Awareness of Nanoparticles in Periodontal Therapy Among Dental Professionals and Students: A Cross-Sectional Survey

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Abstract

This study aimed to assess awareness, knowledge, and perceptions regarding the use of nanoparticles in periodontal therapy among dental professionals and students. A structured online questionnaire was distributed to dental students, interns, postgraduate residents, and practitioners. Data from 102 respondents were analyzed using the Chi-square test ($p < 0.05$). Results showed that 75.5% of respondents were aware of nanotechnology in general, while 63.7% were familiar with its periodontal applications. Although 75% expressed a positive attitude toward clinical adoption, 24.5% reported no formal education on the topic. Key sources of knowledge included journals (31.4%) and online platforms (24.5%). The findings suggest moderate awareness but limited detailed knowledge. There is strong interest in learning and applying nanotechnology in practice, highlighting the need for enhanced curricular integration and continuing education.

Keywords

Nanoparticles, Periodontal Therapy, Awareness, Dental Education, Knowledge

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Introduction

Nanoparticles have emerged as a significant advancement in periodontal therapy, offering innovative solutions to combat periodontitis, a prevalent inflammatory disease affecting the supporting structures of teeth. Traditional treatments often encounter challenges such as limited

drug efficacy, patient compliance issues, and difficulties in targeting specific periodontal pathogens.

The integration of nanotechnology into periodontal treatment aims to address these challenges by enhancing drug delivery, improving antimicrobial effectiveness, and promoting tissue regeneration. Nanoparticles, especially those composed of silver and gold, exhibit potent antibacterial properties against periodontal pathogens due to their high surface area-to-volume ratio, which facilitates more effective interaction with bacterial cells [1,2].

Nanocarriers like polylactic-co-glycolic acid-based polymeric nanoparticles allow for the localized and sustained release of therapeutic agents directly into periodontal pockets, ensuring high drug concentrations at the site of infection while minimizing systemic side effects [3].

In addition, nanoparticles such as cerium oxide possess antioxidant properties that help reduce oxidative stress and inflammation in periodontal tissues, demonstrating both anti-inflammatory and immunomodulatory effects [4,5]. Moreover, nanoparticles can act as scaffolds or carriers for growth factors, thereby facilitating regeneration of the periodontal ligament and alveolar bone[6,7].For example, mesoporous silica nanoparticles have shown promise in delivering osteogenic agents to promote bone formation[7].

Despite these advantages, the clinical application of nanoparticle-based therapies faces several challenges. These include potential cytotoxicity, variability in efficacy in vivo, and regulatory constraints. Current research efforts are focused on optimizing nanoparticle formulations to improve their safety, clinical effectiveness, and broader applicability in periodontal therapy[5,8].

The aim of this study was to assess the level of awareness, knowledge, and perception regarding the use of nanoparticles in periodontal therapy among dental professionals and students. The primary objective is: To evaluate the general awareness of nanotechnology applications in periodontics. The secondary objectives are: To identify the knowledge gaps related to the benefits, types, and mechanisms of nanoparticles in periodontal treatment. To assess the attitude toward incorporating nanotechnology into future clinical practice.

Materials and Methods

A cross-sectional survey was conducted using a 17-question online questionnaire covering demographics, awareness, knowledge, and attitudes. The sample included students and professionals in dentistry. Statistical analysis was performed using SPSS (version 30.0.0), with significance set at $p < 0.05$.


Results:

Results showed that 75.5% of respondents were aware of nanotechnology in general, while 63.7% were familiar with its periodontal applications. Although 75% expressed a positive attitude toward clinical adoption, 24.5% reported no formal education on the topic. Key sources of knowledge included journals (31.4%) and online platforms (24.5%). The findings suggest moderate awareness but limited detailed knowledge. There is strong interest in learning and applying nanotechnology in practice, highlighting the need for enhanced curricular integration and continuing education.

1. What is your professional designation?
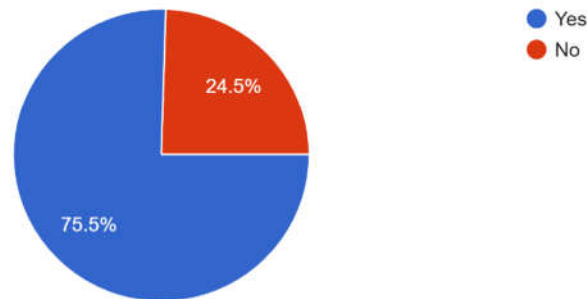102 responses
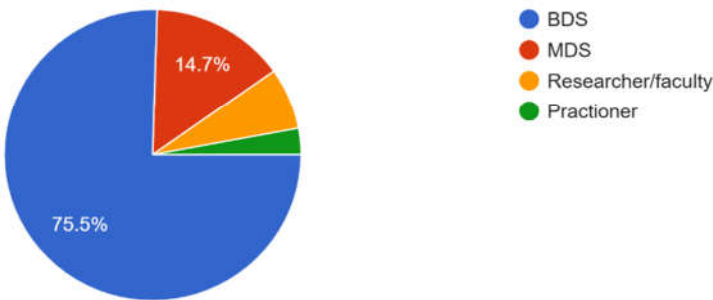
Among the 102 respondents, 75.5% were BDS, 14.7% were MDS, 4.9% were researchers/faculty, and 4.9% were practitioners.

2. How many years of clinical experience do you have?
102 responses
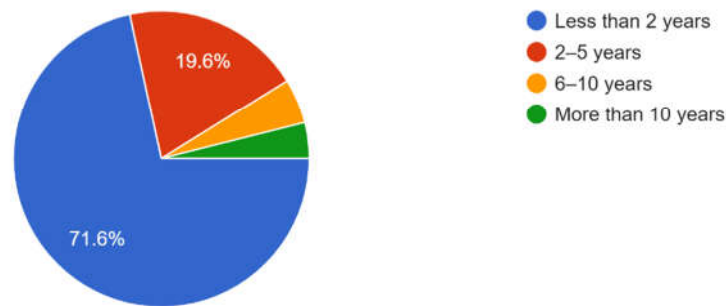
Among the 102 respondents, 71.6% had less than 2 years of clinical experience, 19.6% had 2–5 years, 4.9% had 6–10 years, and 3.9% had more than 10 years of experience.

3. Are you aware of Nanoparticles in dentistry?
102 responses

Out of 102 respondents, 75.5% were aware of nanoparticles in dentistry, while 24.5% were not.

4. Where did you first hear about Nano Particles in dentistry?
102 responses
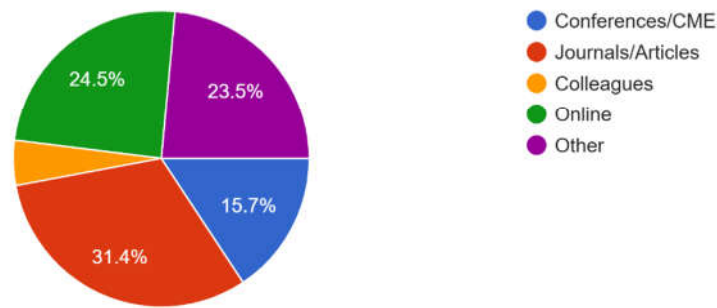
Out of 102 respondents, 31.4% first heard about nanoparticles in dentistry through journals/articles, 24.5% through online sources, 23.5% through other means, 15.7% through conferences/CME, and 4.9% through colleagues.

5. Which dental applications do you think nanoparticles are most useful for?
102 responses
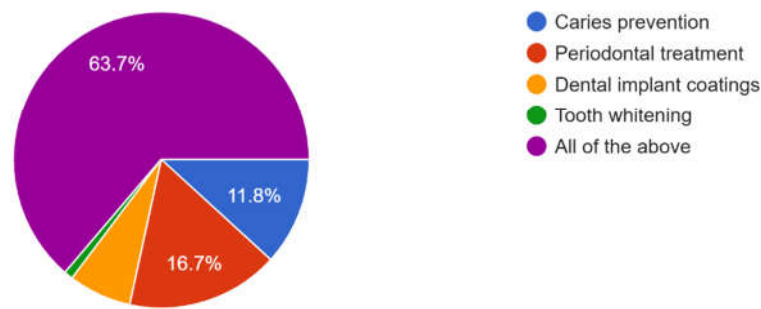
Out of 102 respondents, 63.7% believed nanoparticles are most useful for all of the listed dental applications, 16.7% for periodontal treatment, 11.8% for caries prevention, 7.8% for dental implant coatings, and 1% for tooth whitening.

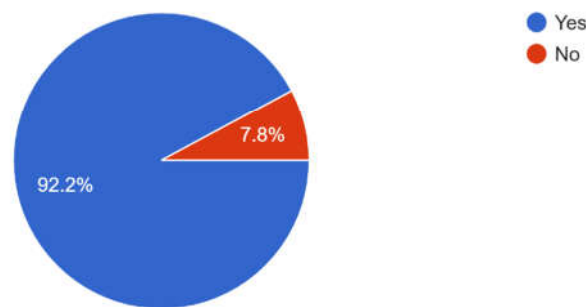6. What are the Various types of Nano particles you are aware of?
102 responses
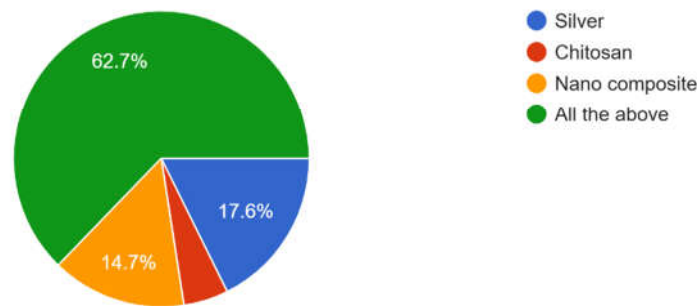
Out of 102 respondents, 62.7% were aware of all the listed types of nanoparticles, 17.6% were aware of silver nanoparticles, 14.7% of nano composites, and 4.9% of chitosan.
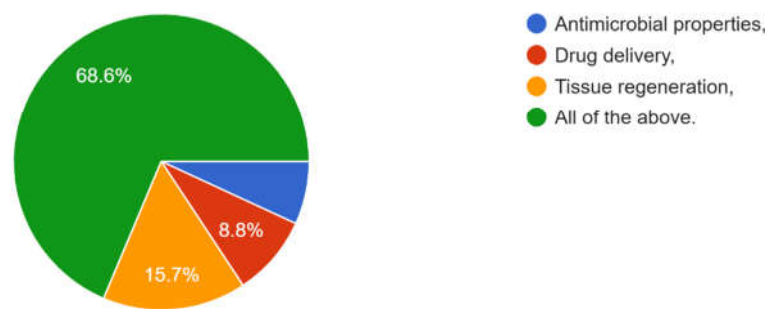
7. Do you think nanoparticles can improve the effectiveness of periodontal treatment?
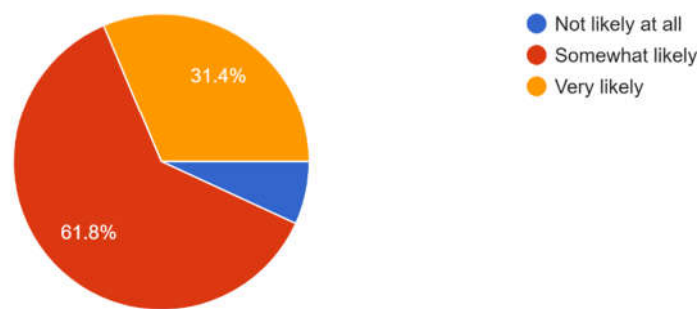102 responses

Out of 102 respondents, 92.2% believed that nanoparticles can improve the effectiveness of periodontal treatment, while 7.8% did not.

8. Which potential benefits of nanoparticles in periodontal therapy are you most interested in?
102 responses

Out of 102 respondents, 68.6% were most interested in all the listed potential benefits of nanoparticles in periodontal therapy, 15.7% in tissue regeneration, 8.8% in drug delivery, and 6.9% in antimicrobial properties.
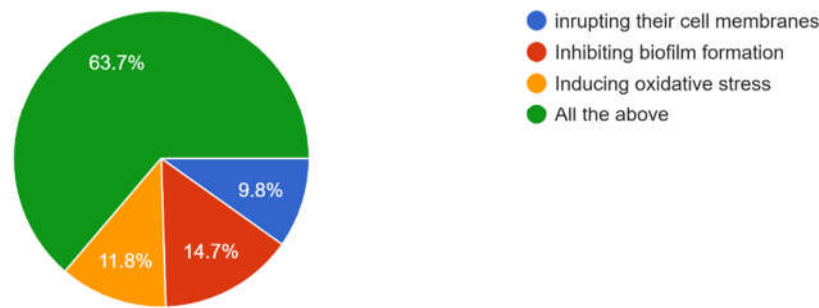
9. How likely are you to recommend nanoparticles in periodontal therapy to your patients?
102 responses

Out of 102 respondents, 61.8% were somewhat likely to recommend nanoparticles in periodontal therapy to their patients, 31.4% were very likely, and 6.8% were not likely at all.

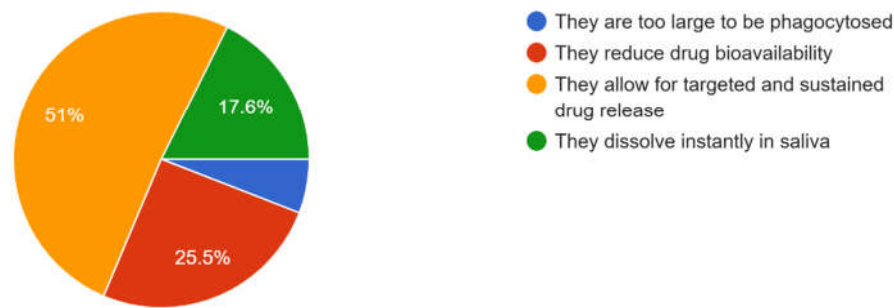10. How do silver nanoparticles act in periodontal therapy?
102 responses

- inrupting their cell membranes
- Inhibiting biofilm formation
- Inducing oxidative stress
- All the above

Out of 102 responses, 63.7% selected "All the above", 14.7% chose "Inhibiting biofilm formation", 11.8% chose "Inducing oxidative stress", and 9.8% chose "inrupting their cell membranes".

11. What is the major advantage of using nanoparticles in periodontal drug delivery?
102 responses

- They are too large to be phagocytosed
- They reduce drug bioavailability
- They allow for targeted and sustained drug release
- They dissolve instantly in saliva
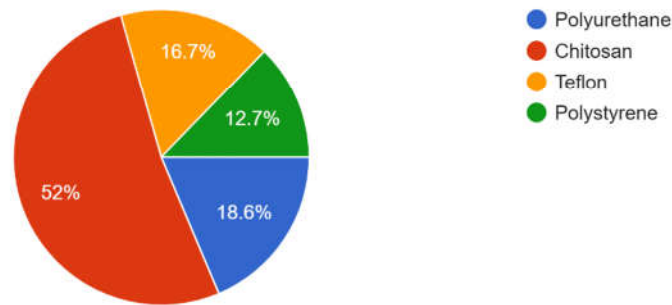
Out of 102 responses, 51% selected "They allow for targeted and sustained drug release", 25.5% chose "They reduce drug bioavailability", 17.6% chose "They dissolve instantly in saliva", and 5.9% chose "They are too large to be phagocytosed".

12. Which biocompatible polymer is commonly used to create nanoparticles for periodontal therapy?

102 responses

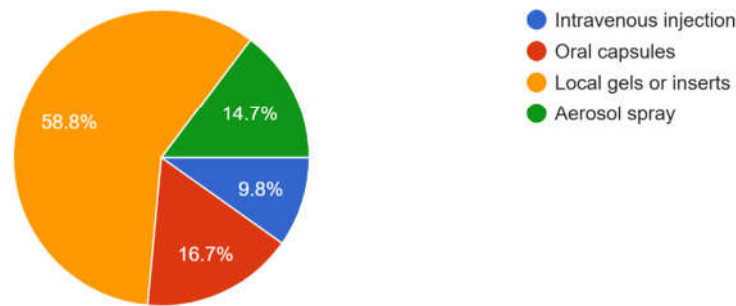Out of 102 responses, 52% selected "Chitosan", 18.6% chose "Polyurethane", 16.7% chose "Teflon", and 12.7% chose "Polystyrene".
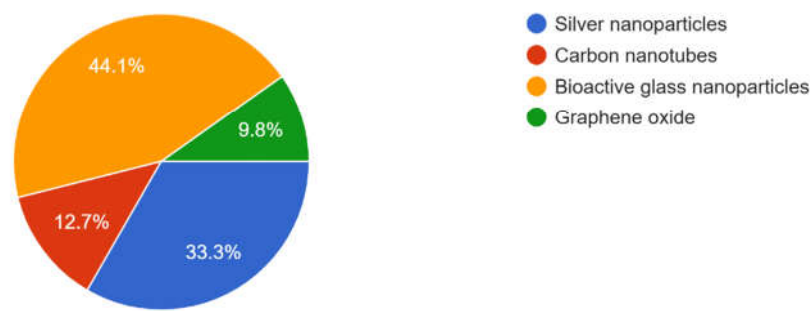
13. In what form are nanoparticle-based periodontal treatments most commonly administered?
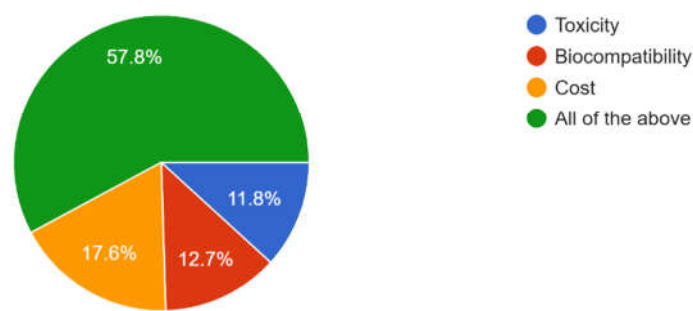
102 responses

Out of 102 responses, 58.8% selected "Local gels or inserts", 16.7% chose "Oral capsules", 14.7% chose "Aerosol spray", and 9.8% chose "Intravenous injection".

14. Which nanoparticle is known to stimulate bone regeneration in periodontal therapy?
102 responses

Out of 102 responses, 44.1% selected "Bioactive glass nanoparticles", 33.3% chose "Silver nanoparticles", 12.7% chose "Carbon nanotubes", and 9.8% chose "Graphene oxide".

15. what are the adverse effects about using nano particles in periodontal therapy?
102 responses

Out of 102 responses, 57.8% selected "All of the above", 17.6% chose "Cost", 12.7% chose "Biocompatibility", and 11.8% chose "Toxicity".

16. Which of the following nanoparticle-based products have you heard of or used?
102 responses
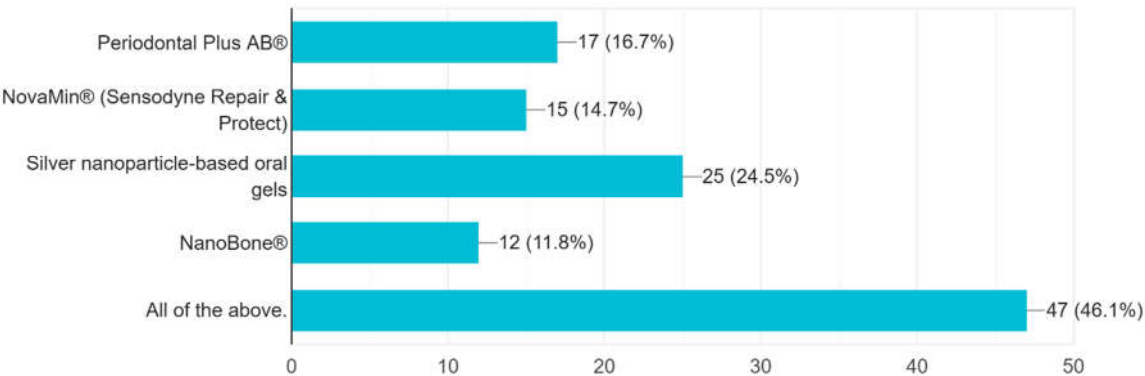
Out of 102 responses, 46.1% selected "All of the above", 24.5% chose "Silver nanoparticle-based oral gels", 16.7% chose "Periodontal Plus AB®", 14.7% chose "NovaMin® (Sensodyne Repair & Protect)", and 11.8% chose "NanoBone®".

Discussion

This survey explored the current level of knowledge and awareness regarding the use of nanoparticles in periodontal therapy. The findings reveal varying degrees of understanding among respondents, highlighting the need for increased educational initiatives and professional training to promote the adoption of nanotechnology in dental practice.

The present study highlights a generally high level of awareness regarding the application of nanoparticles in dentistry, with 75.5% of respondents acknowledging familiarity. Notably, the participant demographic was dominated by BDS graduates (75.5%) and early-career professionals (71.1% with <2 years clinical experience), suggesting that foundational knowledge of nanotechnology is becoming embedded in undergraduate training.

Awareness appears to be primarily derived from academic journals (31.4%) and online resources (24.5%), with conferences contributing modestly (15.7%). The low influence of peer-to-peer learning (4.9%) suggests limited discourse on the topic within clinical settings, highlighting a potential disconnect between research and practice.

Importantly, over half the respondents (57.8%) recognized toxicity, biocompatibility, and cost as key concerns in nanoparticle-based therapies, indicating a mature awareness of translational

challenges. While general awareness of products was high (46.1% knew all listed), specific recognition was lower, with silver nanoparticle-based oral gels being most familiar (24.5%). This underscores a need for greater clinical exposure and structured education around emerging biomaterials.

A survey by Yadav et al. reported that only 28% of UG students were aware of clinical applications of nanoparticles, and most had heard about it only through guest lectures or online sources [9]. According to Sharma et al., nearly 65% of PG students had at least basic theoretical knowledge of nanoparticles, but only 30% had seen or used nanoparticle-based products in clinical or lab settings [10]. Their interest is primarily driven by thesis work, seminars, and journal clubs rather than formal training.

A cross-sectional study by Kaur et al. found that only 50% of dental faculty had included nanotechnology-related topics in their lectures or clinical discussions. Major barriers cited were: limited clinical products approved for use, lack of workshops/training, and insufficient time to incorporate newer technologies into packed academic schedules[11]. Gupta et al. observed that only 22% of general dental practitioners had a basic understanding of the role of nanoparticles in products like mouthwashes, toothpaste, or bone grafts[12]. Many practitioners expressed interest but highlighted the lack of access to credible, hands-on training and cost concerns.

Overall, the findings reflect a receptive but still knowledge-limited professional base. To facilitate safe and evidence-based integration of nanotechnology into periodontal practice, there is a clear imperative for curriculum reinforcement, targeted CDE programs, and stronger clinical-academic linkages.

Conclusion

This study underscores a moderate level of awareness but limited in-depth knowledge regarding the use of nanoparticles in periodontal therapy among dental professionals and students. Although a majority of participants expressed interest in adopting nanotechnology and acknowledged its potential benefits, there remains a significant knowledge gap related to

specific applications, safety concerns, and product familiarity. Information was primarily obtained from academic and online sources, with minimal influence from clinical discussions or formal education. These findings point to the necessity of integrating nanotechnology more comprehensively into dental curricula, enhancing access to hands-on training, and promoting continuing education initiatives. Strengthening the linkage between academic knowledge and clinical practice is essential for fostering the safe, effective, and evidence-based incorporation of nanotechnology into periodontal care.

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