

## Nanocomposite in Paediatric Dentistry – A Systematic Review

Rasveya S<sup>1</sup>, Dinesh Kumar<sup>2\*</sup>

<sup>1</sup>Bachelor of Dental Surgery, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University (Deemed to be University), 162 Poonamallee High Road, Chennai-600 077, Tamil Nadu, India.

Email:ID: 152001018.sdc@saveetha.com

Department of Pedodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University (Deemed to be University), 162 Poonamallee High Road, Chennai-600 077, Tamil Nadu, India

Email:ID: dineshkumarb.sdc@saveetha.com

### \*Corresponding author:

Dr. Dinesh Kumar

Department of Pedodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University (Deemed to be University), 162 Poonamallee High Road, Chennai – 600 077, Tamil Nadu, India.

Email:ID: dineshkumarb.sdc@saveetha.com

---

Cite this paper as: Rasveya S, Dinesh Kumar (2024) Nanocomposite in Paediatric Dentistry – A Systematic Review...Journal of Neonatal Surgery, 13, 2266-2273

---

### ABSTRACT

**Background:** Nanotechnology has revolutionized modern dentistry by introducing nanocomposite materials with enhanced physicochemical and biological properties. In pediatric dentistry, where durability, biocompatibility, and patient compliance are critical, nanocomposites offer promising advantages over conventional restorative materials.

**Aim:** This systematic review aims to evaluate the clinical performance, applications, and effectiveness of nanocomposites in pediatric dentistry.

**Materials and Methods:** A comprehensive literature search was conducted using electronic databases including PubMed, Google Scholar, PsycINFO, and the Cochrane Library. Relevant studies were identified using keywords such as “nanocomposite,” “pediatric dentistry,” and “dental restoration.” Studies were screened based on predefined inclusion and exclusion criteria. A total of 11 clinical studies were included after quality assessment using the Cochrane Risk of Bias tool and Newcastle Ottawa Scale.

**Results:** The included studies demonstrated that nanocomposites exhibit superior mechanical strength, improved wear resistance, and enhanced aesthetic properties. They also showed antibacterial effects, reduced biofilm formation, and decreased incidence of secondary caries. Clinical outcomes such as retention, marginal integrity, and postoperative sensitivity were either improved or comparable to conventional restorative materials. However, some studies reported no statistically significant differences in long-term performance.

**Conclusion:** Nanocomposites represent a significant advancement in pediatric restorative dentistry, offering improved clinical performance and patient outcomes. Despite their promising potential, further long-term, large-scale clinical trials are necessary to establish their safety, cost-effectiveness, and superiority over traditional materials

---

**Key Words:** *Nanocomposites, Pediatric dentistry, Dental restoration, Nanotechnology, Biofilm, Caries prevention*

---

### INTRODUCTION

Nanotechnology has emerged as one of the most significant advancements in modern biomedical science, offering innovative solutions for diagnosis, prevention, and treatment of various diseases [1,2]. Nanomaterials possess unique physicochemical properties such as high surface area-to-volume ratio, nanoscale size, enhanced mechanical strength, and improved chemical reactivity, which make them highly suitable for biomedical and dental applications [3]. Nanotechnology typically involves materials in the size range of 1-100 nm, where they exhibit unique physicochemical properties not seen in bulk materials. At



this nanoscale, materials demonstrate enhanced mechanical strength, improved optical behavior, and increased chemical reactivity. In the field of dentistry, nanotechnology has been widely applied in restorative materials, dental implants, drug delivery systems, and preventive care strategies. These advancements have significantly improved the efficiency, durability, and clinical performance of dental treatments [4,5]. Dental resin nanocomposites are a mixture of the resin matrix, nanofillers, photo initiator, etc., to be filled into the cavity. Here, nanotechnology plays a crucial role in dentistry. Extensively used nanofillers are silica nanoparticles that give mechanical strength to the filling material [6]. The resin matrix commonly consists of monomers such as Bis-GMA, UDMA, and TEGDMA, which provide the basic structural framework of the composite. Nanofillers such as silica and zirconia nanoparticles are incorporated to enhance mechanical strength, wear resistance, and surface smoothness. A silane coupling agent is used to improve the bonding between the organic resin matrix and inorganic filler particles. Photo initiators such as camphor quinone enable polymerization of the material upon exposure to visible light. Based on filler size and distribution, nanocomposites are broadly classified into nano filled and nanohybrid composites [7].

Pediatric dentistry poses unique challenges, demanding dental materials that not only provide effective restorations but also ensure the safety and well-being of young patients [8]. In recent years, nanocomposites have emerged as a promising avenue in addressing these challenges. This essay explores the applications, advantages, and considerations surrounding the use of nanocomposites in pediatric dentistry, emphasizing the potential for improved clinical outcomes and enhanced patient experiences [9,10]. Children are more susceptible to dental caries due to dietary habits and inadequate oral hygiene practices. Achieving proper moisture control during restorative procedures is often difficult in pediatric patients. In addition, behavior management plays a crucial role, and materials that require shorter chair time are preferred. Therefore, restorative materials used in pediatric dentistry must be durable, biocompatible, aesthetically pleasing, and easy to manipulate [11]. The Strength and Durability of the nanocomposites in paediatric dentistry are good. Children are known for their active lifestyles, and their dental restorations must withstand the rigors of daily wear and tear. Nanocomposites, with their enhanced mechanical properties, offer increased strength and durability compared to traditional dental materials. This translates to longer-lasting restorations, reducing the need for frequent replacements [12,13]. In addition, nanocomposites exhibit superior wear resistance and long-term durability, making them suitable for high-stress areas. Their smaller filler particle size contributes to excellent polishability and surface smoothness, which helps in maintaining oral hygiene. Nanocomposites also demonstrate improved color stability over time, ensuring long-lasting aesthetic outcomes [14].

The Aesthetic Appeal of the nanocomposites in Children and parents alike appreciate dental restorations that seamlessly blend with natural teeth. Nanocomposites, designed to mimic the optical properties of enamel, provide superior aesthetics. The ability to achieve lifelike color matching and translucency is particularly crucial in pediatric dentistry, where esthetics play a significant role in patient satisfaction. The application of dental restorations can be a source of anxiety for pediatric patients [15,16]. Nanocomposites, often associated with reduced polymerization shrinkage, contribute to a more comfortable experience. The minimization of shrinkage decreases the risk of postoperative sensitivity, a critical consideration in pediatric dentistry to ensure positive dental experiences for young patients [17,18]. Furthermore, reduced polymerization shrinkage minimizes microleakage and the risk of secondary caries, thereby enhancing the longevity of restorations. These properties collectively make nanocomposites an ideal material for minimally invasive pediatric dental procedures [19].

Nanocomposites find valuable applications in pit and fissure sealants, a preventive measure to protect vulnerable areas of children's teeth from decay. Their ability to form a durable, protective barrier helps in maintaining optimal oral health in primary and permanent molars [20]. Nanocomposites are also widely used in Class I and Class II restorations in both primary and permanent teeth. They are commonly utilized in strip crowns for anterior restorations due to their excellent aesthetic properties. Preventive resin restorations using nanocomposites aid in early caries management and conservation of tooth structure. Some nanocomposites are formulated with fluoride-releasing properties, which help in preventing recurrent caries [21]. Restoring severely decayed or damaged primary teeth often requires crowns or bridges. Nanocomposites, with their superior strength and aesthetics, offer an excellent alternative to traditional materials, ensuring reliable and visually appealing restorations for young patients. The behavior of pediatric patients during dental procedures is a critical aspect of successful treatment [22]. The use of nanocomposites allows for minimally invasive approaches, reducing the need for extensive tooth preparation. This, coupled with the quick and efficient application of nanocomposite restorations, contributes to positive behavior management strategies.

Ensuring the biocompatibility and safety of dental materials is paramount in pediatric dentistry. This essay critically explores research findings on the biocompatibility of nanocomposites in the context of pediatric patients, addressing concerns related to potential adverse reactions. Several studies have evaluated the cytotoxic effects of nanocomposites on oral tissues, demonstrating acceptable levels of biocompatibility. The release of residual monomers and their potential effects on pulp and gingival tissues must be carefully considered. Long-term clinical performance of nanocomposites depends on factors such as fracture resistance, wear resistance, and marginal integrity [23,24]. Evaluating the long-term clinical performance of nanocomposite restorations in pediatric patients is essential. This involves assessing factors such as wear resistance, fracture toughness, and the ability to withstand masticatory forces over time [25,26]. Pediatric dentistry relies heavily on positive patient experiences. Understanding how children and their parents perceive nanocomposite restorations is crucial for their widespread acceptance. This essay explores studies and surveys related to patient satisfaction and acceptance of

nanocomposites in pediatric dental care. The integration of nanocomposites into pediatric dentistry holds great promise for enhancing the quality of care provided to young patients. The unique advantages, applications, and considerations discussed underscore the potential of nanocomposites in addressing the distinctive challenges posed by pediatric restorative dentistry [27,28]. As research in this field continues to evolve, the future looks promising for fostering healthier and happier smiles among the littlest dental patients. Overall, nanocomposites have significantly advanced pediatric restorative dentistry by providing superior mechanical strength, excellent aesthetics, and improved clinical performance. Their ability to enhance patient comfort and reduce treatment time makes them highly suitable for pediatric applications. However, further long-term clinical studies are required to fully establish their effectiveness and safety. With continuous advancements in nanotechnology, nanocomposites are expected to play a pivotal role in the future of pediatric dental care [29,30].

## MATERIALS AND METHODS

### Search Strategy

A comprehensive literature search was conducted using electronic databases including PubMed, PsycINFO, and the Cochrane Library. The search strategy was designed to identify relevant studies evaluating the use of nanocomposites in pediatric dentistry. Appropriate keywords, Medical Subject Headings (MeSH), and Boolean operators (AND, OR) were used to refine the search. The search included studies published up to the most recent available date. Additionally, the reference lists of selected articles were manually screened to identify any further relevant studies [31].

### Inclusion and Exclusion Criteria

Studies were selected based on predefined inclusion and exclusion criteria. The inclusion criteria comprised randomized controlled trials (RCTs) and quasi-experimental studies that evaluated the clinical or mechanical performance of nanocomposites in pediatric dentistry. Only studies published in the English language were considered [32].

Exclusion criteria included studies with insufficient methodological quality, non-English publications, review articles, case reports, conference abstracts, and studies focusing on restorative materials other than nanocomposites [33].

### Study Selection

Study selection was performed in two stages. Initially, two independent reviewers screened the titles and abstracts of all identified studies. Studies that appeared relevant were subjected to full-text review. Full-text articles were assessed for eligibility based on the inclusion and exclusion criteria. Any disagreements between the reviewers were resolved through discussion, and when necessary, consultation with a third reviewer was undertaken to reach a consensus [34].

### Quality Assessment

The methodological quality of the included studies was assessed using standardized assessment tools. The Cochrane Risk of Bias tool was used for randomized controlled trials, while the Newcastle-Ottawa Scale was used for quasi-experimental studies. This quality assessment ensured the reliability, validity, and methodological rigor of the studies included in the systematic review [35].

### Data Extraction

Data were extracted using a standardized data extraction form. The extracted information included study characteristics (author, year, country), sample size, participant demographics, type of nanocomposite used, intervention details, control group details, outcome measures, and follow-up duration. Data extraction was performed independently by two reviewers to minimize errors and bias [36].

### Data Synthesis

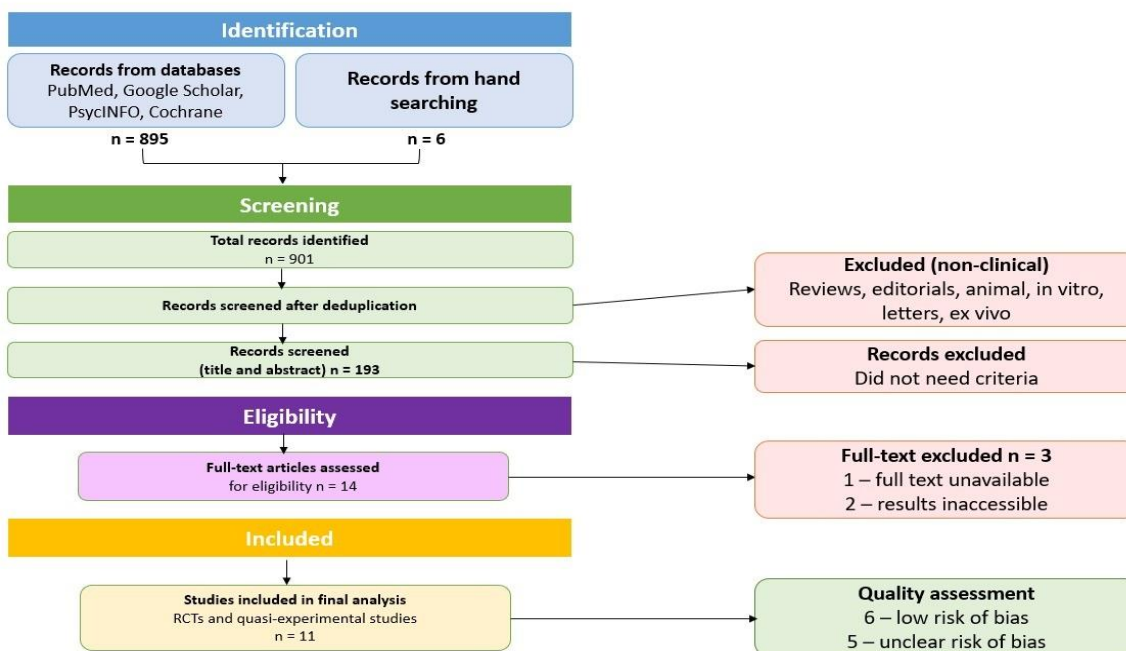
The extracted data were synthesized both qualitatively and quantitatively. Quantitative synthesis was performed through meta-analysis using appropriate statistical methods where sufficient data were available. Effect sizes and 95% confidence intervals were calculated and presented using forest plots. Statistical heterogeneity among studies was assessed using the  $I^2$  statistic, and sensitivity analyses were conducted to identify potential sources of heterogeneity [37].

## RESULTS

### Study Identification and Selection

The initial electronic and manual search yielded a total of 895 citations, with an additional 6 clinical trials identified through hand searching (Fig. 1). Following the removal of duplicates and initial screening, 193 articles were selected based on their titles and abstracts. Subsequently, full-text assessment was conducted for the eligible studies. A total of 14 clinical trials were identified for full-text evaluation; however, 11 studies were included in the final analysis. One clinical trial was excluded due to the unavailability of the full text, and two studies were excluded because their results were not accessible. Additionally, 37 review articles, 1 editorial, 18 animal studies, and 1 letter to the editor were excluded. Other in vitro and ex vivo studies were also excluded, as they did not meet the predefined inclusion criteria.

Key findings indicate that, out of 901 total records retrieved, only 11 high-quality clinical studies (RCTs and quasi-experimental designs) met all inclusion criteria and were included for qualitative and quantitative synthesis. This reflects a rigorous, evidence-based selection rate of approximately 1.2% of the initially identified records.



**Figure 1. PRISMA 2020 flow diagram illustrating the study selection process for the systematic review on nanocomposites in paediatric dentistry. The diagram presents the stepwise selection of studies from initial database searches to final inclusion, organized across four phases**

**Risk of Bias Assessment**

The risk of bias of the included studies was evaluated in accordance with the guidelines outlined in the *Cochrane Handbook for Systematic Reviews of Interventions*. The Cochrane Risk of Bias tool was applied to randomized controlled trials, while the Newcastle-Ottawa Scale was used for quasi-experimental studies.

Among the 11 included studies, six (54.5%) were classified as high-quality studies with a low risk of bias, while five (45.5%) studies were categorized as fair-quality studies with an unclear risk of bias, which was deemed unlikely to significantly affect the overall outcomes. Importantly, no studies were classified as low-quality or high risk of bias, indicating a generally sound methodological standard across the included literature (**Table 1**).

Classification	Risk Level	No. of Studies	Proportion	Assessment Tool
High quality	Low risk of bias	6	54.5%	Cochrane RoB / Newcastle-Ottawa
Fair quality	Unclear risk of bias	5	45.5%	Cochrane RoB / Newcastle-Ottawa
Low quality	High risk of bias	0	0%	—
<b>Total</b>	—	11	100%	—

**Table 1. Illustrate the risk of bias classification of included studies**

## DISCUSSION

The studies included in this review evaluated a wide range of interventions related to nanotechnology in pediatric dentistry. Due to heterogeneity among the study designs, interventions, and outcome measures, quantitative analysis and meta-analysis were not feasible. Therefore, the findings of the clinical trials were summarized qualitatively to provide an overview of the role of nanotechnology in pediatric dentistry. According to the included studies, nanotechnology has shown effectiveness in the management of several dental conditions. For the treatment of dentin hypersensitivity (DHS), experimental nanotechnology-based toothpaste demonstrated a reduction in hypersensitivity over a short duration [38]. Similarly, nano-hydroxyapatite (nHAP) dental cream was found to be effective in relieving symptoms of dentin hypersensitivity when applied daily [39]. In the context of dental remineralization, a 10% nHAP solution significantly increased the microhardness of enamel in permanent teeth following soft drink exposure in a randomized double-blind clinical trial [40]. Nanotechnology also demonstrated cariostatic and antibacterial properties. A randomized clinical trial showed that annual application of 5% nanosilver fluoride was comparable to 38% silver diamine fluoride in preventing the progression of dental caries in primary molars without causing dentinal staining [41]. Additionally, nano sodium fluoride exhibited bactericidal activity against *Streptococcus mutans* biofilm, suggesting its potential role in preventing dental biofilm formation. In restorative dentistry, nanofilled resin sealants showed acceptable performance in sealing occlusal pits and fissures and demonstrated slightly higher retention rates compared to conventional sealants, although the differences were not statistically significant. Improved bonding strength to stainless steel crowns was also observed when universal bonding agents were used with nanocomposites [42].

However, some disadvantages were reported. Studies indicated no significant difference in retention levels between conventional and nanofilled resin sealants over time. Additionally, soft drinks were found to cause clinically unacceptable discoloration of composite materials, particularly Filtek Z350. Follow-up studies showed similar caries prevention rates between conventional and nanofilled sealants over 6- and 12-month evaluation periods, indicating comparable clinical performance [43].

Overall, nanotechnology-based materials demonstrated promising preventive, antibacterial, remineralizing, and restorative properties in pediatric dentistry, although in many cases their performance was comparable rather than significantly superior to conventional materials.

## CONCLUSION

Advancements in nanotechnology have significantly influenced the prevention and management of dental diseases. The application of nanotechnology in dentistry has expanded to various areas, including the treatment of dentin hypersensitivity, remineralization of dental tissues, surface modification of dental implants, prevention of biofilm formation, and prevention of dental caries progression. These applications demonstrate the potential of nanotechnology to improve both preventive and restorative dental care [44,45]. Although nanotechnology shows promising results in improving dental materials and treatment outcomes, many of these technologies are still in the developmental stage. Their widespread clinical application is currently limited due to concerns related to safety, long-term biocompatibility, and cost-effectiveness. Therefore, further well-designed clinical trials with larger sample sizes and long-term follow-up are required to establish clear evidence regarding the effectiveness and safety of nanotechnology-based dental materials [46]. Overall, nanotechnology holds significant potential to enhance future dental prevention and treatment strategies.

## FUTURE DIRECTIONS

Further multicentric randomized clinical trials with larger sample sizes and longer follow-up periods are necessary to establish the clinical efficacy and reliability of nanotechnology-based dental materials. In addition, concerns related to cost-effectiveness, biocompatibility, and potential toxicity of nanoparticles should be thoroughly investigated prior to their routine use in clinical practice.

## ACKNOWLEDGEMENTS

We express our sincere gratitude to the White lab, Saveetha Dental College and Hospitals and Saveetha Institute of Technical and Medical Sciences for their constant support and encouragement

## REFERENCES

1. Patra JK, Das G, Fraceto LF, Campos EVR, Rodriguez-Torres M del P, Acosta-Torres LS, et al. Nano based drug delivery systems: recent developments and future prospects. *J Nanobiotechnology*. 2018;16:71. <https://doi.org/10.1186/s12951-018-0392-8>
2. Khan I, Saeed K, Khan I. Nanoparticles: Properties, applications and toxicities. *Arabian Journal of Chemistry*. 2019;12:908–31. <https://doi.org/10.1016/j.arabjc.2017.05.011>
3. Joudeh N, Linke D. Nanoparticle classification, physicochemical properties, characterization, and applications: a

- comprehensive review for biologists. *J Nanobiotechnology*. 2022;20:262. <https://doi.org/10.1186/s12951-022-01477-8>
4. Hossain N, Islam MA, Chowdhury MA, Alam A. Advances of nanoparticles employment in dental implant applications. *Applied Surface Science Advances*. 2022;12:100341. <https://doi.org/10.1016/j.apsadv.2022.100341>
  5. Khurshid Z, Zafar M, Qasim S, Shahab S, Naseem M, AbuReqaiba A. Advances in Nanotechnology for Restorative Dentistry. *Materials*. 2015;8:717–31. <https://doi.org/10.3390/ma8020717>
  6. Habib E, Wang R, Wang Y, Zhu M, Zhu XX. Inorganic Fillers for Dental Resin Composites: Present and Future. *ACS Biomater Sci Eng*. 2016;2:1–11. <https://doi.org/10.1021/acsbiomaterials.5b00401>
  7. Azmy E, Al-Kholy MRZ, Fattouh M, Kenawi LMM, Helal MA. Impact of Nanoparticles Additions on the Strength of Dental Composite Resin. *Int J Biomater*. 2022;2022:1–9. <https://doi.org/10.1155/2022/1165431>
  8. The Reference Manual of Pediatric Dentistry. *Pediatric Restorative Dentistry*. American Academy of Pediatric Dentistry. 2019;
  9. Sreenivasalu PKP, Dora CP, Swami R, Jasthi VC, Shiroorkar PN, Nagaraja S, et al. Nanomaterials in Dentistry: Current Applications and Future Scope. *Nanomaterials*. 2022;12:1676. <https://doi.org/10.3390/nano12101676>
  10. Besinis A, De Peralta T, Tredwin CJ, Handy RD. Review of nanomaterials in dentistry: interactions with the oral microenvironment, clinical applications, hazards, and benefits. *ACS Nano*. 2015;9:2255–89. <https://doi.org/10.1021/nn505015e>
  11. Wong HM. Childhood Caries Management. *Int J Environ Res Public Health*. 2022;19:8527. <https://doi.org/10.3390/ijerph19148527>
  12. Muntean A, Sarosi C, Sava S, Moldovan M, Condurache AI, Delean AG. Dental Sealant Composition-Retention Assessment in Young Permanent Molars. *Materials*. 2021;14:1646. <https://doi.org/10.3390/ma14071646>
  13. Sreenivasalu PKP, Dora CP, Swami R, Jasthi VC, Shiroorkar PN, Nagaraja S, et al. Nanomaterials in Dentistry: Current Applications and Future Scope. *Nanomaterials*. 2022;12:1676. <https://doi.org/10.3390/nano12101676>
  14. Ferracane JL. Resin composite--state of the art. *Dent Mater*. 2011;27:29–38. <https://doi.org/10.1016/j.dental.2010.10.020>
  15. Elfakhri F, Alkahtani R, Li C, Khaliq J. Influence of filler characteristics on the performance of dental composites: A comprehensive review. *Ceram Int*. 2022;48:27280–94. <https://doi.org/10.1016/j.ceramint.2022.06.314>
  16. Jandt KD, Watts DC. Nanotechnology in dentistry: Present and future perspectives on dental nanomaterials. *Dental Materials*. 2020;36:1365–78. <https://doi.org/10.1016/j.dental.2020.08.006>
  17. Saunders SA. Current practicality of nanotechnology in dentistry. Part 1: Focus on nanocomposite restoratives and biomimetics. *Clin Cosmet Investig Dent*. 2009;1:47–61.
  18. Cramer NB, Stansbury JW, Bowman CN. Recent Advances and Developments in Composite Dental Restorative Materials. *J Dent Res*. 2011;90:402–16. <https://doi.org/10.1177/0022034510381263>
  19. Filemban H, Bhadila G, Wang X, Melo MAS, Oates TW, Weir MD, et al. Novel low-shrinkage-stress bioactive nanocomposite with anti-biofilm and remineralization capabilities to inhibit caries. *J Dent Sci*. 2022;17:811–21. <https://doi.org/10.1016/j.jds.2021.09.032>
  20. Fei X, Li Y, Weir MD, Baras BH, Wang H, Wang S, et al. Novel pit and fissure sealant containing nano-CaF<sub>2</sub> and dimethylaminohexadecyl methacrylate with double benefits of fluoride release and antibacterial function. *Dental Materials*. 2020;36:1241–53. <https://doi.org/10.1016/j.dental.2020.05.010>
  21. Wang Y, Li J, Chen D, Li L. Analysis of Cosmetic Effect of Nanocomposite Resin on Anterior Teeth. *Comput Math Methods Med*. 2021;2021:1–7. <https://doi.org/10.1155/2021/7367320>
  22. Meghna Prakash. Evidence-Based Approach to Avoid Postop Sensitivity in Adhesive Dentistry. *Decisions in dentistry*. 2022;
  23. Zotti F, Falavigna E, Capocasale G, De Santis D, Albanese M. Microleakage of Direct Restorations-Comparison between Bulk-Fill and Traditional Composite Resins: Systematic Review and Meta-Analysis. *Eur J Dent*. 2021;15:755–67. <https://doi.org/10.1055/s-0041-1724155>
  24. Singh S, Pandey R. An evaluation of nanocomposites as pit and fissure sealants in child patients. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. 2011;29:294. <https://doi.org/10.4103/0970-4388.86370>
  25. Gayatri Galyan. *In vitro* Study Comparing Fracture Resistance of Nanocomposites with and without Fiber

- Reinforcement with Different Cavity Designs Used for Obliquely Fractured Incisal Edge Restoration. Fracture Resistance of Nanocomposite and Fiber-reinforced Composite. 2019;
26. Opdam NJM, Collares K, Hickel R, Bayne SC, Loomans BA, Cenci MS, et al. Clinical studies in restorative dentistry: New directions and new demands. *Dental Materials*. 2018;34:1–12. <https://doi.org/10.1016/j.dental.2017.08.187>
  27. Priyadarsini S, Mukherjee S, Mishra M. Nanoparticles used in dentistry: A review. *J Oral Biol Craniofac Res*. 2018;8:58–67. <https://doi.org/10.1016/j.jobcr.2017.12.004>
  28. Alzraikat H, Burrow MF, Maghaireh GA, Taha NA. Nanofilled Resin Composite Properties and Clinical Performance: A Review. *Oper Dent*. 2018;43:E173–90. <https://doi.org/10.2341/17-208-T>
  29. Aspasia Katsimpali. Dimensional stability and microleakage of SMART dental composites in primary teeth. Eastman Dental Institute University College London. 2019;
  30. AlKahtani RN. The implications and applications of nanotechnology in dentistry: A review. *Saudi Dent J*. 2018;30:107–16. <https://doi.org/10.1016/j.sdentj.2018.01.002>
  31. Moothedath M, Moothedath M, Jairaj A, Harshitha B, Baba S, Khateeb S. Role of nanotechnology in dentistry: Systematic review. *J Int Soc Prev Community Dent*. 2019;9:535. [https://doi.org/10.4103/jispcd.JISPCD\\_223\\_19](https://doi.org/10.4103/jispcd.JISPCD_223_19)
  32. Abuzenada BM, Sonbul HM. Bionanocomposites in Caries Prevention and Treatment: A Systematic Review. *J Pharm Bioallied Sci*. 2022;14:S13–8. [https://doi.org/10.4103/jpbs.jpbs\\_128\\_22](https://doi.org/10.4103/jpbs.jpbs_128_22)
  33. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;n71. <https://doi.org/10.1136/bmj.n71>
  34. Stoll CRT, Izadi S, Fowler S, Green P, Suls J, Colditz GA. The value of a second reviewer for study selection in systematic reviews. *Res Synth Methods*. 2019;10:539–45. <https://doi.org/10.1002/jrsm.1369>
  35. Ma L-L, Wang Y-Y, Yang Z-H, Huang D, Weng H, Zeng X-T. Methodological quality (risk of bias) assessment tools for primary and secondary medical studies: what are they and which is better? *Mil Med Res*. 2020;7:7. <https://doi.org/10.1186/s40779-020-00238-8>
  36. Milewska S, Niemirowicz-Laskowska K, Siemiaszko G, Nowicki P, Wilczewska AZ, Car H. Current Trends and Challenges in Pharmacoeconomic Aspects of Nanocarriers as Drug Delivery Systems for Cancer Treatment. *Int J Nanomedicine*. 2021;Volume 16:6593–644. <https://doi.org/10.2147/IJN.S323831>
  37. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al., editors. *Cochrane Handbook for Systematic Reviews of Interventions*. Wiley; 2019. <https://doi.org/10.1002/9781119536604>
  38. Orsini G, Procaccini M, Manzoli L, Giuliodori F, Lorenzini A, Putignano A. A double-blind randomized-controlled trial comparing the desensitizing efficacy of a new dentifrice containing carbonate/hydroxyapatite nanocrystals and a sodium fluoride/potassium nitrate dentifrice. *J Clin Periodontol*. 2010;37:510–7. <https://doi.org/10.1111/j.1600-051X.2010.01558.x>
  39. Amaechi BT, Lemke KC, Saha S, Luong MN, Gelfond J. Clinical efficacy of nanohydroxyapatite-containing toothpaste at relieving dentin hypersensitivity: an 8 weeks randomized control trial. *BDJ Open*. 2021;7:23. <https://doi.org/10.1038/s41405-021-00080-7>
  40. Moothedath M, Moothedath M, Jairaj A, Harshitha B, Baba S, Khateeb S. Role of nanotechnology in dentistry: Systematic review. *J Int Soc Prev Community Dent*. 2019;9:535. [https://doi.org/10.4103/jispcd.JISPCD\\_223\\_19](https://doi.org/10.4103/jispcd.JISPCD_223_19)
  41. Tirupathi S, SVSG N, Rajasekhar S, Nuvvula S. Comparative cariostatic efficacy of a novel Nano-silver fluoride varnish with 38% silver diamine fluoride varnish a double-blind randomized clinical trial. *J Clin Exp Dent*. 2019;e105–12. <https://doi.org/10.4317/jced.54995>
  42. Rattan S, Fawcett D, Tennant M, Granich J, Jai Poinern GE. Progress of Nanomaterials in Preventative and Restorative Dentistry. *Recent Prog Mater*. 2021;03:1–42. <https://doi.org/10.21926/rpm.2101007>
  43. Kamath V, Hebbal M, Ankola A, Sankeshwari R, Jaliyal S, Choudhury A, et al. Comparison of Retention between Conventional and Nanofilled Resin Sealants in a Paediatric Population: A Randomized Clinical Trial. *J Clin Med*. 2022;11:3276. <https://doi.org/10.3390/jcm11123276>
  44. Umopathy VR, Natarajan PM, SumathiJones C, Swamikannu B, Johnson WMS, Alagarsamy V, et al. Current trends and future perspectives on dental nanomaterials – An overview of nanotechnology strategies in dentistry. *J King Saud Univ Sci*. 2022;34:102231. <https://doi.org/10.1016/j.jksus.2022.102231>
  45. Pepla E, Besharat LK, Palaia G, Tenore G, Migliau G. Nano-hydroxyapatite and its applications in preventive, restorative and regenerative dentistry: a review of literature. *Ann Stomatol (Roma)*. 2014;5:108–14.

46. Fadeel B, Farcas L, Hardy B, Vázquez-Campos S, Hristozov D, Marcomini A, et al. Advanced tools for the safety assessment of nanomaterials. *Nat Nanotechnol.* 2018;13:537–43. <https://doi.org/10.1038/s41565-018-0185-0>