

# Preclinical Models as a Critical Component in Advancing Dental Research

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## Opinion Article

**Received:** 17-May-2024, Manuscript No. JDS-24-139680; **Editor assigned:** 21-May-2024, Pre QC No. JDS-24-139680 (PQ); **Reviewed:** 04-Jun-2024, QC No. JDS-24-139680; **Revised:** 11-Jun-2024, Manuscript No. JDS-24-139680 (R); **Published:** 18-Jun-2024, DOI: 10.4172/2320-7949.12.2.009

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**Citation:** Bridget E. Preclinical Models as a Critical Component in Advancing Dental Research. RRJ Dental Sci. 2024;12:009

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## DESCRIPTION

Animal models play a vital role in dental research, providing valuable knowledge into the pathophysiology, diagnosis, and treatment of various oral health conditions. Despite the ethical considerations and ongoing debates surrounding their use, animal models remain hold an important role in preclinical studies in dentistry. This article explores the importance of animal models in dental research, the types of models commonly used, and the advancements they have facilitated in understanding and treating dental diseases.

### Use of animal models in dental research

**Biological similarity:** Animals share many anatomical and physiological similarities with humans, particularly in their oral and craniofacial structures. These similarities allow researchers to study dental diseases and interventions in a living system that closely mimics human conditions.

**Controlled environment:** Animal models provide a controlled environment where variables can be carefully managed. This control is essential for understanding the mechanisms of disease and the effects of various treatments without the ethical and practical constraints of human studies.

**Preclinical testing:** Before new treatments, materials, or drugs can be approved for human use, they must undergo rigorous testing to ensure their safety and efficacy. Animal models are a critical step in this preclinical phase, helping to predict how a treatment might behave in humans.

**Ethical and logistical considerations:** Certain experimental procedures and conditions cannot be ethically imposed on human subjects. Animal models offer a way to conduct these essential studies while adhering to ethical standards, although the use of animals in research must also meet strict ethical guidelines and oversight.

Various animal species are used in dental research, each offering unique advantages depending on the study's objectives.

**Rodent models:** Mice and rats are among the most commonly used animals in dental research. Their small size, well-characterized genetics, and ease of handling make them ideal for studying a wide range of dental conditions, including periodontal disease, dental caries (cavities), and bone regeneration. For example, mouse models of periodontitis allow researchers to investigate the inflammatory processes and genetic factors involved in gum disease.

**Non-human primates:** Due to their close genetic and physiological similarities to humans, non-human primates (such as macaques) are invaluable for studying complex oral functions and conditions, including temporomandibular joint disorders and craniofacial development. They provide insights into dental pathologies and treatments that are difficult to replicate in other species.

**Canine models:** Dogs are often used in dental research because their dental and periodontal structures closely resemble those of humans. Canine models are particularly useful for studying periodontal disease and evaluating dental implants and bone grafts. Their larger size compared to rodents also facilitates surgical procedures and the testing of dental devices.

**Swine models:** Pigs are increasingly used in dental research due to their anatomical and physiological similarities to humans, especially regarding their teeth and jaw structure. Porcine models are beneficial for studying maxillofacial surgery, dental restorations, and bone regeneration techniques.

**Rabbit models:** Rabbits are used in dental research primarily for studies involving bone regeneration and biomaterials. Their relatively large size allows for easy surgical manipulation and implantation studies.

### Contributions of animal models to dental research

**Periodontal disease research:** Animal models, especially rodents and dogs, have been instrumental in elucidating the complex interactions between bacteria, host immune responses, and environmental factors in periodontal disease. These studies have led to the development of targeted therapies to modulate the immune response and control bacterial infection.

**Dental caries studies:** Research using rodent models has provided critical insights into the etiology and progression of dental caries. These models have facilitated the evaluation of preventive strategies, such as fluoride treatments and dietary modifications, and the testing of novel antimicrobial agents.

**Bone regeneration and implantology:** Animal studies have played a pivotal role in the development of bone grafts, dental implants, and regenerative materials. Large animals like dogs and pigs have been essential for evaluating the biocompatibility and efficacy of these interventions, leading to improved outcomes in clinical settings.

**Craniofacial research:** Non-human primates and other animal models have contributed to our understanding of craniofacial development and disorders. They have provided insights into congenital conditions such as cleft palate and have supported the refinement of surgical techniques for corrective procedures.

Advancements in technologies such as organ-on-a-chip, 3D bioprinting, and improved imaging techniques hold promise for reducing reliance on animal models in the future. However, until these methods are fully validated and capable of replicating the complex interactions within a living organism, animal models will remain an important component of dental research.

### **CONCLUSION**

Animal models have been and continue to be, an essential part of dental research. They provide critical insights into the mechanisms of dental diseases and the development of innovative treatments that improve oral health. While ethical considerations and the push for alternative methods will shape future research practices, the contributions of animal models to dentistry explain their indispensable role in advancing scientific knowledge and clinical practice.