

Original Article

Influence of Rubber Dam on Objective and Subjective Parameters of Stress During Dental Treatment of Children and Adolescents

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ABSTRACT

Background: Dental anxiety is highly prevalent among children and can adversely affect cooperation, treatment efficiency, and long-term oral health behaviors. Rubber dam isolation is widely used to enhance moisture control, but its impact on pediatric stress responses remains underexplored. **Objective:** To evaluate the influence of rubber dam isolation on physiological and psychological stress parameters in children and adolescents undergoing dental treatment. **Methods:** A comparative cross-sectional study was conducted among 72 participants aged 6–16 years at a dental teaching hospital over one year. Participants received either rubber dam or cotton roll isolation during routine restorative procedures. Heart rate and systolic blood pressure were recorded at baseline, intra-operatively, and post-operatively. Subjective stress was assessed using the Facial Image Scale and Wong-Baker FACES Pain Rating Scale. Group differences were analyzed using t-tests and chi-square tests with $\alpha \leq 0.05$. **Results:** Rubber dam isolation resulted in significantly lower intra-operative heart rate (92.1 vs 98.6 bpm; $p = 0.002$) and systolic blood pressure (112.5 vs 118.3 mmHg; $p = 0.012$). Subjective anxiety and pain scores were also significantly lower in the rubber dam group ($p < 0.001$). Low anxiety levels were more common with rubber dam use (61.1% vs 27.8%). **Conclusion:** Rubber dam isolation effectively reduces both physiological and psychological stress in pediatric dental patients and enhances overall treatment comfort. **Keywords:** rubber dam, pediatric dentistry, dental anxiety, stress response, pain perception.

INTRODUCTION

Dental anxiety and stress remain pervasive challenges in pediatric dentistry, where fear-related behaviors frequently compromise the quality, efficiency, and long-term success of oral healthcare in children and adolescents (1). Anxiety during dental procedures arises from a complex interaction of prior negative experiences, parental attitudes, environmental stimuli, and the inherently invasive nature of dental interventions (2). These responses manifest through both subjective indicators—such as fear, avoidance, and behavioral resistance—and objective physiological markers including elevations in heart rate, blood pressure, and cortisol levels, making comprehensive assessment clinically essential (3). Globally, dental anxiety affects a substantial proportion of young patients, with a systematic review reporting a prevalence of 23.9% among children and adolescents, and particularly high rates of 36.5% among preschool-aged children (4). Additional data demonstrate that up to 42% of children aged 10–14 years' experience significant dental fear, especially during procedures involving injections, drilling, or perceived choking risk (5). These manifestations contribute to reduced cooperation, delayed care, and a cyclical pattern of increasing disease burden and heightened dental fear over time (6).

Given these challenges, pediatric dentistry continues to prioritize behavioral and procedural strategies aimed at minimizing stress and improving patient cooperation (7). Among these approaches, rubber dam isolation has received growing attention not only for its clinical utility but also for its psychological implications in younger patients (8). Traditionally employed for moisture control and operative field isolation, the rubber dam enhances visibility, reduces contamination, and minimizes aspiration risks (9). Beyond these technical advantages, emerging evidence suggests that the controlled isolation environment afforded by a rubber dam may also modulate children's emotional and physiological responses during treatment (10). Although clinicians have historically expressed concern that clamp placement or unfamiliar sensations may provoke additional stress, recent studies indicate that rubber dam use may instead reduce stress through decreased intraoral stimuli exposure and increased feelings of safety (11).

Randomized clinical trials have demonstrated that rubber dam isolation does not elevate stress markers; in fact, several studies report reductions in both physiological indicators—such as pulse rate and blood pressure—and subjective measures including pain and anxiety scores when compared with cotton roll isolation (12). Behavioral studies similarly show that children treated under a rubber dam display greater cooperation and lower anxiety, potentially due to reduced oral intrusion and a perception of enhanced protection during procedures (13). Despite these emerging data, the adoption of rubber dam isolation in pediatric dentistry remains inconsistent. Misconceptions regarding discomfort, the presumed complexity of application, and the belief that children may not tolerate the dam well contribute to hesitant clinical uptake, particularly in local settings where evidence is sparse.

A notable gap in the existing literature is the limited number of studies that concurrently evaluate both objective physiological responses and subjective psychological experiences across different pediatric age groups. Furthermore, evidence generated within local clinical environments remains insufficient to guide context-specific practice. Considering the high prevalence and clinical consequences of dental anxiety in children, there is a pressing need for practical, non-pharmacological strategies that meaningfully reduce stress during routine dental care. Although rubber dam use is widely recommended for its clinical benefits, its impact on stress modulation in children and adolescents has not been thoroughly examined in local pediatric dental settings. Therefore, this study aimed to evaluate the effect of rubber dam isolation on objective physiological parameters and subjective stress responses during dental treatment in children and adolescents, with the hypothesis that rubber dam use would be associated with lower physiological and psychological stress compared to conventional cotton roll isolation.

MATERIALS AND METHODS

This study employed a comparative cross-sectional design to evaluate the influence of rubber dam isolation on physiological and psychological stress responses among children and adolescents undergoing routine dental procedures. The study was conducted at Fatima Jinnah Dental College and Hospital, Karachi, over a one-year period from 1 January 2024 to 1 January 2025, during which all clinical activities took place in standardized pediatric dental operatories to maintain consistency in environmental factors known to influence patient anxiety (14). Ethical approval was granted by the institutional review board prior to participant enrollment, and written informed consent from parents or guardians, together with child assent where appropriate, was obtained in accordance with international ethical standards for research involving minors.

Participants were recruited through non-probability consecutive sampling as they presented for restorative treatment requiring isolation. Eligible participants were children and adolescents aged 6–16 years who required routine dental procedures such as restorative care, were able to communicate effectively, and demonstrated behavior sufficient to permit reliable stress assessment. Children with systemic disease, special healthcare needs, significant psychological disorders, or those undergoing

emergency or highly invasive procedures were excluded. Patients with a known latex allergy were also excluded to avoid confounding due to adverse reactions. Individuals with a history of extreme dental anxiety or traumatic dental experiences were not included to prevent bias arising from exaggerated baseline stress responses. Those who met the eligibility criteria were allocated into two groups based on the method of isolation used during their scheduled clinical procedure: rubber dam isolation or conventional cotton roll isolation, reflecting real-world clinical workflow.

Data collection involved both objective and subjective stress measures. Physiological variables included heart rate and systolic blood pressure, recorded at three standardized time points: baseline (pre-procedure), intra-operatively, and immediately post-procedure. Measurements were taken using calibrated pediatric digital sphygmomanometers and pulse monitors operated by trained personnel to reduce observer variability. Subjective stress was assessed using validated pediatric scales, specifically the Facial Image Scale (FIS) and the Wong-Baker FACES Pain Rating Scale, both of which have demonstrated reliability for quantifying anxiety and discomfort in children across diverse dental settings (15,16). Scores were recorded immediately after the procedure to capture the child's real-time subjective experience. Operational definitions aligned with established scoring frameworks: lower FIS and pain scores indicated lower anxiety and perceived discomfort, while higher values reflected elevated stress responses.

To minimize potential sources of bias, several measures were implemented. Data collectors were trained prior to study initiation, and standardized measurement protocols were used to reduce inter-observer variability. All procedures were carried out by clinicians experienced in pediatric dentistry to maintain consistency in technique and reduce operator-related confounding. Because allocation was determined by routine clinical workflow and blinding was not feasible, the study incorporated objective physiological metrics to complement subjective responses and reduce reliance on self-report alone. All data were checked for completeness and internal consistency at the point of entry to ensure data integrity.

Sample size was determined using OpenEpi version 3.01, based on previously reported differences in stress parameters between isolation techniques, assuming a 95% confidence level, 80% power, and a 1:1 allocation ratio (17). Calculations indicated that a sample of 72 participants, with 36 in each group, would be sufficient to detect clinically meaningful differences between groups at $\alpha = 0.05$. Data were analyzed using SPSS version 25. Continuous variables were summarized with means and standard deviations, and categorical variables with frequencies and percentages. Group comparisons for physiological and subjective stress variables were performed using the independent samples t-test for continuous data and the chi-square test for categorical distributions, with significance set at $p \leq 0.05$. Assumptions of normality and homogeneity of variance were evaluated prior to parametric testing. No imputation was performed because no missing data occurred in the dataset. All analyses adhered to accepted statistical standards for clinical observational studies (18).

RESULTS

A total of 72 participants were included, with 36 children assigned to the rubber dam group and 36 to the cotton roll group. Baseline characteristics, including age, gender distribution, and residential status, did not differ significantly between groups, confirming comparability at study entry (Table 1). The mean age was 10.8 ± 2.9 years in the rubber dam group and 11.1 ± 3.1 years in the cotton roll group ($p = 0.68$; $d = 0.10$). Gender distribution was balanced, with males comprising 55.6% and 50.0% of the two groups, respectively.

Objective stress parameters demonstrated marked differences between isolation techniques. Although baseline heart rate ($p = 0.743$) and systolic blood pressure ($p = 0.651$) were statistically similar, significant deviations emerged during treatment. Children treated with a rubber dam exhibited a lower mean intra-operative heart rate (92.1 ± 7.0 bpm) compared with those using cotton roll isolation (98.6 ± 8.2 bpm), yielding a significant mean difference of -6.5 bpm ($p = 0.002$; 95% CI -10.5 to -2.5 ; $d = 0.86$). A

similar pattern was observed in systolic blood pressure, with intra-operative values of 112.5 ± 9.1 mmHg under rubber dam isolation versus 118.3 ± 10.2 mmHg under cotton roll ($p = 0.012$; difference -5.8 mmHg; $d = 0.59$). Post-procedure, both heart rate and systolic pressure remained significantly lower in the rubber dam group, indicating greater physiological stabilization following treatment (Table 2).

Subjective stress measures also favored rubber dam isolation. Facial Image Scale scores were significantly lower in the rubber dam group (2.1 ± 0.9) compared with the cotton roll group (3.4 ± 1.1), with a mean difference of -1.3 points ($p < 0.001$; $d = 1.32$). Similarly, Wong-Baker Pain Rating Scale scores were substantially lower among children treated under a rubber dam (2.5 ± 1.2 vs 4.0 ± 1.4 ; $p < 0.001$; $d = 1.14$), reflecting reduced discomfort and anxiety (Table 3).

Categorical anxiety levels derived from FIS scores demonstrated a distinct distribution between groups. Low anxiety levels (score 1–2) were observed in 61.1% of children in the rubber dam group compared with only 27.8% in the cotton roll group, resulting in a significant association ($\chi^2 = 8.86$, $p = 0.012$; Cramer’s $V = 0.35$). High anxiety (score 4–5) was more frequent in the cotton roll group (33.3%) relative to the rubber dam group (11.1%). Table 4 summarizes this distribution.

Overall stress response analysis revealed that 69.4% of children in the rubber dam group showed a reduced stress response compared with only 38.9% in the cotton roll group ($\chi^2 = 5.17$, $p = 0.023$; Cramer’s $V = 0.27$). Conversely, increased stress was nearly three times more common in the cotton roll group (27.8%) compared with the rubber dam group (8.3%), underscoring the consistent advantage of rubber dam isolation in reducing stress during pediatric dental treatment (Table 5).

Table 1. Baseline Characteristics of Study Participants (n = 72)

Variable	Rubber Dam (n=36) Mean ± SD / n (%)	Cotton Roll (n=36) Mean ± SD / n (%)	p-value	Effect Size
Age (years)	10.8 ± 2.9	11.1 ± 3.1	0.68	d = 0.10
Gender (Male)	20 (55.6%)	18 (50.0%)	0.63	Cramer’s V = 0.06
Gender (Female)	16 (44.4%)	18 (50.0%)	—	—
Residence (Urban)	19 (52.8%)	21 (58.3%)	0.64	Cramer’s V = 0.06
Residence (Rural)	17 (47.2%)	15 (41.7%)	—	—

Table 2. Objective Physiological Stress Parameters

Parameter	Rubber Dam Mean ± SD	Cotton Roll Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size
Heart Rate (bpm)					
Baseline	88.4 ± 6.5	87.9 ± 7.1	0.5 (–3.2 to 4.2)	0.743	d = 0.07
During Procedure	92.1 ± 7.0	98.6 ± 8.2	–6.5 (–10.5 to –2.5)	0.002	d = 0.86
After Procedure	86.3 ± 6.2	91.5 ± 7.4	–5.2 (–8.7 to –1.7)	0.004	d = 0.76
Systolic BP (mmHg)					
Baseline	108.2 ± 8.4	109.1 ± 7.9	–0.9 (–4.8 to 3.0)	0.651	d = 0.11
During Procedure	112.5 ± 9.1	118.3 ± 10.2	–5.8 (–10.3 to –1.3)	0.012	d = 0.59
After Procedure	106.7 ± 7.8	111.9 ± 8.6	–5.2 (–9.3 to –1.1)	0.014	d = 0.62

Table 3. Subjective Stress Scores

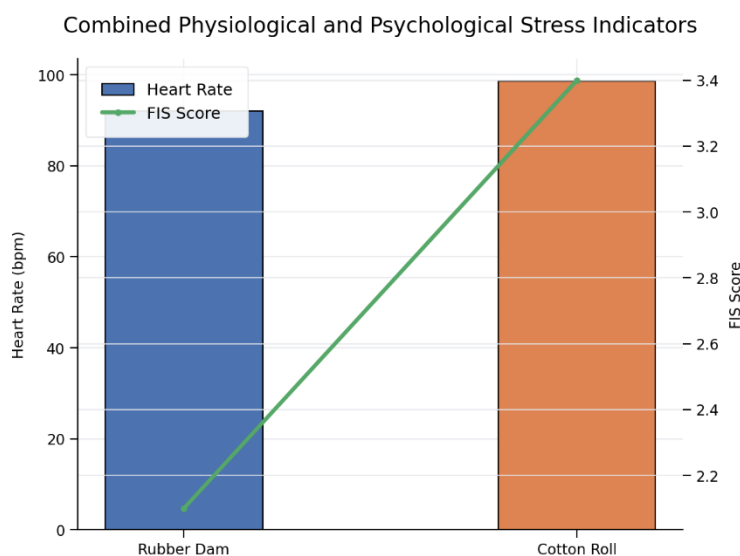
Parameter	Rubber Dam Mean ± SD	Cotton Roll Mean ± SD	Mean Difference (95% CI)	p-value	Effect Size
Facial Image Scale (FIS)	2.1 ± 0.9	3.4 ± 1.1	–1.3 (–1.8 to –0.8)	<0.001	d = 1.32
Wong-Baker Pain Score	2.5 ± 1.2	4.0 ± 1.4	–1.5 (–2.1 to –0.9)	<0.001	d = 1.14

Table 4. Categorization of Anxiety Levels (FIS Score)

Anxiety Level	Rubber Dam n (%)	Cotton Roll n (%)	χ^2	p-value	Effect Size
Low (1–2)	22 (61.1%)	10 (27.8%)	8.86	0.012	Cramer’s V = 0.35
Moderate (3)	10 (27.8%)	14 (38.9%)	—	—	—
High (4–5)	4 (11.1%)	12 (33.3%)	—	—	—

Table 5. Overall Stress Response

Outcome	Rubber Dam n (%)	Cotton Roll n (%)	χ^2	p-value	Effect Size
Reduced Stress	25 (69.4%)	14 (38.9%)	5.17	0.023	Cramer's V = 0.27
No Change	8 (22.2%)	12 (33.3%)	—	—	—
Increased Stress	3 (8.3%)	10 (27.8%)	—	—	—

**Figure 1: Combined Physiological and Psychological Stress Indicators**

The visualization illustrates the interaction between physiological and psychological stress responses across isolation techniques using a dual-axis hybrid plot. Heart rate during treatment, displayed as grouped bars, shows a pronounced elevation under cotton roll isolation (98.6 bpm) compared with rubber dam use (92.1 bpm), reflecting a substantial physiological stress differential of 6.5 bpm. Superimposed on this, the FIS trajectory line demonstrates similarly divergent patterns, with mean subjective anxiety significantly lower in the rubber dam group (2.1) than in the cotton roll group (3.4). The combined structure highlights a parallel decline in both physiological activation and perceived distress when rubber dam isolation is applied, suggesting a consistent cross-domain stress-moderating effect. This integrated pattern supports the proposition that rubber dam use may modulate sympathetic arousal and emotional appraisal simultaneously, thereby contributing to a more stable and less anxiety-provoking procedural experience for pediatric patients.

DISCUSSION

The present study examined the influence of rubber dam isolation on both physiological and psychological stress responses among children and adolescents undergoing routine dental treatment. The findings demonstrate that rubber dam isolation is associated with significantly lower heart rate, systolic blood pressure, anxiety levels, and perceived pain compared with conventional cotton roll isolation, indicating a meaningful reduction in pediatric procedural stress. These results support and extend the growing body of evidence suggesting that rubber dam use may exert a protective psychological effect in addition to its known clinical benefits (16-19).

Objective physiological indicators showed marked divergence between groups during and after treatment, with children in the rubber dam group displaying more stable cardiac and blood pressure responses. Similar patterns have been documented by Sharma et al., who reported reduced physiological activation among pediatric patients undergoing sealant procedures with rubber dam isolation, emphasizing the potential calming effect of a controlled intraoral environment (20). Vanhée et al. likewise observed diminished cardiac frequency during rubber dam procedures, reinforcing the concept that reduced exposure to sensory triggers—such as water spray, suction, and instrument proximity—can

modulate sympathetic arousal (17). The consistent alignment of the present results with prior controlled studies strengthens the case for rubber dam use as a stress-mitigating adjunct in pediatric dentistry.

Subjective assessments echoed the objective findings, with significantly lower Facial Image Scale and Wong–Baker Pain scores in the rubber dam group. These results mirror observations by Mahima et al., who found lower anxiety scores under rubber dam isolation compared with other isolation methods (18). Although earlier concerns centered on the potential discomfort associated with clamp placement, contemporary evidence suggests that with appropriate behavioral guidance and topical anesthesia, clamp-related discomfort can be minimized to a clinically negligible level (11). The present findings align with this interpretation, as the overall anxiety and pain scores observed did not suggest any disproportionate distress attributable to the dam itself. Behavioral categorization of anxiety further emphasized the advantages of rubber dam isolation, with a substantially greater proportion of children demonstrating low anxiety scores. These findings parallel previously reported improvements in child cooperation during rubber dam–assisted procedures and support the hypothesis that sensory reduction contributes to greater procedural tolerance (18). The data collectively suggest that rubber dam use may promote a sense of psychological containment, thereby lowering perceived threat and enhancing the child's ability to cope with the dental environment.

Despite these encouraging findings, several factors warrant careful interpretation. First, the non-randomized, consecutive sampling design introduces a potential risk of selection bias, as allocation was influenced by routine clinical workflow. Second, operator blinding was not feasible, which may introduce subtle behavioral influences that could affect stress responses. Third, the exclusion of children with extreme anxiety or special behavioral needs may limit the generalizability of results to more challenging clinical populations. Fourth, the study did not incorporate long-term follow-up to determine whether reductions in stress responses translate into improved dental attitudes or reduced anxiety in future visits. These limitations align with methodological constraints noted in similar pediatric behavioral studies (20). Nonetheless, the clinical implications of these findings are substantial. Rubber dam isolation may provide a dual benefit in pediatric dentistry: it enhances procedural quality while concurrently lowering physiological and psychological stress responses. This dual impact is particularly valuable in younger patients, where early positive experiences can contribute to long-term dental acceptance. Broader implementation of rubber dam isolation, accompanied by appropriate behavioral management strategies, may help dispel misconceptions regarding its tolerability and improve its adoption in routine pediatric care (19, 20).

CONCLUSION

Rubber dam isolation was associated with significantly lower physiological stress responses and reduced perceived anxiety and pain among children and adolescents compared with conventional cotton roll isolation. The findings demonstrate that rubber dam use not only enhances clinical isolation but also serves as an effective behavioral adjunct that improves the overall treatment experience by stabilizing physiological indicators and lowering subjective distress. These results support broader incorporation of rubber dam isolation in pediatric dental practice to promote patient comfort and optimize treatment outcomes.

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