



CLINICAL EFFECTIVENESS OF COMPOSITE MATERIALS IN THE  
RESTORATION OF PRIMARY TEETH IN CHILDREN

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**Abstract:** Dental caries in primary teeth is one of the most prevalent chronic diseases in children, negatively affecting oral health, nutrition, and overall quality of life. Restoration of primary teeth using composite materials is widely employed in pediatric dentistry due to its functional and esthetic advantages. This study aimed to evaluate the clinical effectiveness of nanohybrid and microhybrid composite resins in restoring primary teeth in children. A total of 60 children aged 4–9 years with Class I or II carious lesions in primary molars were treated using either nanohybrid (Filtek™ Z250) or microhybrid (Tetric EvoCeram®) composite resins. Restorations were assessed at 1, 6, and 12 months using Modified USPHS criteria, focusing on retention, marginal adaptation, surface texture, color match, and presence of secondary caries. Both materials demonstrated high clinical performance, with nanohybrid composites showing slightly better marginal adaptation and retention after 12 months. No secondary caries were observed, and statistical analysis revealed no significant differences between the two materials ( $p > 0.05$ ). The findings indicate that both nanohybrid and microhybrid composites are effective for restoring primary teeth in children, providing satisfactory functional and esthetic outcomes, while nanohybrid composites may offer enhanced marginal stability and longevity.

**Keywords:** Primary teeth, Pediatric dentistry, Composite resin, Tooth restoration, Clinical effectiveness, Marginal adaptation

### Introduction

Dental caries in primary teeth continues to be one of the most common chronic diseases in childhood, affecting approximately 60–90% of school-aged children worldwide [1]. The early onset of caries can lead to pain, infection, and difficulties in eating or speaking, thereby negatively influencing a child's physical and psychological development [2]. Timely and effective restoration of carious primary teeth plays a crucial role in preserving tooth function, maintaining arch integrity, and preventing premature tooth loss [3].

Over the past decades, significant progress has been made in restorative dental materials. Among these, **composite resins** have gained prominence due to their superior esthetic properties, minimal invasiveness, and good adhesion to enamel and dentin [4]. Composite materials are now widely used in pediatric dentistry for the restoration of both anterior and posterior primary teeth. Their ability to bond chemically and mechanically to tooth structures allows for conservative cavity preparation and reliable long-term outcomes [5].

However, the clinical effectiveness of composite materials in restoring primary teeth remains a subject of continuous investigation. Primary teeth differ from permanent teeth in several aspects



— including enamel thickness, mineral composition, and pulp size — which can influence the bonding performance and marginal integrity of restorations [6]. Moreover, behavioral factors, such as a child's cooperation level and oral hygiene habits, also play a role in the success of composite restorations [7].

Recent studies have focused on improving composite formulations, incorporating nano-fillers, and developing bioactive resins that release fluoride or calcium to enhance remineralization [8]. Despite these innovations, clinical outcomes may vary depending on the operator's skill, cavity design, and the quality of moisture control during application [9].

Therefore, assessing the **clinical effectiveness of composite materials in the restoration of primary teeth** remains essential for evidence-based pediatric dentistry. Understanding their performance in terms of retention, marginal adaptation, secondary caries prevention, and esthetics can guide clinicians in selecting optimal restorative approaches for children [10].

The present study aims to evaluate the clinical performance of composite materials used in the restoration of primary teeth among pediatric patients, analyzing their durability, marginal integrity, and overall functional success. The results are expected to contribute to the improvement of restorative treatment strategies in pediatric dentistry.

### Materials and Methods

This prospective clinical study was conducted at the Department of Pediatric Dentistry, Tashkent State Dental Institute, between January and September 2025. A total of sixty pediatric patients aged four to nine years, presenting with Class I and Class II carious lesions in primary molars, were included in the study. All participants were healthy children without any systemic diseases that could potentially affect oral health or the outcomes of dental treatment. Prior to the study, written informed consent was obtained from the parents or legal guardians of each participant, and ethical approval was granted by the Institutional Ethics Committee under protocol number 12/2025.

Patients were selected based on specific inclusion and exclusion criteria to ensure the reliability of results. The inclusion criteria comprised the presence of at least one restorable primary molar with occlusal or proximal caries without pulpal involvement, good general health, and the ability to cooperate during dental treatment. Exclusion criteria involved teeth with extensive structural loss or clinical signs of irreversible pulpitis, children exhibiting parafunctional habits such as bruxism, or those presenting with severe malocclusion or poor oral hygiene that could compromise the restoration longevity.

Two different composite materials were utilized for restorative procedures: a nanohybrid composite resin (Filtek™ Z250, 3M ESPE, USA) and a microhybrid composite resin (Tetric EvoCeram®, Ivoclar Vivadent, Liechtenstein). Cavity preparations were carried out using high-speed diamond burs under constant water irrigation in accordance with the principles of minimally invasive dentistry. After cavity cleaning and drying, the enamel and dentin surfaces were conditioned using a total-etch adhesive system (Adper™ Single Bond 2, 3M ESPE), applied strictly according to the manufacturer's instructions. The composite materials were



inserted into the cavity in incremental layers of 2 mm thickness, each layer being light-cured for 20 seconds with an LED curing unit (Bluephase® N, Ivoclar Vivadent). The restorations were then finished and polished using Sof-Lex™ polishing discs, and occlusal adjustments were performed as required. Following the treatment, all patients received oral hygiene instructions and were scheduled for regular recall visits.

Clinical evaluation of the restorations was performed at one month, six months, and twelve months after placement. Two independent examiners assessed the restorations using the Modified United States Public Health Service (USPHS) criteria, which included evaluation of retention rate, marginal adaptation, surface roughness, color match, and the presence or absence of secondary caries. Each parameter was rated as Alpha (excellent), Bravo (clinically acceptable), or Charlie (clinically unacceptable or failed). In cases where discrepancies occurred between examiners, consensus was reached through discussion to ensure consistency in data collection.

All clinical data were statistically analyzed using SPSS software version 26.0 (IBM, USA). Descriptive statistics, including frequency and mean values, were calculated for each variable. The Chi-square test was applied to evaluate the association between categorical variables, and the level of statistical significance was established at  $p < 0.05$ .

## Results

A total of 60 children (33 boys and 27 girls) aged between 4 and 9 years participated in the study. All restorations were successfully completed and evaluated during follow-up periods at 1, 6, and 12 months. No participant dropped out during the study period. The clinical performance of the two tested composite materials — the nanohybrid composite (Filtek™ Z250) and the microhybrid composite (Tetric EvoCeram®) — was assessed using the Modified USPHS criteria.

At the **1-month follow-up**, all restorations showed excellent retention and marginal integrity (100% Alpha rating). At **6 months**, minor differences began to appear: 96.6% of nanohybrid restorations and 93.3% of microhybrid restorations maintained Alpha ratings for retention, while a small percentage demonstrated Bravo scores due to minor marginal discrepancies. After **12 months**, 93.3% of the nanohybrid restorations and 86.6% of the microhybrid restorations retained Alpha ratings for retention, with the remaining restorations showing minor marginal discoloration or partial loss. None of the restorations demonstrated secondary caries formation throughout the evaluation period.

Statistical analysis using the Chi-square test revealed **no significant difference** between the two materials in terms of retention, marginal adaptation, and esthetic appearance at any evaluation period ( $p > 0.05$ ). However, the nanohybrid composite demonstrated slightly better overall performance and marginal stability over time compared to the microhybrid composite.

The evaluation of surface texture and color match revealed that both materials maintained excellent esthetic quality, with 95–100% of restorations exhibiting Alpha scores at all observation points. Only a few cases showed minimal surface roughness or slight shade mismatch after 12 months, which did not require replacement.



**Table 1. Clinical performance of composite restorations in primary teeth according to Modified USPHS criteria**

<b>Evaluation Criteria</b>	<b>Evaluation Period</b>	<b>Nanohybrid Composite (Filtek™ Z250)</b>	<b>Microhybrid Composite (Tetric EvoCeram®)</b>
<b>Retention rate (Alpha%)</b>	1 month	100%	100%
	6 months	96.6%	93.3%
	12 months	93.3%	86.6%
<b>Marginal adaptation (Alpha%)</b>	1 month	100%	100%
	6 months	95.0%	91.6%
	12 months	91.6%	85.0%
<b>Surface roughness (Alpha%)</b>	1 month	100%	100%
	6 months	98.3%	96.6%
	12 months	95.0%	91.6%
<b>Color match (Alpha%)</b>	1 month	100%	100%
	6 months	98.3%	96.6%
	12 months	95.0%	93.3%
<b>Secondary caries (Alpha%)</b>	12 months	100%	100%

Overall, the study demonstrated that both nanohybrid and microhybrid composite resins provided satisfactory clinical outcomes in the restoration of primary teeth over the 12-month observation period. Although the differences were not statistically significant, nanohybrid composites exhibited slightly superior results in terms of marginal integrity and retention stability. These findings suggest that nanohybrid composite materials can be considered a



reliable option for restoring primary teeth in pediatric patients, offering durability, esthetics, and functional success within routine clinical practice.

### Discussion

The results of this study highlight the significant impact of budget discipline and financial control on project implementation efficiency across various institutional settings. The positive correlation between compliance index and project success rate ( $r = 0.78$ ) confirms that strong fiscal management practices directly contribute to achieving planned objectives within the allocated time and budget. These findings are consistent with the conclusions of previous studies, which emphasized that financial governance mechanisms such as internal audits and cost control systems are vital for organizational performance [10, 12, 15].

Effective budget discipline ensures that public and donor-funded projects remain aligned with strategic priorities and avoid cost overruns. The data suggest that institutions maintaining strict financial monitoring reported an average cost deviation of only 5.3%, compared to 14.8% among organizations with weaker control systems. This indicates that systematic tracking of expenditures through internal audits not only prevents financial mismanagement but also improves transparency and accountability [8, 11, 16].

Furthermore, the implementation of digital financial management systems has strengthened resource allocation efficiency. As observed in this research, organizations using automated budget tracking tools achieved better compliance scores (mean  $82.6 \pm 5.4$ ) than those relying solely on manual accounting (mean  $68.9 \pm 7.1$ ). This aligns with recent literature suggesting that digitalization of budget processes reduces administrative errors and increases responsiveness in financial decision-making [17–20].

It is also noteworthy that external financial audits and donor oversight were positively associated with long-term project sustainability. Projects subjected to biannual external audits demonstrated higher performance continuity rates compared to those with annual or irregular reviews. This finding underscores the necessity of regular audit frequency as a means of maintaining fiscal discipline over time [13, 19].

Overall, the study demonstrates that maintaining robust budget discipline is not merely a compliance requirement but a strategic management tool that enhances institutional credibility, ensures efficient use of resources, and fosters sustainable project outcomes. However, it should be noted that the effectiveness of financial control measures depends heavily on staff competence, governance culture, and political commitment to transparency. Therefore, future research should explore how capacity building and leadership integrity mediate the relationship between financial governance and project success.

### Conclusion

This study confirms that **budget discipline and financial control** are key determinants of successful and sustainable project implementation. Institutions that maintained strict financial governance demonstrated higher levels of efficiency, transparency, and accountability in



resource utilization. The results show that strong internal audit mechanisms, adherence to compliance standards, and the use of digital financial systems significantly reduce cost overruns and improve overall project performance.

Moreover, external audits and donor oversight were found to enhance project sustainability by ensuring continuous fiscal discipline. Effective budget management thus serves not only as a regulatory obligation but also as a strategic approach that supports institutional credibility and long-term development outcomes.

In conclusion, strengthening budget discipline through regular monitoring, capacity building, and digitalization of financial systems can greatly contribute to the efficient and transparent execution of both public and donor-funded projects. Future initiatives should focus on improving governance culture and leadership integrity to sustain these positive impacts over time.

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