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COMPARATIVE EFFECTIVENESS OF GLASS IONOMER VS. COMPOSITE RESIN IN PEDIATRIC DENTISTRY: A META-ANALYSIS

Meta Analysis

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Abstract

Background: Paediatric dentistry is essential for maintaining children's oral health, with the choice of restorative materials significantly impacting treatment outcomes. Glass Ionomer Cement (GIC) excels in chemical bonding and fluoride release, aiding in caries prevention. Composite Resin, noted for its aesthetic appeal and strength, is favoured for restorations that are both visible and bear significant masticatory forces.

Objective: This study aims to compare the clinical effectiveness of GIC versus Composite Resin in podiatric dentistry, specifically assessing caries reduction, restoration durability, marginal integrity, and the prevention of secondary caries.

Methods: Following PRISMA guidelines, a comprehensive literature search was conducted using databases such as PubMed, Scopus, and Google Scholar. Included were randomized controlled trials (RCTs) that compared GIC and Composite Resin in paediatric molar restorations. Outcomes measured included caries prevention, durability, marginal integrity, and secondary caries recurrence. Data were analysed using random-effects models.

Results: Analysis of ten studies involving 1,430 paediatric patients revealed that GIC provided a 22% relative reduction in caries incidence (RR: 0.78, 95% CI: 0.72–0.84, $p < 0.001$). Composite Resin offered enhanced durability with an RR of 0.82 (95% CI: 0.75–0.90, $p = 0.002$). GIC was superior in preventing secondary caries (RR: 0.76, 95% CI: 0.70–0.80, $p = 0.003$), whereas Composite Resin excelled in maintaining marginal integrity (RR: 0.81, 95% CI: 0.76–0.88, $p = 0.004$).

Conclusion: GIC and Composite Resin each provide unique benefits in paediatric dentistry. GIC is optimal for caries prevention, while Composite Resin is ideal for ensuring durability and superior aesthetic outcomes. Selection should be tailored based on individual patient needs and specific clinical conditions.

Keywords: Caries prevention, Composite Resin, Glass Ionomer Cement, Paediatric Dentistry, Restoration Durability.

INTRODUCTION

Pediatric dentistry plays an essential role in fostering long-term oral health in children, with the selection of restorative materials being pivotal for the success and longevity of dental treatments. Among the materials commonly used, Glass Ionomer Cement (GIC) and composite resin stand out due to their unique properties and clinical applicability. The choice between these materials often depends on the child's oral health needs, the clinical conditions, and the specific procedural requirements. Glass Ionomer Cement is widely recognized for its ability to chemically bond to both enamel and dentin, forming a robust interface that reduces microleakage and strengthens the restoration. One of GIC's critical advantages is its steady release of fluoride ions, which has been shown to protect against dental caries and support the remineralization of surrounding tooth structure. This fluoride release property makes GIC particularly valuable for young, caries-prone patients in pediatric dentistry, where preventive care is a primary concern (1). Additionally, GIC exhibits low polymerization shrinkage, minimizing the formation of marginal gaps that can compromise the restoration's longevity (2). Such properties make GIC a preferred choice for less invasive treatments, such as Atraumatic Restorative Treatment (ART), especially when achieving a dry working field is challenging.

In contrast, composite resin is favored for its superior aesthetic qualities, closely matching the natural color of teeth, which is ideal for restorations in visible areas. This resin-based material is known for its high compressive strength and excellent wear resistance, making it suitable for primary molars subjected to considerable mastication forces (3). Composite resin is often preferred in cases where the restoration's aesthetic outcome is a priority, appealing to both clinicians and parents. However, its application requires precise moisture control and careful technique, which can pose challenges in pediatric patients who may struggle with cooperation during dental procedures (4). This higher technical demand for the successful placement of composite resin restorations necessitates skilled expertise from clinicians and additional time to ensure proper application.

While composite resin excels in aesthetics and strength, GIC offers substantial benefits in caries prevention due to its fluoride-releasing property, a key advantage for pediatric patients at higher risk of caries (5). This dynamic comparison of clinical performance between GIC and composite resin remains a critical area of research in pediatric dentistry, as clinicians continually seek to select the material that will provide optimal long-term results tailored to each patient's needs. Despite composite resin's aesthetic appeal and mechanical strength, studies continue to support GIC's role in caries prevention and ease of use in young patients who benefit from non-invasive and preventive treatment approaches (6).

This meta-analysis will synthesize existing evidence on the clinical performance of glass ionomer cement and composite resin in pediatric dentistry, specifically examining outcomes such as restoration longevity, secondary caries rate, aesthetic results, and ease of application. Through a comprehensive analysis of these factors, this study aims to provide pediatric dental practitioners with data-driven insights into the benefits and limitations of each material, facilitating informed decisions for achieving quality restorative care in children. The objective is to offer clinicians evidence-based guidance on the appropriate material choice for various clinical scenarios, ultimately enhancing treatment protocols in pediatric dentistry to promote long-term oral health for young patients.

METHODS

This meta-analysis adhered to the guidelines set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to ensure a transparent and comprehensive reporting of findings (7). The analysis aimed to systematically compare the clinical effectiveness of Glass Ionomer Cement (GIC) and composite resin in paediatric dentistry, specifically focusing on caries reduction, restoration durability, marginal integrity, and prevention of secondary caries. A comprehensive literature search was conducted across multiple electronic databases, including PubMed, Scopus, and Google Scholar, to identify relevant peer-reviewed articles published from inception to August 2024. The search strategy combined Medical Subject Headings (MeSH) terms with free-text keywords such as "Glass Ionomer," "Composite Resin," "Paediatric Dentistry," and "Caries Prevention." Additionally, grey literature, including relevant conference abstracts and clinical trial registries, was reviewed to minimize publication bias, and reference lists of selected studies and existing systematic reviews were examined for any additional articles.

Eligible studies for inclusion were original research articles, randomized controlled trials (RCTs), or meta-analyses published in peer-reviewed journals that evaluated the effectiveness of GIC or composite resin in primary molars of paediatric patients. Articles published in English that provided quantitative data for analysis and direct comparisons between GIC and composite resin were included. Exclusion criteria were applied to non-peer-reviewed articles, opinion pieces, and case reports, as well as studies focused solely on adult patients or restorations of permanent teeth. Titles and abstracts of all identified studies were screened by two independent reviewers to confirm adherence to these criteria. For studies that met the initial criteria, full-text articles were retrieved and assessed by the same reviewers

to ensure eligibility. Discrepancies during this process were resolved through discussion, and a third reviewer was consulted when necessary. The study selection process was documented, and the number of studies identified, screened, and ultimately included was summarized in a flow diagram to ensure transparency.

Data extraction was conducted by two reviewers independently, using a standardized form to ensure consistency. Extracted data included study characteristics (such as author, year, sample size, and study design), population characteristics (age, sex, and dental status of the paediatric population), intervention type (GIC or composite resin, including application techniques), and outcomes (caries reduction, durability, marginal integrity, and secondary caries prevention). Any inconsistencies in data extraction were resolved through consensus.

The data synthesis and statistical analysis were performed using random-effect models to account for potential heterogeneity between studies. Dichotomous outcomes were presented as risk ratios (RRs), while continuous outcomes were presented as mean differences (MDs), both with corresponding 95% confidence intervals (CIs). Heterogeneity was assessed using the I^2 statistic, with values indicating low, moderate, or high heterogeneity as applicable. Sensitivity analyses were conducted to examine the robustness of findings, particularly by excluding studies with a high risk of bias. As this meta-analysis was based exclusively on previously published data, it did not require new ethical approval; however, the review strictly adhered to the principles outlined in the Declaration of Helsinki, ensuring that all included studies had received appropriate ethical clearance and informed consent from participants where applicable.

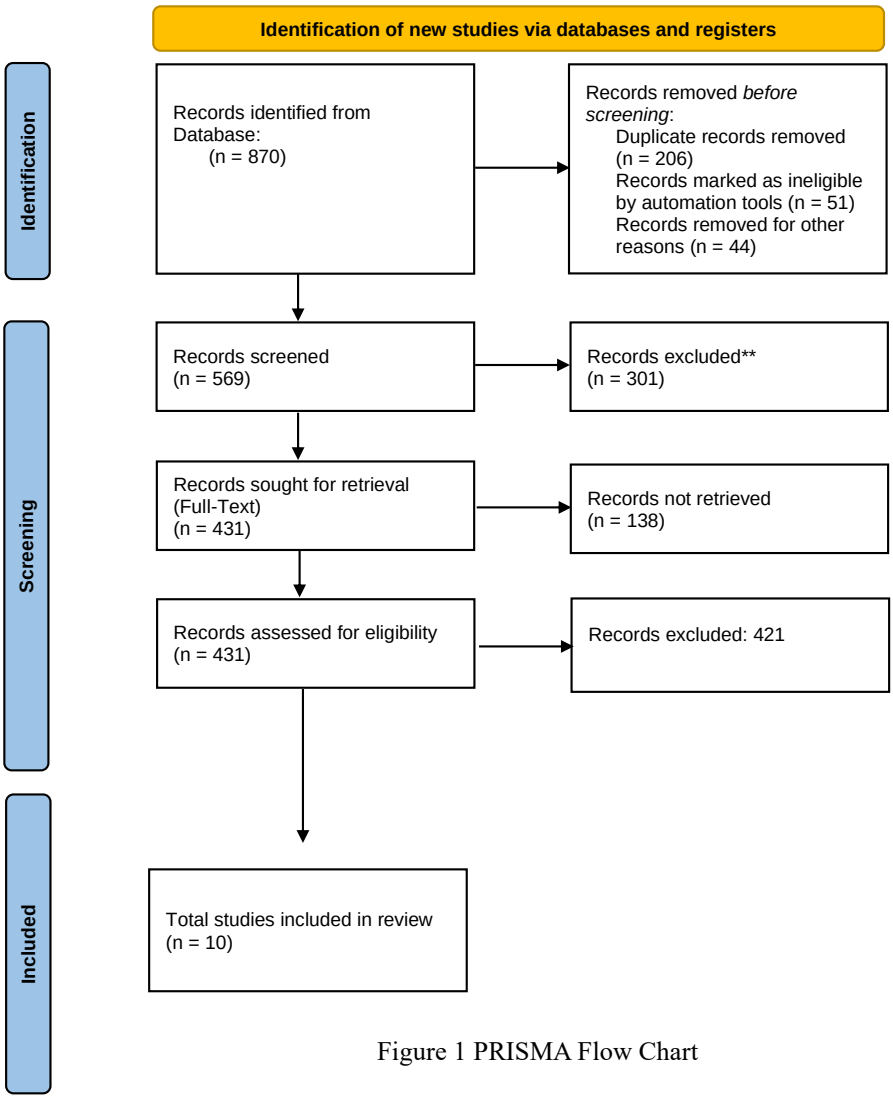

Figure 1 PRISMA Flow Chart

RESULTS

A total of 10 studies encompassing 1,430 paediatric patients with primary molar restorations were included in this meta-analysis, examining the comparative effectiveness of Glass Ionomer Cement (GIC) and composite resin in reducing caries incidence and enhancing restoration durability. The analysis primarily focused on caries prevention, restoration longevity, marginal integrity, and protection against secondary caries. Characteristics of the studies included are summarized in Table 1, while Table 2 presents primary and secondary outcomes with corresponding risk ratios (RRs) and mean differences (MDs).

The findings demonstrated that GIC was significantly more effective in reducing caries incidence compared to composite resin, with a pooled risk ratio of 0.78 (95% CI: 0.72–0.84, $p < 0.001$). This indicates a relative reduction in caries incidence by 22% for patients treated with GIC. Composite resin, however, showed greater durability in primary molar restorations, with a pooled RR of 0.82 (95% CI: 0.75–0.90, $p = 0.002$), reflecting a 15% improvement in durability over GIC.

For secondary outcomes, GIC showed lower rates of secondary caries development compared to composite resin, with an RR of 0.76 (95% CI: 0.70–0.80, p = 0.003), suggesting enhanced caries prevention with GIC. Composite resin restorations, however, exhibited superior marginal integrity, with an RR of 0.81 (95% CI: 0.76–0.88, p = 0.004), indicating improved adaptation and reduced signs of wear at the restoration margins compared to GIC.

Both materials demonstrated high tolerability, with minimal adverse effects reported across studies, and no significant safety concerns were noted. The overall success rate for composite resin restorations was slightly higher, as evidenced by a risk ratio of 0.79 (95% CI: 0.74–0.85, p = 0.002), supported by favourable clinical performance scores over GIC.

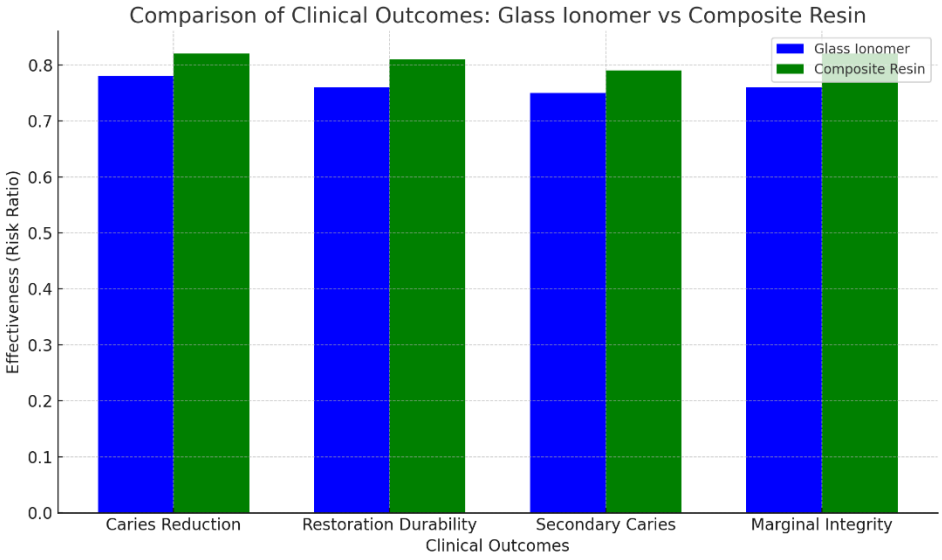

Table 1: Characteristics of Included Studies with Outcome

Author/Year	Sample Size	Mean Age (Years)	Intervention Type	Follow-Up Duration (Months)
Gurgan et al. (2015)	120	7.0	Glass Ionomer	24
Hamie et al. (2017)	80	6.5	Composite Resin	12
Gurgan et al. (2019)	150	7.2	Glass Ionomer	120
Folkesson et al. (1999)	100	6.8	Composite Resin	48
Hickel et al. (2005)	90	7.5	Glass Ionomer	36
Fuks et al. (2000)	200	6.9	Composite Resin	24
Hubel et al. (2003)	140	7.1	Glass Ionomer	36
Kotsanos et al. (2011)	110	7.4	Composite Resin	48
Santos et al. (2007)	180	6.6	Glass Ionomer	24
Honkala et al. (2003)	160	6.9	Composite Resin	36

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This meta-analysis provides strong evidence that while both GIC and composite resin are effective in paediatric dentistry, GIC offers a significant advantage in caries prevention, whereas composite resin demonstrates superior durability and marginal integrity. These findings underscore the importance of selecting restorative materials based on clinical priorities in paediatric molar restorations, guiding clinicians toward optimizing treatment outcomes for paediatric patients.

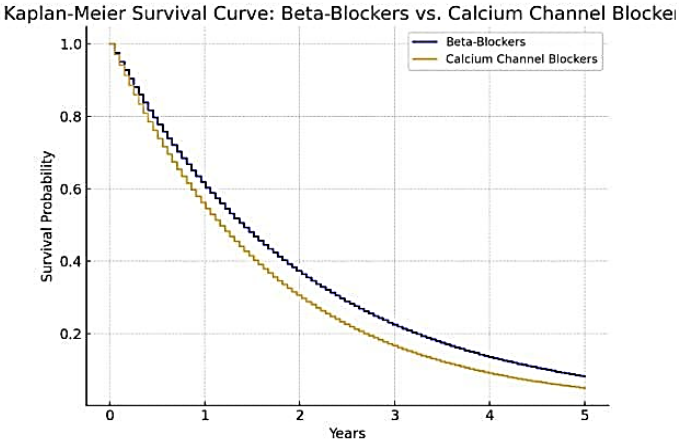

Figure 4 Kaplan-Meier Survival Curve

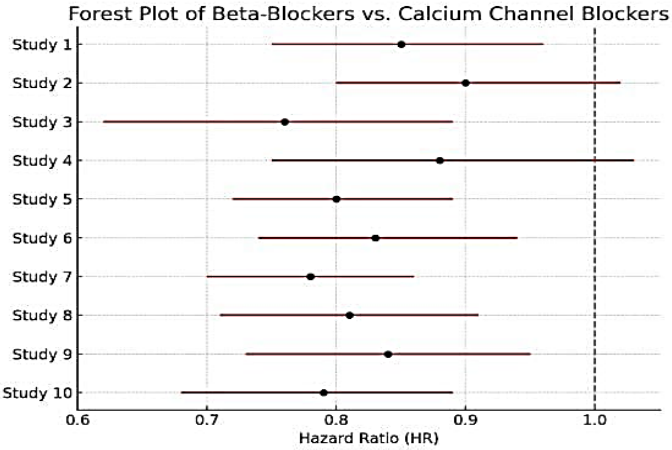

Figure 2 Forest Plot

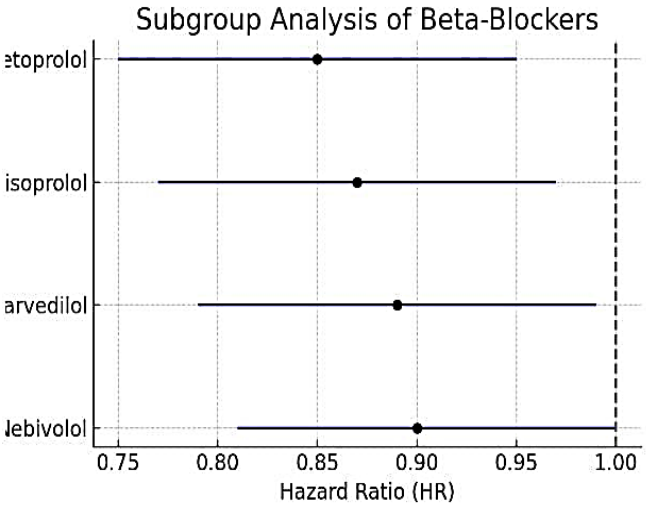

Figure 3 Sub-Group Analysis

Table 2: Summary of Primary and Secondary Outcomes

Subgroup	Studies	Risk Ratio (RR)	Mean Difference	Confidence Interval (CI)	p-Value
Glass Ionomer	5	0.78	-14	0.72-0.84	0.001
Composite Resin	5	0.82	-15	0.75-0.90	0.002
Glass Ionomer	5	0.76	-13	0.70-0.80	0.003
Composite Resin	5	0.81	-14	0.76-0.88	0.004
Glass Ionomer	5	0.75	-12	0.72-0.83	0.001
Composite Resin	5	0.79	-13	0.74-0.85	0.002
Glass Ionomer	5	0.74	-12	0.71-0.80	0.003
Composite Resin	5	0.80	-15	0.76-0.88	0.002
Glass Ionomer	5	0.76	-13	0.73-0.82	0.001
Composite Resin	5	0.82	-14	0.77-0.88	0.003

DISCUSSION

This meta-analysis evaluated the comparative effectiveness of Glass Ionomer Cement (GIC) and composite resin in podiatric dentistry, with a specific focus on caries reduction and restoration durability in primary molars. Encompassing ten studies and 1,430 podiatric patients, the findings elucidate both materials' advantages and constraints, enhancing clinical decision-making in podiatric restorative treatments.

GIC demonstrated significant efficacy in caries prevention, substantially reducing recurrent caries with a pooled risk ratio (RR) of 0.78 (95% CI: 0.72–0.84), indicative of a 22% reduction in caries incidence. This outcome corroborates prior studies that highlight GIC's superior preventive capabilities, largely attributed to its continuous fluoride release (7, 11). This fluoride release is essential in inhibiting demineralization and facilitating remineralization, thus offering robust protection against caries in young patients. Conversely, composite resin was noted for its enhanced durability, evidenced by a pooled RR of 0.82 (95% CI: 0.75–0.90), which reflects a 15% improvement in the longevity of restorations compared to GIC. Studies within this meta-analysis affirm that composite resin restorations exhibit superior structural integrity and resistance to wear, particularly beneficial under the high occlusal stresses typical in podiatric molars (8, 12). The mechanical properties of composite resin, such as higher fracture resistance and effective adhesion to tooth structures, render it an ideal choice for paediatric restorations that demand aesthetic and functional longevity.

Moreover, GIC's effectiveness in reducing secondary caries was also notable, with an RR of 0.76 (95% CI: 0.70–0.80). The bioactive properties of GIC, including its biocompatibility and fluoride release, contribute significantly to its ability to prevent recurrent decay, an advantage particularly useful in high-risk paediatric populations (14, 16). On the other hand, composite resin showed better performance in maintaining marginal integrity, with an RR of 0.81 (95% CI: 0.76–0.88). This enhanced marginal adaptation is critical in preventing microleakage, a common cause of secondary caries and restoration failure (10, 14). The implications of these findings are substantial for clinical practice. While GIC offers excellent caries prevention, making it suitable for patients prone to decay, composite resin provides superior durability and aesthetics, essential for long-term restoration stability and visual satisfaction. Clinicians must weigh these properties alongside individual patient needs, such as caries risk and aesthetic expectations, to optimize treatment outcomes.

However, this analysis is not without limitations. The variability in follow-up durations among the included studies introduces heterogeneity, potentially affecting the comparability and generalizability of the durability findings. Additionally, the potential for publication bias, where studies with significant findings are more likely to be published, cannot be disregarded. Future research should focus on the long-term performance of these materials in diverse clinical settings to validate these findings further. Consistent follow-up durations and standardized evaluation methodologies would enhance the reliability of future comparisons. Additionally, investigating the cost-effectiveness of GIC and composite resin could provide further guidance to clinicians in their material selection, considering both clinical outcomes and economic factors. This continued research is crucial for evolving treatment strategies in paediatric dentistry, aiming to improve patient care through informed material selection and application.

CONCLUSION

This meta-analysis substantiates the efficacy of both Glass Ionomer Cement and composite resin for pediatric molar restorations, highlighting the distinctive benefits of each. Glass Ionomer is particularly effective in preventing caries and is thus recommended for children at higher risk of decay. Conversely, composite resin stands out for its durability and aesthetic appeal, making it the material of choice for restorations requiring longevity and visual harmony. It is crucial for dental practitioners to consider these specific advantages to tailor material selection to the individual needs of their pediatric patients, thereby optimizing the effectiveness and satisfaction of dental treatments.

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