.71 lower (1.46 lower to 0.03 higher) ⁶	⊕⊕⊕⊕ Low ⁷
	Subjective anxiety from baseline to induction (8 RCTs)	No serious ¹⁰	Serious ²	No serious ⁴	Detected ⁵	381	390	SMD: 1.13 lower (2.10 lower to 0.16 lower) ¹¹	⊕⊕⊕⊕ Moderate ⁹
	Objective anxiety (HR) from baseline to induction (3 RCTs)	Serious ¹	Serious ²	No serious ⁴	Undetected ⁵	192	206	WMD: 8.74 lower (14.64 lower to 2.84 lower) ⁸	⊕⊕⊕⊕ Moderate ⁹

Table 3 (continued)

Outcomes (number of studies)	Quality assessment					Summary of findings			
	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Number of participants	Effect (95% CI)	Quality of evidence	
PPIA vs. premedication						Intervention	Comparison		
	Subjective anxiety at the transition to the OR (3 RCTs)	Serious ¹	No serious ³	Serious ¹²	Undetected ⁵	78	69	SMD: 0.95 higher (0.57 lower to 2.46 higher) ¹¹ Very low ¹³	⊕⊕⊕⊕
	Subjective anxiety from baseline to OR transition (3 RCTs)	Serious ¹	No serious ³	Serious ¹²	Undetected ⁵	78	69	SMD: 2.03 higher (0.67 lower to 4.74 higher) ⁸	⊕⊕⊕⊕ Moderate ⁹
	Subjective anxiety at induction (5 RCTs)	No serious ¹⁰	Serious ²	No serious ³	Undetected ⁵	202	197	SMD: 1.06 higher (0.15 higher to 1.96 higher) ¹¹	⊕⊕⊕⊕ High ¹⁴
	Subjective anxiety from baseline to induction (5 RCTs)	No serious ¹⁰	Serious ²	No serious ³	Undetected ⁵	202	197	SMD: 2.15 higher (0.71 higher to 3.60 higher) ⁸	⊕⊕⊕⊕ High ¹⁴
PPIA plus premedication vs.	Subjective anxiety at induction (3 RCTs)	Serious ¹	No serious ³	No serious ⁴	Undetected ⁵	108	111	SMD: 0.40 lower (1.33 lower to 0.53 higher) ¹⁵ Low ⁷	⊕⊕⊕⊕

Abbreviations: CI Confidence interval, HR Heart rate, NPPIA No parental presence at induction of anesthesia, OR Operating room, PPIA Parental presence during induction of anesthesia, qRCT Quasi-randomized controlled trial, RCT Randomized controlled trial, SMD Standard mean difference, WMD Weighted mean difference

¹ Higher percentage of risk of bias domains across the studies was unclear or high

² $I^2 > 70.0\%$

³ Studies were sufficiently directed regarding population, intervention protocol, comparator, and intended outcomes

⁴ The confidence interval crossed the line of no effect; however, the optimal information size was achieved

⁵ Begg's or Egger's tests ($P > 0.05$)

⁶ Moderate magnitude of effect ($0.50 \leq \text{effect size} < 0.79$)

⁷ We have low confidence in the effect estimate: the true effect may be substantially different from the estimate

⁸ Very large magnitude of effect ($1.30 \leq \text{effect size}$)

⁹ We have moderate confidence in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

¹⁰ Higher percentage of risk of bias domains across the studies was low or unclear

¹¹ Large magnitude of effect ($0.80 \leq \text{effect size} < 1.29$)

¹² The confidence interval crossed the line of no effect, and the optimal information size criterion was not met, indicating imprecision of the estimate

¹³ We have very low confidence in the effect estimate: the true effect is likely to be substantially different from the estimate

¹⁴ We are very confident that the true effect lies close to that of the estimate of the effect

¹⁵ Small magnitude of effect ($0.20 \leq \text{effect size} < 0.49$)

may also stem from methodological variations, such as pooling data from heterogeneous time points (i.e., OR transition, induction, and post-induction) and combining diverse interventions (PPIA with or without premedication versus various controls), whereas our study stratified analyses according to both timing of anxiety assessment and intervention type.

Another meta-analysis by Shih et al. [42] found no significant differences in preoperative anxiety between PPIA and control groups, although anxiety at induction was significantly lower in the PPIA group ($MD = -0.49$, $P = 0.009$), a result that contrasts with our findings. In our study, the reduction in anxiety from baseline to induction was significantly greater in the PPIA group, differing from the aforementioned review. These differences are likely due to methodological refinements in the current review, including stricter definitions of preoperative assessment, clearly defined comparator groups, and inclusion of only fully randomized and quasi-randomized trials. By contrast, the aforementioned review included non-RCTs, more heterogeneous interventions, and ambiguous preoperative time points, which may have contributed to the variability in their findings.

Compared with meta-analyses that examined PPIA within broader non-pharmacological interventions, our findings show moderate yet notable inconsistencies. In line with our findings, a Cochrane review reported no significant difference in children's anxiety during induction between PPIA and NPPIA groups ($MD = 0.03$) [10]; however, a trend toward reduced anxiety was observed in our analysis. In contrast, a more recent meta-analysis reported that PPIA alone significantly reduced anxiety during induction ($MD = -0.91$) [11], a result that diverges from our study. These discrepancies likely reflect differences in the number of included trials, study objectives, and methodological approaches. Notably, we conducted a comprehensive and focused search across multiple databases without language restrictions, which allowed for the inclusion and pooling of a greater number of ESs than in the aforementioned meta-analyses.

Strengths and limitations

This meta-analysis is the first to directly compare pharmacological premedication with PPIA alone and with the combination of PPIA and premedication. Furthermore, to our knowledge, it is the first to specifically assess the effects of PPIA on both subjective and objective measures of children's perioperative anxiety.

Several limitations should be acknowledged. First, the results should be interpreted with caution due to the substantial heterogeneity observed in the pooled analyses. Although subgroup analyses identified some potential sources of heterogeneity, residual heterogeneity may have stemmed from other factors, such as parental gender

and age, as well as differences among child age groups. Additionally, while SMDs were used to standardize outcomes, inherent discrepancies among scales may have further contributed to variability. Second, most outcomes were rated as low to moderate certainty according to GRADE, with only five studies achieving high quality per the Cochrane RoB-2 tool. Common methodological limitations, including unclear allocation concealment and partial overlap of populations, may have influenced the results. Third, some studies lacked complete data required for inclusion in the quantitative synthesis. Although we attempted to contact the corresponding authors to obtain missing information, responses were not always received, necessitating the use of standard estimation methods. Finally, the limited number of eligible studies precluded pooled analyses for certain outcomes or specific perioperative time points, thereby restricting the robustness of conclusions for these measures. Similarly, we were unable to perform supplementary analyses to identify an optimal PPIA protocol due to the small number of eligible studies.

Implications for future research

Data on PPIA's effects on cortisol levels and its comparison with VD remain limited, which precludes meta-analysis and underscores the need for further research. Furthermore, given the limited number of studies on the combined use of PPIA with pharmacological agents, more RCTs are essential to validate these potential synergistic effects, which may provide additive benefits, particularly when reducing sedative dosages or minimizing adverse drug effects is a priority. Moreover, as most trials were conducted in high-income countries where PPIA is standard practice, extending research to upper- and lower-middle-income settings, particularly facilities without dedicated induction rooms, would enhance generalizability. In addition, future studies should be specifically designed to include children with chronic illnesses, behavioral disorders, developmental delays, or those undergoing repeated procedures, populations that were excluded in the existing studies. Contextual factors, such as the number of medical personnel present and the anesthesiologist's communication style, should also be systematically evaluated, as they may independently influence pre-induction anxiety and modulate the effects of PPIA.

Furthermore, safety considerations remain insufficiently explored. Only a limited number of studies have systematically evaluated adverse events. Although PPIA is generally regarded as safe, rare yet noteworthy incidents have raised important safety concerns [67]. These events highlight the need for PPIA to be implemented within a clearly defined and standardized protocol, under the supervision of experienced anesthesia personnel.

Future trials should incorporate systematic safety assessments to ensure that PPIA can be offered as a reliable and safe component of pediatric anesthesia care.

Implications for practice

While the routine use of PPIA remains a topic of ongoing debate, the present findings reveal a complex balance between potential benefits and inherent limitations that may vary across individual patient characteristics and cultural contexts. This underscores the need for a nuanced, context-sensitive approach in which the decision to adopt PPIA is grounded in careful multidisciplinary evaluation before its incorporation into routine clinical practice.

First, implementation should be preceded by a comprehensive assessment of clinical, psychosocial, and institutional determinants that may influence feasibility and outcomes. Second, successful implementation will depend on targeted training for anesthesia teams, adequate preparation for participating parents, and the availability of institutional resources to support consistent delivery. Ultimately, the decision to employ PPIA should remain at the discretion of the attending anesthesiologist, who must carefully balance its psychological advantages against potential procedural and safety considerations.

Conclusion

Although PPIA demonstrates modest benefits over NPPIA in reducing both psychological and physiological indicators of anxiety, the overall certainty of evidence remains limited and context-dependent. Notably, when applied as a standalone intervention, PPIA appears less effective than pharmacological premedication in alleviating children's preoperative anxiety. Additionally, combining PPIA with premedication has not demonstrated a statistically significant incremental anxiolytic effect beyond premedication alone, although emerging trends suggest potential synergistic benefits. Future research should aim to address these inconclusive findings to more robustly support the integration of PPIA into evidence-based anesthesia practice, considering the remaining evidence gaps. Ultimately, the clinical application of PPIA should be guided by careful consideration of contextual, cultural, and logistical factors to ensure both safety and feasibility.

Abbreviations

ASA	American Society of Anesthesiologists
BP	Blood Pressure
CENTRAL	Cochrane Central Register of Controlled Trials
CI	Confidence Interval
DEX	Dexmedetomidine
ES	Effect Size
GRADE	Grading of Recommendations Assessment, Development, and Evaluation approach
HR	Heart Rate
IQR	Interquartile Range

MD	Mean Difference
MDZ	Midazolam
MeSH	Medical Subject Headings
mYPAS	Modified Yale Preoperative Anxiety Scale
NPPIA	No Parental Presence at Induction of Anesthesia
OR	Operating Room
PPIA	Parental Presence during Induction of Anesthesia
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International Prospective Register of Systematic Reviews
qRCT	Quasi-Randomized Control Trial
RCT	Randomized Controlled Trial
RoB	Risk of Bias
SD	Standard Deviations
SMD	Standardized Mean Difference
WMS	Weighted Mean Difference
VD	Video Distraction

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12871-026-03717-y>.

Supplementary Material 1

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Declaration of generative AI in scientific writing

While preparing this paper, the authors utilized Grammarly to enhance its readability and language. After employing this tool, the authors carefully reviewed and edited the content, assuming full responsibility for the final published article.

Authors' contributions

HADA: Study conception and design, Study search, Study selection, Data extraction, Assessing the risk of bias and the quality of the evidence, and Critical revision of the manuscript; MS and AS: Study conception and design, Data interpretation, and Critical revision of the manuscript; MZ: Study conception and design, Data analysis and interpretation, and Writing the first draft of the manuscript; MN: Study conception and design, Study search, Study selection, Data extraction, Assessing the risk of bias and the quality of the evidence, Data analysis and interpretation, and Writing the first draft of the manuscript. The authors read and approved the final manuscript for submission.

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Data availability

Data and materials are obtainable by contacting the corresponding author.

Declarations

Ethics approval and consent to participate

Informed consent was not required for this study, as the data were obtained from previous investigations where verbal or written consent had already been granted by the original study authors. However, before the study began, we received approval from the Regional Research Ethics Committee of Tehran University of Medical Sciences, Tehran, Iran (No. IR.TUMS.SPH.REC.1403.178). The authors also adhered to the guidelines established by this committee.

Consent for publication

No individual's data are included in this study.

Competing interests

The authors declare no competing interests.

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