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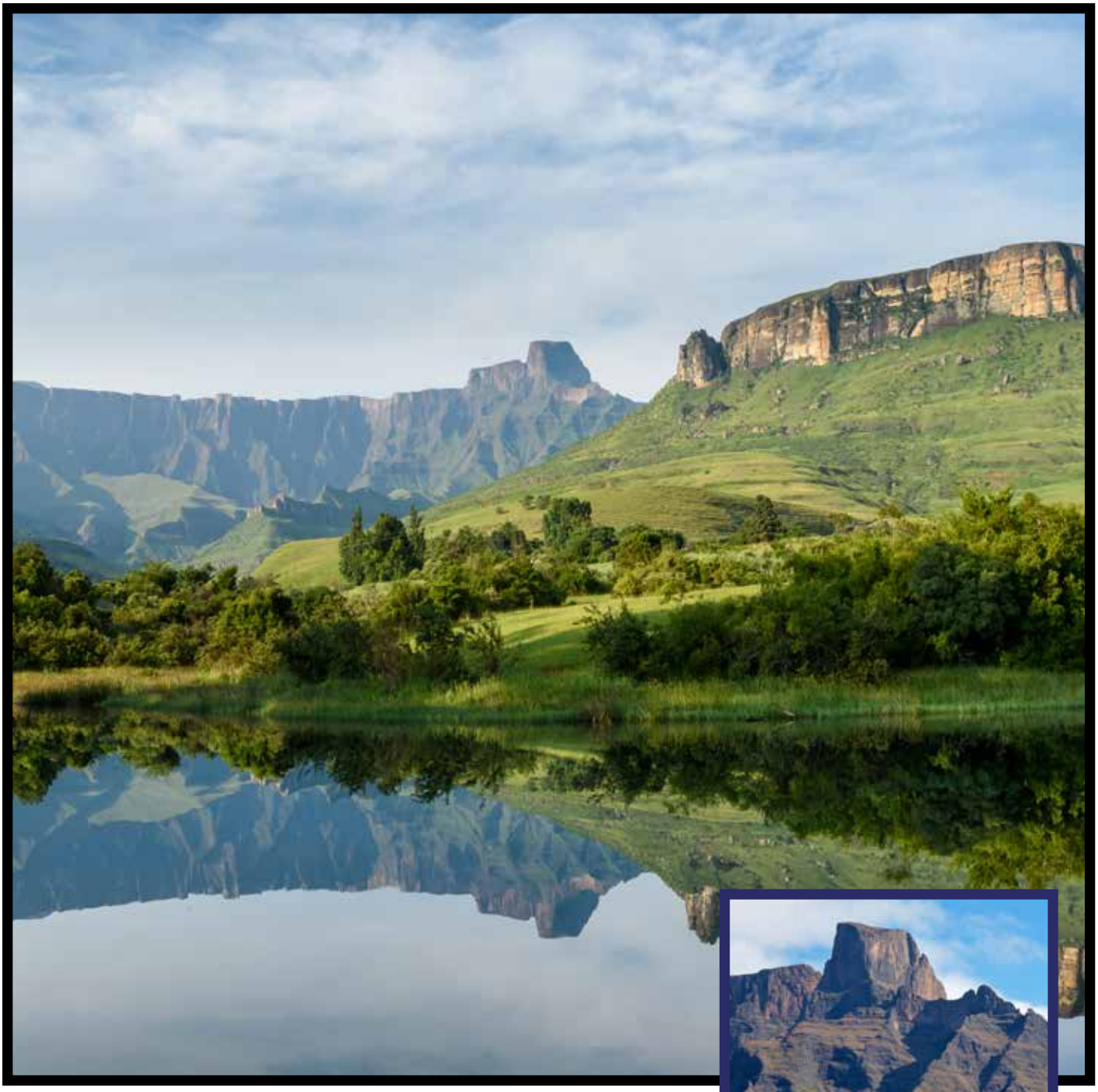

Drakensberg Mountains

The Drakensberg Mountains stretch over 1,000 kilometres along South Africa's eastern border. The range forms part of the Great Escarpment and includes peaks above 3,000 metres. It is home to the uKhahlamba Drakensberg Park, a UNESCO World Heritage Site known for biodiversity and ancient San rock art. Tugela Falls, one of the world's tallest waterfalls, flows from the Amphitheatre. The area attracts hikers, climbers and nature lovers year round.

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Systematic reviews, meta-analyses, the European Federation of Periodontology S3 level clinical practice guidelines, and a recent consensus report from global experts, support the adjunctive use of antiseptic mouth rinses.[1-3]

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References: 1. Treatment of stage I-III periodontitis. The EFP S3 level clinical practice guideline. *J Clin Periodontol.* 2020 Jul;47. **2.** Figuero *et al.* 2020. **3.** Bosma, M.L., McGuire, J.A., DelSasso, A. *et al.* Efficacy of flossing and mouth rinsing regimens on plaque and gingivitis: a randomized clinical trial. *BMC Oral Health* 24, 178 (2024). https://doi.org/10.1186/s12903-024-03924-4

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CONTENTS

EDITORIAL
The mouth returns to medicine: Dentistry in the new global health agenda – *Prof NH Wood* 1

COMMUNIQUE
The Future-Proof Dental Practice: The 2030 and Beyond Dentist – *Mr Makhubele* 5

RESEARCH
The Evolution and Efficacy of Disinfection Methods in Dental Practices: From Traditional to Advanced Technologies – A Review Article – *R Ahmed, S Ahmed* 7

Feasibility of a Digital Mindfulness Intervention for Stress Reduction Among Dental Students: A Pilot Study – *J Fourie, Carla Kotze, Hamza Hendricks, Ahmed Bhayat* 13

A Comparative Analysis of Traditional Dental Screening versus Smart Phone Screenin – *N Singh, S Naidoo* 18

Design and Implementation of the Oral Medicine South Africa Registry: Epidemiology of Oral Lesions at three tertiary academic facilities in the Western Cape, South Africa – *TA Vedan, M Engel, S Mulder Van Staden, H Holmes* 24

Antibiotics in Dentistry: To Prescribe Or Not To Prescribe? That Is The Question – *Y Rampersad, V Premviyasa* 31

Biosafety practices among dental undergraduates in AIMST University: A cross-sectional study – *Lim Ee Enm, Liew Denlee, Leong Suki Lew, Zhe Xuan, Vaishnavi Vedam* 35

Our Front Cover for this Issue...

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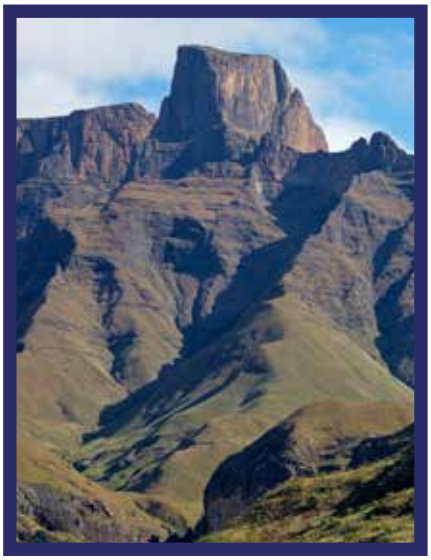

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CONTENTS

EVIDENCE BASED DENTISTRY
What's new for the clinician – summaries of recently published papers (FEBRUARY 2026) – *Prof V Yengopal* 40

ETHICS
Confidentiality – it's about trust – *By Dr Yash Naidoo, Dentolegal Consultant at Dental Protection.* 45

RADIOLOGY
The use of hand-held X-ray equipment among Dentists and Dental Specialists in Gauteng Province – *B Walsh,[1] LJ Hazell,[2] PL Mokoena,[3] K Tshite[4],* 47

CPD
CPD questionnaire 52

AUTHOR GUIDELINES
Instructions to authors and author's checklist 54

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The mouth returns to medicine: Dentistry in the new global health agenda

SADJ FEBRUARY 2026, Vol. 81 No.1 P1-P4

Prof NH Wood, Managing Editor, SADJ – BChD, DipOdont(MFP), MDent(OMP), FCD(SA), PhD

The rediscovery of the mouth

For much of modern healthcare history, oral health has occupied a curious position: clinically indispensable, yet politically peripheral. Dentists have always known that the mouth is inseparable from the body, but global health systems have often behaved as though it were not. National health policies, universal health coverage frameworks, and even major non-communicable disease strategies have historically given little attention to oral health, despite the fact that oral diseases remain among the most prevalent health conditions worldwide.

This separation has had consequences. Oral health services in many countries developed along parallel tracks to mainstream healthcare systems, often financed, organized, and regulated differently from other medical services. The result has been a quiet marginalization of oral health in policy discussions, even as billions of people continue to live with untreated dental disease, pain, infection, and the social consequences that accompany them.

Yet the global health landscape is beginning to shift. In recent years, oral health has re-entered international policy discourse in a way not seen for decades. The adoption of the World Health Assembly Resolution on Oral Health in 2021, followed by the WHO Global Strategy on Oral Health and the Global Oral Health Action Plan for 2023 - 2030, signals a turning point. For the first time in a generation, oral health is being deliberately repositioned within the broader framework of universal health coverage and the global response to non-communicable diseases.

This moment is more than a bureaucratic milestone. It represents a conceptual shift: the recognition that oral diseases are not isolated clinical problems, but part of the same social, behavioral, and biological systems that drive the global burden of chronic disease. In this emerging agenda, the mouth is no longer peripheral. It is returning, quite appropriately, to medicine.

A global turning point in oral health policy

The repositioning of oral health within global health policy did not occur spontaneously. It is the result of a deliberate sequence of decisions taken by the World Health Organization and its Member States over the past several years. In 2021, the World Health Assembly adopted Resolution WHA74.5 on Oral Health, formally acknowledging the enormous global burden of oral diseases and the long-standing neglect of oral health within health systems. The resolution recognised that oral diseases, particularly dental caries, periodontal disease, tooth loss, and oral cancers, are among the most prevalent non-communicable diseases worldwide and impose significant social and economic costs across the life course.

This resolution did more than simply highlight the problem. It mandated the development of a coordinated global policy response. The following year, the Global Strategy on Oral Health (2022) was adopted, outlining a long-term vision for addressing oral diseases as part of broader health system reform. That vision was subsequently translated into a concrete implementation framework through the Global Oral Health Action Plan 2023 - 2030, endorsed by the World Health

Assembly in 2023. Together, these three policy instruments, the resolution, the strategy, and the action plan, now define the global oral health agenda for the coming decade.

The ambition of this agenda is substantial. The Global Oral Health Action Plan provides more than a set of aspirations; it outlines a coordinated programme of action containing over one hundred recommended interventions and a monitoring framework with measurable targets to track progress toward 2030. Central to this framework is the integration of oral health into universal health coverage and national responses to non-communicable diseases, ensuring that oral health is addressed through the same prevention strategies, health system structures, and public health policies that guide broader healthcare delivery.

This shift carries particular significance for countries such as South Africa. Health systems in many low- and middle-income settings have historically struggled to integrate oral health into primary care services, financing mechanisms, and population health strategies. Yet the WHO agenda makes it clear that the future of oral health cannot be built on isolated dental services alone. Instead, oral health must be embedded within national health policy, workforce planning, disease prevention strategies, and universal health coverage frameworks. In other words, the global policy environment is now asking health systems to recognize what clinicians have always known: oral health is not an optional extension of healthcare—it is an essential component of it.

Why oral health matters to medicine

To understand why oral health has returned to the global health agenda, one must first appreciate the scale and nature of the problem. Oral diseases are among the most common health conditions affecting humanity. Current global estimates suggest that nearly half of the world's population lives with at least one untreated oral disease, making dental caries in permanent teeth the most prevalent health condition globally. Periodontal disease, tooth loss, and oral cancers add to this burden, collectively affecting billions of people across all age groups and socioeconomic strata. What makes this situation particularly striking is that many of these conditions are largely preventable.

The implications extend far beyond the dental chair. Oral diseases cause chronic pain, infection, impaired nutrition, difficulty speaking, and diminished quality of life. In children, untreated dental caries is associated with school absenteeism and reduced academic performance. In adults, oral disease contributes to lost productivity, social exclusion, and significant economic costs at both household and national levels. Health systems ultimately absorb the consequences when untreated oral infections lead to emergency care visits or hospital admissions. The global economic burden of oral diseases is estimated to exceed hundreds of billions of dollars annually when both treatment costs and productivity losses are considered.

What makes oral health particularly relevant to medicine is the growing recognition that oral diseases share common risk factors with many of the major non-communicable diseases that dominate global morbidity and mortality. High sugar consumption, tobacco use, harmful alcohol consumption, and broader social determinants such as poverty and limited access to healthcare drive not only dental caries and periodontal disease, but also conditions such as diabetes, cardiovascular disease, and certain cancers. In this sense, oral diseases are not isolated pathologies confined to the mouth; they are manifestations of the same behavioral, environmental, and systemic forces that shape overall health.

The relationship between oral and systemic health is also becoming increasingly evident in clinical research. Periodontal inflammation has been associated with diabetes control, adverse pregnancy outcomes, and cardiovascular risk. Oral infections may exacerbate systemic inflammatory pathways, while systemic diseases may influence the progression of oral conditions. These interactions reinforce an important principle: the mouth cannot be meaningfully separated from the body in either biological or clinical terms.

For decades, dentistry has operated somewhat independently from mainstream healthcare policy and service design. Yet the evidence now points in the opposite direction. Addressing oral diseases effectively requires the same population-level strategies used to tackle other non-communicable diseases, reducing sugar consumption, controlling tobacco use, strengthening preventive services, and integrating care into primary health systems. The new global oral health agenda therefore represents more than a policy adjustment; it reflects a deeper understanding that oral health must be addressed within the broader architecture of medicine and public health.

The strategic priorities of the global oral health action plan

The Global Oral Health Action Plan for 2023 - 2030 provides a structured roadmap for translating policy aspirations into practical change. While the earlier strategy articulated the vision for integrating oral health into broader health systems, the action plan identifies specific priority areas through which countries can operationalize that vision. Taken together, these priorities represent an attempt to move oral health from the margins of health policy into the core architecture of national health systems.

One of the central priorities is strengthening governance and national policy leadership in oral health. Many countries lack comprehensive oral health policies or national surveillance systems capable of accurately measuring disease burden and service access. The action plan therefore encourages governments to develop clear national strategies, supported by reliable epidemiological data, monitoring frameworks, and accountability mechanisms. Without such policy infrastructure, oral health services remain fragmented and reactive rather than strategic.

A second priority is the integration of oral health into primary health care. The traditional model of stand-alone dental services has often limited access to care, particularly for vulnerable populations. The WHO agenda instead promotes the inclusion of essential oral health services within primary health care systems, allowing prevention, early diagnosis, and referral pathways to be embedded within routine healthcare delivery. This approach recognizes that oral diseases share risk factors with other chronic conditions and therefore benefit from coordinated prevention strategies at the population level.

The oral health workforce represents another critical pillar of the action plan. Across many regions, there are profound imbalances in the distribution of oral health professionals, with shortages in rural areas and oversupply in others. The WHO framework calls for workforce models that are responsive

to population needs, including expanded roles for different categories of oral health professionals and stronger alignment between training programmes and public health priorities. This emphasis reflects a broader understanding that the structure of the workforce must evolve if oral health services are to reach underserved communities.

Prevention occupies a central place in the action plan. Oral diseases are largely preventable, yet global health systems continue to devote significant resources to the treatment of advanced disease rather than its prevention. The WHO framework emphasizes risk-factor reduction strategies that mirror those used in broader non-communicable disease programmes. Reducing sugar consumption, strengthening tobacco control, promoting healthier environments, and improving public awareness are all essential components of this preventive approach.

Finally, the action plan calls for improved data, research, and surveillance systems. Reliable data are essential for understanding disease patterns, guiding resource allocation, and evaluating the effectiveness of interventions. Strengthening oral health information systems allows countries to monitor progress toward the targets set for 2030 and to identify areas where policy adjustments may be required.

Taken together, these strategic priorities signal a significant shift in thinking. Oral health is no longer framed solely as a clinical discipline concerned with treating disease at the individual level. Instead, it is increasingly understood as a population health issue requiring coordinated policy, prevention strategies, workforce planning, and integration within broader health systems. For the dental profession, this evolving framework invites a reconsideration of its role, not only as providers of clinical care, but also as participants in the design and stewardship of health systems.

What this means for dentistry in South Africa

For South Africa, the renewed global attention to oral health presents both an opportunity and a responsibility. The country's health system, like many others, continues to face significant disparities in access to oral healthcare, particularly between urban and rural populations and between the public and private sectors. At the same time, the broader national health policy environment, particularly ongoing discussions around universal health coverage and health system reform, creates a context in which oral health can no longer remain peripheral to primary healthcare planning.

The WHO Global Oral Health Action Plan challenges countries to rethink how oral health services are organized, financed, and delivered. For South Africa, this raises important questions about how oral healthcare can be integrated more effectively into primary health services, prevention strategies, and population health initiatives. It also highlights the need for stronger national data on oral disease burden, clearer policy direction, and workforce models that respond to the realities of the country's public health landscape.

These developments place an important responsibility on the dental profession and on academic institutions. Universities, professional organizations, and clinical leaders play a critical role in shaping how oral health priorities are translated into policy and practice. Training programmes

must prepare graduates not only for clinical excellence, but also for participation in public health systems, prevention strategies, and interprofessional healthcare environments. In this sense, the global oral health agenda is not merely a policy development; it is an invitation for the profession to engage more actively with the broader health system in which it operates.

A moment the profession should recognize

Moments of policy realignment in global health are rare. When they occur, they often reflect the culmination of years of accumulating evidence, advocacy, and changing scientific understanding. The adoption of the World Health Assembly Resolution on Oral Health and the subsequent Global Strategy and Action Plan represent such a moment for dentistry. For the first time in decades, oral health has been formally repositioned within the architecture of global health policy, explicitly linked to universal health coverage, non-communicable disease prevention, and the strengthening of primary health systems.

This development should not be viewed merely as a policy milestone occurring in distant international forums. It carries direct implications for the profession itself. If oral health is to become fully integrated into health systems, dentistry must increasingly engage with the broader medical and public health community, contributing not only clinical expertise but also leadership in prevention, research, workforce development, and policy dialogue. The profession's future influence will depend not only on its technical skill but on its willingness to participate in the structures that shape population health.

For countries such as South Africa, where oral disease remains widespread and access to care remains uneven, the global oral health agenda offers a framework through which longstanding challenges may be addressed more strategically. Integrating oral health into primary care, strengthening prevention strategies, developing responsive workforce models, and improving surveillance systems are not simply administrative goals; they are essential steps toward reducing the burden of disease and improving the quality of life of millions of people.

There is also a deeper message embedded in the current global policy shift. Dentistry has always understood the biological truth that the mouth is inseparable from the body. The emerging global health agenda now acknowledges this reality at the level of policy and systems design. In that sense, the current moment represents less a revolution than a long-overdue correction. Oral health is returning to the place it has always belonged, within the broader continuum of medicine and public health.

For the dental profession, the question is therefore not whether this change will occur, but how actively it will participate in shaping it. The opportunity now exists for clinicians, educators, researchers, and professional organizations to contribute meaningfully to the evolving global health agenda. If embraced with the seriousness it deserves, this shift may well define the next chapter in the relationship between dentistry, medicine, and society.

The mouth has always been part of the body. The global health community is finally beginning to act accordingly.

The Future-Proof Dental Practice: The 2030 and Beyond Dentist

SADJ FEBRUARY 2026, Vol. 81 No.1 P5-P6

Mr KC Makhubele – CEO, South African Dental Association

We stand at an inflection point. The world of dentistry, once defined by its comforting consistency, is now being reshaped by converging forces of technology, economics, and societal change. The practices that will thrive in 2030 are not merely those that buy the latest gadget, but those that fundamentally reimagine their purpose, their team, and their relationship with the patient. This is not a distant forecast; the future is being built in the decisions we make today. Here is a blueprint for building a dental practice that is resilient, relevant, and ready.

The Convergence: Four Forces Reshaping Our Landscape

The future will not be shaped by a single trend, but by their intersection:

1. **The Intelligence Layer: Pervasive and Practical AI.** Artificial Intelligence will move from a novel diagnostic aid to the embedded nervous system of the practice. It will autonomously analyse radiographs for pathology, predict treatment outcomes based on vast datasets, optimise scheduling for efficiency, and personalise patient communication. The question will shift from "Should I use AI?" to "How do I ethically manage the AI that manages my practice?"
2. **The Human Symphony: Expanded Scope and Collaborative Care.** The dental team will expand and specialise. Oral Health Therapists, dental therapists, and advanced hygiene practitioners will work in collaborative, skill-based models with dentists as leaders and complex-case specialists. This isn't about delegation; it's about orchestration – leveraging the full scope of the team to improve access, enhance preventive care, and elevate the dentist's role to that of a true oral physician.
3. **The Empowered Consumer: The Rise of Healthcare Retail.** Patients are no longer passive recipients. They are consumers who research online, read reviews, and demand transparency, convenience, and experience. Marketing evolves from simple advertising to building a trusted brand through digital storytelling, educational content, and seamless digital journeys – from online booking to virtual consultations and digital treatment plans.
4. **The Regulatory Evolution: From Gatekeeper to Enabler.** In this dynamic environment, regulation must evolve. The HPCSA's role will be critically re-examined: will it be a bottleneck of bureaucracy or a catalyst for safe innovation? Simultaneously, the imperative of a unified coding system and data-driven engagement with funders (and potentially the NHI) becomes non-negotiable for the profession's economic survival and influence.

The 2030 Dentist: Architect, CEO, and Chief Empathy Officer

In this new world, the skills of the successful dentist must expand dramatically, evolving from a primarily technical repertoire to a multifaceted professional identity. Clinical

excellence – the mastery of anatomy, materials, and hand skills – remains the non-negotiable foundation upon which all trust is built. However, in an era of informed patients, disruptive technology, and team-based care, clinical prowess alone has become mere table stakes; it is the expected baseline that grants you entry to the game, but it no longer guarantees you can win it. The dentist of 2030 must therefore consciously cultivate a parallel skill set, becoming a strategic architect of health, a savvy leader of people and technology, and a trusted communicator who can navigate the complex intersection of biology, business, and human emotion.

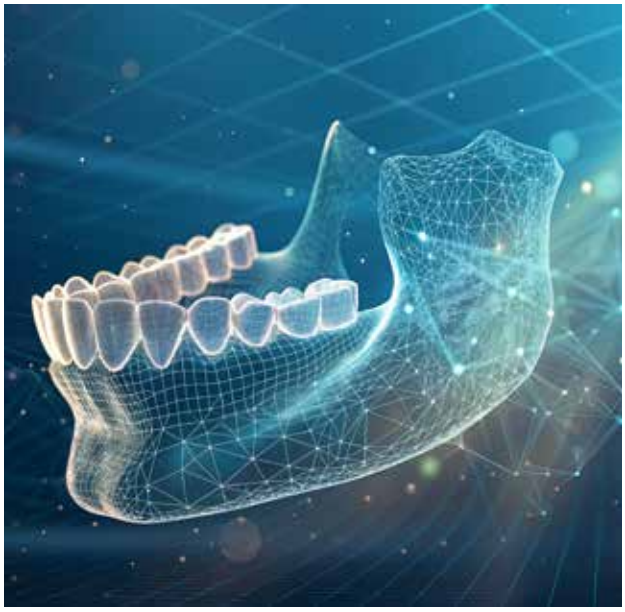
- **Digital Literacy & Data Fluency:** Understanding how to select, implement, and interpret AI-driven tools. Knowing how to leverage practice data for clinical and business decisions. Mastering the platforms that connect with patients.
- **Business Acumen & Financial Intelligence:** Moving from clinician to CEO of your own healthcare micro-enterprise. This means strategic budgeting, savvy resource allocation (human and technological), understanding value-based care, and navigating complex reimbursement landscapes.
- **Collaborative Leadership & Emotional Intelligence:** The ability to lead a diverse, skilled team – to inspire, mentor, and create a culture of psychological safety where every member practices at the top of their licence. This also means unparalleled communication skills to connect with the anxious, the informed, and the sceptical patient.
- **The Adaptive & Ethical Mindset:** Embracing continuous, self-directed learning. Developing the agility to pivot when needed. Most crucially, holding an unwavering ethical compass to guide decisions where technology, marketing, and finance intersect with patient welfare.

The Future-Proof Practice: Key Pillars

1. **The Seamless Digital Front Door:** Your practice's first impression is its website and social presence. By 2030, this extends to AI-powered chatbots for initial triage, online booking integrated with real-time availability, and secure patient portals for records, forms, and treatment plan acceptance.
2. **Precision, Preventative & Personalised Care:** Care moves from reactive and episodic to predictive and continuous. AI analyses historical and real-time data to identify individual risk profiles. Care plans are co-created with patients, focusing on long-term health preservation, supported by in-practice monitoring tools and wearable data.
3. **The Collaborative Care Clinic:** Physical space is redesigned for team-based care. Dento-legal frameworks support clear scopes of practice and collaborative agreements. The dentist's time is focused on diagnosis, complex treatment planning, and advanced procedures, while the team ensures comprehensive preventive and maintenance care.
4. **The Sustainable Enterprise:** Sustainability is two-fold: **Financial** – through efficient operations, clear value propositions, and diversified services (aesthetics, sleep, TMJ). **Environmental** – adopting green technologies, reducing waste, and communicating this ethos to a growing eco-conscious patient base.

SADA: Your Essential Partner on the Journey

Navigating this transformation alone is daunting. This is where your Association evolves from a traditional representative body to your indispensable strategic partner.



- **Education & Upskilling:** We will curate and provide access to world-class, contextually relevant learning on AI implementation, practice leadership, digital marketing ethics, and collaborative practice management. We will be your source for future-skills development.
- **Advocacy & Influence:** We will aggressively champion a modernised, efficient HPCSA that supports innovation. We will drive the standardised coding agenda and be the strong, evidence-based voice negotiating with funders and government on tariffs and the shape of any NHI, ensuring the profession's sustainability is central to all plans.
- **Community & Connection:** We will foster networks of practitioners – forums, masterminds, and special interest groups – where you can share challenges, solutions, and insights with peers navigating the same journey. In a digital age, human connection and peer support are more valuable than ever.
- **Frameworks & Guidance:** We will develop and disseminate South Africa-specific guidelines for the ethical use of AI, tele-dentistry, social media marketing, and collaborative practice models, giving you the confidence to innovate within a safe professional framework.

The Call to Action

The blueprint is clear. The future belongs not to the biggest practice, but to the most **adaptive**; not to the cheapest, but to the most **valuable**; not to the isolated technician, but to the connected **leader**.

Start today. Audit one system in your practice – be it patient communication or recall. Explore one new technology. Have one strategic conversation with a team member about future roles. Join one SADA forum dedicated to practice innovation.

The year 2030 will be shaped by the choices we make in 2024. Let us choose to be architects of our future, not relics of our past. Let us build practices that are not just future-proof, but future-ready – practices that continue to deliver excellence, build health, and stand as pillars of our communities in a rapidly changing world.

Together, we will not just adapt to the future. We will define it.

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The Evolution and Efficacy of Disinfection Methods in Dental Practices: From Traditional to Advanced Technologies – A Review Article

SADJ FEBRUARY 2026, Vol. 81 No.1 P7-P12

R Ahmed[1], S Ahmed[2]

ABSTRACT

Ensuring effective disinfection in dental clinics is crucial for safeguarding patient health and preventing cross-contamination. Traditional disinfection practices have been widely used to maintain a sterile environment. However, these methods often encounter limitations and necessitates finding alternative methods.

Objectives

This review aims to provide an overview of existing disinfection methods used in dental clinics and focuses on evaluating the efficacy and versatility of advanced technologies, specifically vaporised hydrogen peroxide (VHP) and hypochlorous acid (HOCl). The review also examines the effectiveness of these methods as well as the operational benefits and potential limitations associated with the use of VHP, HOCl, and vaporizers in dental settings.

Methods

This review involved analysing and synthesizing findings from various published articles and studies on disinfection practices in dental clinics. It focused on their efficacy, application methods, and impact on microbial decontamination in clinical environments.

Results

The articles reported the mechanisms of action, effectiveness, and practical applications of these advanced disinfection technologies such a vaporiser in dental clinics. It highlights recent research and case studies demonstrating the superior performance in achieving thorough microbial decontamination, reducing environmental contamination, and enhancing overall infection control protocols. Additionally, the review explores the operational benefits of these technologies, such as reduced application time and lower toxicity risks compared to conventional agents.

Conclusion

Advanced technologies like VHP and HOCl show superior microbial reduction and practical advantages over traditional methods. Their integration into dental settings can strengthen infection control, though further research and clear guidelines are needed to support widespread adoption.

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INTRODUCTION

Surface decontamination in dental clinics presents unique challenges due to the presence of high-touch areas, diverse surfaces, and constant movement of people, all of which complicate effective disinfection. Effective surface disinfection is critical to minimise the risk of cross-contamination and protect both patients and dental staff. Over the years, methods have evolved from manual cleaning to advanced automated technologies, enhancing efficacy, coverage, and safety.

Mechanical disinfection

Mechanical disinfection, or physical decontamination, is the crucial first step in the disinfection process. It involves the physical removal of visible debris, organic matter, and contaminants from dental instruments, equipment, and environmental surfaces, allowing the active ingredients of disinfectants to work effectively.[1,2]

The primary goal of pre-cleaning is to reduce the microbial load on surfaces by eliminating larger particles and residues that could otherwise shield microorganisms from subsequent disinfection efforts. This process typically involves physical actions such as scrubbing, wiping, or rinsing, which are essential for effectively dislodging and removing contaminants. Other methods of physical disinfection include steam, heat, ultraviolet-C (UV-C) radiation, and filtration. 1Steam sterilisation uses high pressure steam to penetrate and kill microorganisms while UV-C radiation is an efficient method used to reduce microbial contamination by disinfecting the air and environmental surfaces. Plasma sterilisation and gas sterilisation use ionized gas, ethylene oxide and formaldehyde respectively to sterilise dental instruments and equipment by.[1,5]

The significance of mechanical disinfection lies in its ability to enhance the efficacy of chemical disinfectants. This step is vital because the presence of organic matter can inhibit the effectiveness of disinfectants, potentially leading to incomplete or ineffective disinfection.[1,2]

In dental settings, where precision and cleanliness are paramount, effective mechanical disinfection sets the

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stage for the success of subsequent chemical disinfection processes. It helps in ensuring the intended antimicrobial action by disinfectants on surfaces and instruments, thus significantly contributing to infection control and patient safety. Mechanical disinfection is not merely a preliminary step but a foundational practice that underpins the entire disinfection process.

Chemical disinfection

Chemical disinfectants can be classified based on their chemical composition, spectrum of activity, and practical applications in dental settings. Alcohols (ethanol, isopropanol) are effective against bacteria, fungi, and enveloped viruses but are not sporicidal, and they act rapidly with low residue.[6] Aldehydes (glutaraldehyde, formaldehyde) are high-level disinfectants capable of inactivating bacteria, viruses, fungi, and spores, but require careful handling due to toxicity and potential corrosiveness.[9] Halogen-releasing agents (chlorine and iodine compounds) are broadly effective, including against mycobacteria, and are often used for surface disinfection.[6] Quaternary ammonium compounds are low- to intermediate-level disinfectants that are effective against bacteria and enveloped viruses but have limited activity against spores and some non-enveloped viruses.[6] Hydrogen peroxide and peracetic acid are potent oxidizing agents with broad-spectrum activity, including bacteria, viruses, fungi, and spores, and are increasingly used as environmentally friendly alternatives.[6,9] Other agents, such as phenolics, acids, alkalis, and heavy metals, provide additional options depending on the clinical setting and the type of surface or instrument being disinfected.[9] Selecting the appropriate chemical disinfectant requires consideration of the target microorganisms, compatibility with materials, safety for staff and patients, and environmental impact.[7,8]

Surface disinfection can be one-step (direct chemical application) or two-step (pre-cleaning followed by chemical disinfection). Two-step methods ensure removal of organic matter but are time-consuming, while one-step methods are more practical in high-throughput dental settings.[7]

Disinfectant wipes offer a convenient alternative, providing targeted application with reduced chemical exposure and improved coverage, while saving time.[8] However, the efficacy of the disinfectant wipes is dependent on the correct storage of the wipes.

The spray-and-wipe method remains the most commonly used approach in dental clinics, supported by a wide range of formulations. The chemicals that could potentially be used in surface disinfection include formaldehyde, glutaraldehyde, hydrogen peroxide, aldehydes, halogen-based biocides, quaternary ammonium compounds, phenolics, acids/alkalis, heavy metals, and alcohols, each with its unique properties and applications.[9]

The various types of disinfectants

Maintaining hygiene and preventing cross-contamination in dental settings requires the careful selection of disinfectants. The wide array of disinfectants available, each with specific mechanisms of action and target pathogens, underscores the need for a tailored approach to infection control. From the potent oxidative effects of hydrogen peroxide and sodium hypochlorite to the broad-spectrum efficacy of alcohols and quaternary ammonium compounds, understanding the strengths and limitations of these agents is essential. Additionally, considerations such as potential corrosiveness, toxicity, and shelf life play a significant role

Table I: summarizing the disinfectants used in dentistry along with their target pathogens or indications:

Disinfectant	Pathogens/Indications	Environmental Considerations
Sodium Hypochlorite	Bacteria, viruses, fungi, spores; used in endodontics for root canal disinfection; also dissolves organic tissues. [1,2,]	Corrosive; toxic fumes if misused. Must avoid mixing with other chemicals.
Hydrogen Peroxide	Bacteria, viruses, fungi, spores; used for root canal disinfection in endodontics; effective at 0.5% for disinfection against SARS-CoV-2; recommended for mouth rinse. [,6-8,11,]	Oxidative; safe residues. Can reach hard-to-clean areas.
Chlorine Compounds	Bacteria, viruses, fungi, spores; includes sodium chlorate(I), sodium dichloroisocyanurate, and chloramine; used for surface disinfection; sodium hypochlorite recommended for SARS-CoV-2. [1,2,6-8,]	May form toxic by-products, and corrosive.
Ethanol	Bacteria, fungi, viruses (excluding spores); used in disinfecting surfaces, skin disinfection, and hand sanitizers; recommended in 62-71% concentration for SARS-CoV-2. [1,11,13]	Flammable; low environmental impact Fast acting; limited residual effect
Isopropyl Alcohol	Bacteria, fungi, viruses; used for surface disinfection and hand sanitisation; recommended in 70% concentration for surface disinfection; combined with silver nanoparticles for enhanced adhesion. [1,2,6-8]	Highly flammable; evaporates quickly, minimal long-term environmental impact.
Povidone-Iodine	Bacteria, fungi, viruses; effective as mouth rinse; recommended for SARS-CoV-2 at 0.2%; acts by oxidizing cell components; also used for skin disinfection. [1,2,8,11,13]	Safe when used in small amounts; avoid large-scale disposal.
Chlorhexidine	Bacteria, fungi; ineffective against spores and mycobacteria; used for hand disinfection, oral gels, and endodontic final irrigant; not effective against SARS-CoV-2 unless combined with alcohol. [1,2,6-8,]	Low biodegradability.
Quaternary Ammonium Compounds (QACs)	Bacteria (especially gram-positive), enveloped viruses, fungi; used for disinfection of noncritical surfaces and undamaged skin; less effective against mycobacteria. [1,2,6-8,]	Low toxicity Less effective on spores/mycobacteria.

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Glutaraldehyde	Bacteria, fungi, viruses, spores; high-level disinfectant; used for disinfection of medical equipment; activated in alkaline pH; potential toxic effects. [1,2,6-8,1]	Toxic; requires ventilation High-level disinfection.
Aldehydes (OPA)	Bacteria (including mycobacteria), fungi, viruses, spores; high-level disinfectant; stable across a wide pH range; used for disinfecting medical equipment. [-8,11,13]	Proper waste management required.
Phenolic Compounds	Bacteria, fungi; used for disinfecting surfaces; includes eugenol and thymol; ineffective against spores; used as antiseptic in endodontics and dental treatments. [1,2,6-8,13]	Toxicity varies Limited antiviral activity
Silver Compounds	Bacteria; used for preventing infections in wounds and treating eye infections; includes silver sulfadiazine. [1,2]	Toxicity varies Limited antiviral activity

in ensuring safe and effective disinfection practices. This section discusses the disinfectants commonly used in dentistry, their applications, and the regulatory guidance that shapes their clinical use. [1,2,10,11]

Guidelines from the centres for Disease Control and Prevention (CDC) and the World Health organisation (WHO) provide universally accepted principles for surface disinfection. Regulatory requirements for environmental disinfectants vary by country, but the WHO and dental regulatory bodies recommend that an ideal surface disinfectant should demonstrate broad-spectrum antimicrobial activity, rapid action, and effectiveness in the presence of organic matter. It must also be non-toxic, non-corrosive, compatible with dental materials, easy to use, and environmentally safe. Additionally, it should comply with regulatory safety standards and show proven efficacy against bacteria, viruses, fungi, and spores commonly encountered in dental settings.[28]

Challenges associated with surface decontamination.

During dental procedures, both direct and indirect contact with instruments, equipment, and environmental surfaces is unavoidable, frequently involving saliva, blood, biological fluids, or bioaerosols, and consequently exposing dental staff and patients to infectious microorganisms present in the oral cavity. Kchaou et al. (2020) and Tzoutzas et al. (2022) highlight several challenges associated with effective surface disinfection in dentistry, including the wide range of pathogen exposure, the constant interaction between patients and dental staff, the diversity of surface types, high levels of movement within confined clinical spaces, and the emerging resistance to existing disinfectants.[21-23] In addition, dental procedures inevitably generate splatter and subvisible blood droplets that further increase the risk of pathogen transmission.[15, 16] These factors underscore the importance of prioritising high-touch and frequently contaminated areas during routine disinfection.[1,17] However, manual cleaning alone may leave residual microorganisms on hard-to-reach surfaces, contributing to persistent contamination, while workflow constraints in busy clinics often hinder strict adherence to recommended disinfection protocols. Identifying zones with consistently high contamination risk and directing targeted cleaning efforts toward these areas can therefore enhance overall efficacy and significantly reduce cross-contamination.

Objectives of Surface Disinfection

The primary aim of surface disinfection is to eliminate and neutralize pathogens on environmental surfaces in a dental clinic.[17,18] However, the lack of comprehensive data on nosocomial infections in dental clinics poses challenges for developing effective infection control strategies. Studies suggest that optimal surface disinfection should eliminate and deactivate microorganisms present, prevent the spread of infection, and avoid any idiopathic harm to staff or patients.[8,12,19,20]

Routes and Sources of Contamination

During dental procedures there is direct and indirect contact with instruments, equipment, and environmental surfaces. This can occur by contact with saliva, blood, biological fluids or bioaerosols and by default with various infectious microorganism present in the oral cavity during dental treatment. Kchaou et al. (2020), and Tzoutzas et al. (2022), reported several challenges facing surface disinfection in dentistry ranging from the range of pathogen exposure, direct and indirect contact by patients and dental staff, the variety of surfaces, continuous movement of individuals in a short space of time in the same environment and the development of resistance to existing disinfectants.[21-23]

Selecting the Appropriate Disinfectant

Based on the above-mentioned factors, the disinfectant of choice should be broad-spectrum in nature to effectively eliminate a wide range of pathogens and prevent transmission through direct or indirect contact.[20] It must also be effective against biofilm-producing microorganisms and contribute to reducing cross-contamination by adequately managing most, if not all, areas of contamination. Manual disinfection methods, although widely used, are often time-consuming and may not reach all contaminated areas – particularly hard-to-reach surfaces or those that are difficult to clean – resulting in incomplete coverage and allowing pathogens to persist on surfaces within the dental clinic.[24] Furthermore, manual disinfection relies heavily on human consistency and is therefore prone to variability.[18]

Dental clinics comprise a wide range of materials, equipment, instruments, and environmental surfaces, all of which can retain bacteria, viruses, and fungi, serving as reservoirs for microbial contamination.[1,25] The challenge, therefore, lies in selecting a disinfectant that is compatible with these diverse surfaces, does not degrade materials, and is environmentally safe while posing no harm to staff or patients. It is essential that the disinfectant of choice prevents damage to equipment and materials and does not compromise their functionality or longevity.[12]

Resistance to Disinfectants and Biofilm Formation

One of the most current challenges faced by the dental fraternity is the development of resistance to existing disinfectants which is often as a result of noncompliance with infection control protocol.[27] Pathogens, like *E. faecalis* and

www.sada.co.za / SADJ Vol. 81 No.1
https://doi.org/10.17159/sadj.v81i01.19935

C. albicans, can develop resistance to certain disinfectants, reducing their effectiveness. Furthermore, biofilms formed by these organisms can inhibit disinfection efforts. This trend is increasing the risk of nosocomial infection amongst dental staff and patients and poses a significant threat.

Sterilisation and Disinfection Methods

The CDC has proposed guidelines and protocols for disinfection of environmental surfaces in order to combat the development of antimicrobial resistance.[28] In order to prevent or hinder the transmission of infectious diseases, strategies that aid in the reduction or elimination of microorganisms including bacterial spores should be selected based on the needs of the dental clinic. The strategies can be categorised as either sterilisation or disinfection. Sterilisation and disinfectants are fundamental processes in dentistry to prevent the transmission of infectious diseases.[23]

The aim of sterilisation involves the complete elimination or deactivation of microorganisms, resilient bacterial spores. The sterilisation process is closely associated with disinfection.[1] Disinfection is an essential part of the infection control protocol in a dental clinic. The aim of the disinfection process is to completely eliminate trace of all microorganisms but there is a possibility that some may survive the disinfection process.[1,23] Disinfection is divided into high, intermediate and low-level disinfection and is used depending on the item and its level of contamination.[29]

There are various methods of disinfection namely mechanical, and chemical. Mechanical disinfection involves physical actions such as wiping, scrubbing, and removal of organic matter. This process is typically the first step before the application of a chemical disinfectant.[30] Chemical disinfection uses chemical agents to eliminate or inactivate microorganisms. Lastly physical disinfection uses agents to disinfect surfaces or equipment namely: ultraviolet germicidal irradiation (UVGI) and moist heat sterilisation.[29] The end result of the aforementioned methods is to eliminate or reduce the number of microorganisms on instruments, equipment, and environmental surfaces.

However chemical-based disinfectants can have an environmental impact as well due to harmful residues or toxic by-products.[24] This consequently will impact the safety of the dental team and patients, as well as a long-term environmental fallout. Lastly, traditional disinfection methods might require special disposal methods for certain chemicals, which aids to the intricacy of bio decontamination techniques.[1]

Compliance and Human Factors

Adherence to infection control guidelines can be challenging due to several factors. Members of the dental team often work in high-pressure environments with limited time, which may result in inadequate disinfection.[11] This can be as a result of noncompliance, negligence, or inadequate training. The dental clinic has equipment and materials with various compositions and often have areas that are hard to reach that influences the complete removal of pathogens. In light of these challenges an alternative disinfection technique like the use of vapor provides an effective alternative.[31]

Alternative Approaches: Vapor-Based Disinfection

Advancements in technology have developed infection-control techniques which include equipment and surfaces that have materials within it which enhance infection control measures in dental practices. Despite the advancements in the field of infection control, the ideal disinfection and technique that meet all requirements has not been developed.[31]

The manual spray-wipe-spray-wipe surface disinfectants can be used in various concentrations for a variety of surfaces in the dental practice.[24] Due to the configuration of the dental practice with many inanimate items and surfaces, the need for an all-room disinfection protocol that is not reliant on the dental staff member completing the tasks.[31] The use of a vaporiser will be able to reach multiple surfaces that rarely get disinfected in the treatment room and could possibly lead to cross contamination.[1]

A vaporiser or fogger offers a practical and efficient solution for disinfecting dental clinics, especially in areas that are hard to reach through manual cleaning methods. These devices can disperse disinfectant solutions as aerosols or steam, and in doing so disinfect the majority of the surfaces and equipment.[24] The non-touch bio-decontamination have been successfully implemented to decontaminate enclosed areas, like incubators, medicine trolleys, laboratory cabinets, operating rooms, isolation room, general medical wards, and intensive care units.[24,31]

The development of a vaporised disinfection technique offers several benefits for infection control in the dental clinics.4 It provides an automated, fast acting, comprehensive coverage in a shorter period of time that can impact both air and surfaces and in doing so reduces the risk of contamination.[24] It reduces the impact of human error by providing uniform disinfection across all surfaces and is less reliant on manual methods and reduces the workload of the dental team members. This method of infection control allows for adaptability, which is advantageous especially in light of the recent COVID 19 pandemic.[1,11]

There is a need for advancement of technology that can use various products quickly, efficiently, and is cost effective. A collaboration between dental health care workers and researchers will positively influence disinfection protocols that addresses the growing concern of the development of microbial resistance and the other challenges faced by the dental team.[32] vaporised disinfection provides an alternative that can penetrate biofilms and effectively inactivate resistant pathogens. This can possibly overcome the resistance issues associated with traditional disinfection methods.[32] Vaporised disinfection devices often use less harmful chemicals and minimise residues, reducing the environmental impact.[24] This makes it a safer option for disinfection within a dental clinic and the environment. Vaporising devices is a possible disinfection solution by providing automated, consistent, and comprehensive decontamination, the challenges associated with traditional methods.[18]

Vaporising devices

The vaporisation of the active ingredient into a vapour or fog is termed a vapour generator or a fogger in the medical / hospital health care industry. A vaporising unit has a generator that uses a four-stage cycle: conditioning, gassing, gas dwell and aeration.[24] During the conditioning phase, the air from the cabinet is passed through the generator where moisture is removed reducing the relative humidity of the air returned to the.[20] A chemical like liquid hydrogen peroxide

is then vaporised and injected into the cabinet during the gassing phase and allowed to form micro-condensation on the surfaces, and this is then held in the chamber for the duration of the gas dwell phase.[24,33] The dwelling phase is the time that the gaseous vapour is allowed to be suspended in the room air before removal with the aeration phase.[31] Studies have reported the efficacy of vaporised hydrogen peroxide (VHP) and vaporised hypochlorous acid as the active ingredient in non-touch bio decontamination units.[4]

The review study by Ahmed & Mulder (2021) highlighted that dental environments are prone to contamination risks, and VHP's effectiveness suggests its potential as a valuable decontamination tool achieving significant pathogen reduction, including bacteria, fungi, and viruses. Falaise et al. reported that VHP is highly effective in decontaminating a range of hazardous microorganisms, including bacterial spores, HG3 bacteria, and viruses like SARS-CoV-2.[35] It is deemed a safer alternative to formaldehyde fumigation since it leaves no harmful residues and requiring no post-process neutralisation. Mickelson et al. (2019) tested low-concentration VHP (3% hydrogen peroxide) over a long duration and reported effective decontamination of Bacillus anthracis spores. Mead et al. (2022), demonstrated effective decontamination of N95 filtering respirators with VHP, providing a low-cost alternative for PPE decontamination.[36,37] The disadvantage of VHP is the potential oxidative damage to certain materials and might require careful laboratory preparation to mitigate risks. Overall, these studies demonstrate that VHP decontamination is a viable solution for achieving effective decontamination in various settings. However, there are limitations and challenges, such as potential material damage, and the need for accurate sensor calibration. These findings suggest that while VHP is effective, careful planning, standardization, and safety protocols are necessary to ensure optimal results.[4]

HOCl is emerging as an alternative disinfectant in a dental clinic due to its effectiveness against a range of pathogens and safety profile when used according to the manufacturer's instructions. Guan et al. (2022) reported that HOCl can reduce viral transmission in dental practices. HOCl at 100 ppm effectively destroys aerosolized viruses, like SARS-CoV-2 and HSV1, within 30 seconds, and provides an alternative for reducing infection risks in dental settings.[38] Boecker et al. (2021) reported that aerosolized HOCl can deactivate various microbial contaminants at safe concentrations, making it a useful method for controlling airborne contamination, especially in public indoor spaces.[39] Mehendale et al. (2023), emphasises the importance of safely using chlorine- based disinfectants.[40] It distinguishes between hypochlorous acid (HOCl) and other chlorine-based solutions. HOCl is a safe alternative for clinical applications, while hypochlorite (OCl-) is more suitable for surface disinfection. The study highlights the dangers of mixing chlorine-based solutions with other chemicals and calls for proper storage, handling, and safety protocols to prevent hazardous outcomes.[38-40]

Safety Considerations and Guidelines – Vaporising device
Staff should be trained on how to use disinfectants, including vaporised forms. It is important to label all disinfectants clearly, indicating the chemical composition and safety warnings.[24] It is essential to follow the manufacturer's instructions and to adhere to Occupational Safety and Health Administration (OSHA) guidelines and Environmental Protection Agency (EPA) standards, along with local and national health department requirements.[11] Inhalation of high concentrations of disinfectant fumes or being exposed for extended periods can cause respiratory irritation, eye discomfort, and other adverse effects. The use of PPE during disinfection, especially when vaporised chemicals are used, is recommended.30 In order to mitigate these risks, ensure sufficient ventilation is in place with appropriate filtration systems, like HEPA filters, to maintain air quality.1,24

CONCLUSION

The growing concern of microbial resistance to disinfectants, often stemming from noncompliance with infection control protocols, underscores the critical need for strict adherence to recommended guidelines. Ensuring consistent and proper use of disinfectants is essential to prevent resistance and maintain the efficacy of disinfection practices. Moreover, the selection of disinfectants must also consider environmental safety and sustainability, aligning with the broader goal of minimising the ecological impact in healthcare settings. Balancing effectiveness with environmental responsibility is key to fostering a safer and more sustainable approach to infection control.

Modern disinfection techniques offer significant benefits in enhancing infection control within dental settings, providing more efficient, effective, and targeted solutions to reduce microbial load and prevent cross-contamination. By embracing these advanced methods, dental practitioners can ensure a safer environment for both patients and staff. It is crucial for dental professionals to consider upgrading their disinfection practices to leverage the full potential of these innovations, ultimately leading to improved patient outcomes and a higher standard of care.

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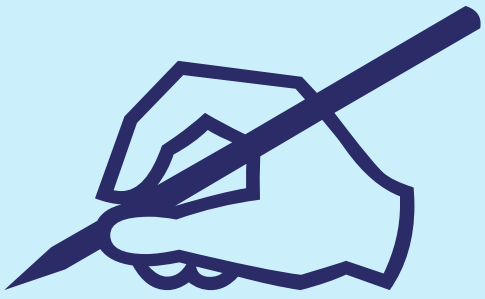
CPD questionnaire on page 52

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.



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Feasibility of a Digital Mindfulness Intervention for Stress Reduction Among Dental Students: A Pilot Study

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ABSTRACT

Objectives

To evaluate the feasibility, uptake and preliminary effects of an app-based mindfulness meditation intervention on perceived stress among undergraduate dental students in South Africa.

Methods

All oral hygiene and 2nd–4th year dentistry students were invited to complete the PSS-10 and participate in an 8-week daily mindfulness practice using the free Medito app. This single-arm pilot captured self-rated stress (0–10), PSS-10 scores, and app usage.

Results

Thirty-one students enrolled (12% response rate), and nine (29%) completed follow-up. Mean self-rated stress decreased from 7.54±1.27 to 5.78±2.11 (non-significant trend), and mean PSS-10 decreased from 25.81±7.96 to 20.33±8.31 (non-significant trend). Adherence was modest (~53 minutes total; ~6 days of practice).

Conclusions

This pilot suggests potential acceptability of app-based mindfulness, but sustained engagement was limited, and reductions were not statistically significant. Larger, controlled studies are required.

Key words

Mindfulness, dentistry, stress, feasibility, pilot study.

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Jeanine Fourie, Hamza Hendricks and Ahmed Bhayat. The first draft of the manuscript was written by Jeanine Fourie and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

1. INTRODUCTION

Stress is defined as "a state of mental or emotional strain or tension resulting from adverse or demanding circumstances".[1] It represents a fundamental response that enables adaptation to daily challenges. [2] Coping strategies determine an individual's perception of stressors and ultimately affect the mental well-being of a person.[3]

Dental students, both in South Africa and globally, experience significant levels of stress;[4-9] exceeding those reported by medical students.[5]

The annual trend varies among curricula across different faculties, notably intensifying with clinical work.[8] Stress levels fluctuate depending on assessment tools; the Depression, Anxiety and Stress Scale (DASS-21) showed 11% of Australian students had above-normal stress levels,[10] while 56% of UK students, assessed using the PSS, demonstrated high stress levels (considering a PSS score of 20 or greater as 'high stress').[8] Standardising assessment tools is necessary to facilitate comparisons.

Various instruments evaluate stress experience, with the Perceived Stress Score (PSS) most frequently used among health professional students.[11] A recent South African study provided valid psychometric evidence for its reliability across diverse (race and gender) student populations.[12] Stress impacts students' academic performance, causing burnout, mental health issues (including anxiety, depression and psychological distress) and impaired concentration.[7,13] Academic faculties should prioritise preventing and reducing stress among undergraduate students,[5,14] particularly dental students.[15] Mindfulness is a widely used stress management technique,[16] defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding experience moment by moment."[16]

Mindfulness may include formal meditation practice, where the practitioner focuses on sensations of the breath. When the mind wanders, focus is redirected, without judgment, to the breath.[17] Other formal practices include 'mindful walking', 'body scanning' or 'observations of thoughts and emotions'.[18]

Mindfulness practice has shown numerous positive outcomes,[19] including reduced stress, depression and anxiety[20] through improved adaptive coping strategies.[21] It can enhance academic performance by improving focus and productivity through increased concentration and reduced distraction.[18,22] Mindfulness can also mitigate burnout, characterised by emotional, physical, and mental exhaustion leading to decreased motivation among healthcare professionals and students.[19]

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Mindfulness practices can be implemented through online platforms or mobile applications. By 2020, 605 mindfulness-based mobile applications (MBMA) existed in the European market.[23] However, few applications had empirical evidence supporting their efficacy in mindfulness training or health indicators,[24] with only 7 MBMAs tested in randomised controlled trials,[23] despite offering advantages in accessibility, standardisation, personalisation and efficacy [25]. Studies have demonstrated the viability of such cellphone applications to reduce student stress.[26-32] A digital delivery format for mindfulness-based practice may offer practical advantages, flexibility, scalability and low cost, suited to students who face time constraints and variable schedules.

This pilot study assessed the feasibility of an 8-week mindfulness intervention via a smartphone application to alleviate stress in dental students at a South African university focusing on uptake, adherence and preliminary changes in perceived stress.

2. METHODS

A prospective, single-arm, interventional study was conducted among undergraduate dental students at a dental school in South Africa. All undergraduate oral hygiene students, and 2nd- 4th year dentistry students enrolled in 2024 were invited to participate. Recruitment occurred over three weeks from late July to early August 2024. Recruitment used posters, and an introductory lecture. Students were enrolled in a university website module titled "Meditation Challenge". The module page provided an explanation of meditation and study protocol, participant information letter, a link to self-select a unique identification number, links to complete the Perceived Stress Scale (PSS) anonymously (via Qualtrics) and a link to the Medito application and privacy policy. Students received contact information for university emotional support services. The 'meditation challenge' ran for eight weeks, from August 2024 to October 2024.

2.1 Measure

The Perceived Stress Scale (PSS) assessed self-perceived stress levels before and after the study intervention. The PSS evaluates how individuals perceive situations in their lives as stressful. Events in the preceding four weeks may be experienced as unpredictable, uncontrollable or overwhelming; respondents are also asked about feeling stressed. Ten items are rated on a Likert scale from '0' to '4', corresponding to never, almost never, sometimes, fairly often, and very often. The minimum score was 0 and the maximum score 40. Scores were reversed for the positively worded items and summed. While scores are not diagnostic, and Cohen *et al.* (1983) did not establish cut-offs, total scores of 0-13 indicated low stress, 14-26 moderate stress, and 27-40 high perceived stress.

The PSS shows strong internal consistency among university students, with adequate reliability over two-week and four-week periods. It displays construct validity in measuring perceived helplessness and self-efficacy, and convergent validity with stressful life events.[33] The PSS also demonstrates concurrent validity with anxiety and depression.[33]

The pre-intervention questionnaire asked respondents to rate their stress levels and meditation interest, on a scale from 1 to 10, and indicate prior meditation experience. The post-intervention questionnaire asked participants to evaluate their stress levels, report significant life stressors during the eight weeks, and indicate their intention to continue meditation. Participants retrieved their total number of meditation minutes and days from the Medito application.

2.2 Intervention

Participants engaged in mindfulness meditation for 10 minutes daily over 8 weeks using the Medito smartphone application. The Medito application was selected by undergraduate dental students during protocol development due to its free accessibility. This application offers beginner and intermediate meditation courses, daily meditations, offline use, and tracks usage in minutes, sessions, and days completed. The daily meditation sessions are available in various durations, including 10-minute intervals. An introductory course introduces techniques like breathing exercises, walking meditations, and mantra meditations, as well as mindfulness aspects including open awareness, observing the observer, and non-judgment. The application was developed by the Medito Foundation, a non-profit organisation committed to making mindfulness and meditation accessible.

2.3 Data analysis

The data were retrieved from Qualtrics in Excel format, and subsequently exported into Statistical Package for the Social Sciences (SPSS) version 21. All statistical analyses were conducted in SPSS following cleaning of the data. Descriptive statistics summarized uptake and adherence; emphasis was placed on means with 95% confidence intervals rather than p-values. Paired testing results are reported for transparency but interpreted cautiously.

A CONSORT extension checklist for pilot and feasibility trials is provided as supplementary material.

2.4 Ethical approval

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the university where the study was conducted (REC 263/2024). Student participation was voluntary and anonymous, without incentives or consequences for withdrawal. Participants were provided with an information letter detailing the study requirements and gave their informed consent by choosing to participate in the study.

RESULTS

A total of 31 students (among 259 students) enrolled in this study, yielding a response rate of 12%. Five students did not complete the initial assessment, and 9 (34.6%) participants who completed the initial assessment completed the study (attrition 67%). Based on predetermined threshold values of total PSS scores, 13 students (50%) reported high perceived stress levels (PSS > 26), while the remaining 13 students reported moderated perceived stress levels at the study's commencement (PSS 14 – 26). Following the intervention, one student reported high perceived stress, one student reported low perceived stress, and the remainder reported moderate perceived stress.

The mean PSS score decreased from 25.81 ±7.96 to 20.33 ±8.31 (p=0.500), and the mean self-reported stress levels reduced from 7.54±1.27 out of 10 to 5.78±2.11 (p=0.50) post-intervention. These changes were non-significant. The individual stress scores are presented in Figure 1.

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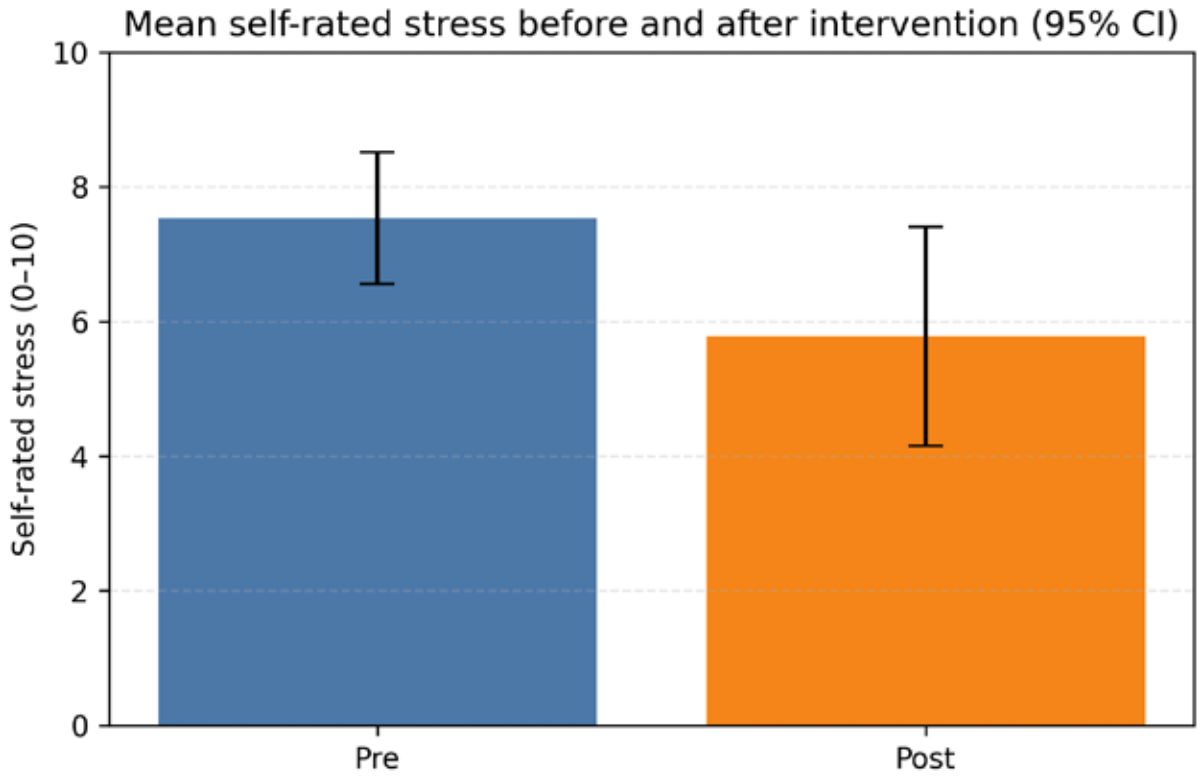

Figure 1 Mean self-rated stress before and after intervention with 95%CI.

Prior to the study, 19 (73%) of the participants scored their interest in meditation as 6 or more out of 10, indicating a high level of interest in learning about meditation. Only 4 students possessed prior meditation experience. Following the study, 6 students expressed their intention to continue using the Medito application.

Adherence was modest (mean duration of meditation sessions = 53 minutes, for 6 days of meditation).

4. DISCUSSION

Studies have investigated mindfulness applications' effects on mental health and perceived stress across populations, including the general public,[34-40] undergraduate students [26-28,30-32], and postgraduate students.[29] Most studies used Headspace,[26,28-30,36-37,39] and were conducted over 30 days or less.[26,28-32,34,36-37]

Among students, mindfulness applications enhanced mood and mindfulness of medical residents [29], and reduced stress among medical [26], and dental students [32], as well as undergraduate students in general, measured by the PSS [27-28,30-31].

4.1 Recruitment and incentives

A total of 31 (12%) dental students participated in this pilot study; only 33 students accessed the introduction page on the website, and merely 5 viewed the TEDx talk on meditation. This sample size is smaller than other studies; yet, a proportional comparison is possible with Yang *et al.* (2018) who also enrolled 12.29% of their undergraduate medical students [26], and Kuhlman *et al.* (2016) who enrolled 21.46% of eligible students [41], though the latter study did not employ a mindfulness app.

Unlike studies by other authors,[28,30-31,35,41] we did not incentivise participation. We did not exclude students with prior meditation experience, as Huberty *et al.* (2019) and Zollars *et al.* (2019) had done,[27,30] which appears unnecessary as it does not influence outcomes,[38] but may risk selection bias.[28] Yang *et al.* (2018) also raised their concern about selection bias, as students perceiving high stress levels are more likely to volunteer, and their volunteers, like ours, expressed a keen interest in meditation.[26] Imposing mindfulness meditation upon all students may be considered unethical and result in resistance to the practice.

In fact, stress-relieving effects of mindfulness programs among healthcare students were by some only shown in studies with voluntary enrolment,[42] suggesting that a receptive environment is necessary for the efficacy of mindfulness interventions.

High stress levels alone are insufficient to motivate students to engage in mindfulness practice.[30] Huberty *et al.* (2019) used high perceived stress as a criterion for participation, potentially exaggerating mindfulness benefits, as a higher initial PSS score predicts greater score changes.[38] Stress is pervasive among our dental students; however, despite being offered a stress management strategy, only a small proportion volunteered, and fewer completed the study.

4.2 Retention

Nine students completed the final assessment, resulting in a 67% attrition rate. This rate is comparable to the 65% attrition rate reported by Kuhlmann *et al.* (2016),[41] yet substantially higher than the 29% reported by Zolllars *et al.* (2019).[30] Remskar *et al.* (2024), using the Medito application across 91 countries, observed a retention rate of 16.2%.[40] In all these studies, participants received monetary incentives, thus, retention cannot be fully attributed to extrinsic rewards. Jayewardene *et al.* (2017) reported that 67% of participants were lost to follow-up in their meta-analysis of randomised controlled trials examining preventive online mindfulness

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interventions on stress [43]. From this, as well as other studies, retention appears to be a significant barrier to the successful delivery of mindfulness meditation interventions.

4.3 Adherence

Following Yang *et al.*'s (2018) methodology,[26] we adopted a non-interventional approach to evaluate students' intrinsic motivation. They reported that 60% of participants downloaded the app and used the application at least once during the study period. They suggested that personal contact after the study's start might have enhanced student motivation.[26] In our study, direct contact with participants was not feasible without compromising anonymity, except for motivational reminders via the LMS announcement. Personal contact should strongly be considered in future studies to improve adherence. Self-reported adherence was relatively low, with students meditating for an average of 53 minutes, or 6 out of 56 (10%) days, significantly less than the 11.97 out of 30 (40%) days reported by Yang *et al.* (2018).[26] Other studies have employed reliable measures of participant adherence,[26-27,30] however, it seems that students accurately represent their meditation efforts[30] and that such measures are not necessary for future studies.

Six (66%) of our students indicated their intention to continue meditating and using the application, whereas Yang *et al.* (2018) found that 72% of the students who used the application continued using it for the subsequent 30 days.[26] Most Calm application users (68%) expressed satisfaction and likelihood of continued use, although their weekly meditation hours decreased by 50% during follow-up.[27] Pharmacology students also perceived meditation as valuable and were likely to pursue it.[30] Nevertheless, Flett *et al.* (2018) observed that despite initial high adherence, when left to use the application at their discretion, only half continued, with no more than 16.4% using it twice or more per week.[28] While most students recognise mindfulness benefits and express intention to continue,[26-27,30] many struggle to establish a consistent practice.[27-28] Thus, overcoming the initial barrier of starting the practice,[26] may be the first challenge; however, establishing a persistent meditation practice may present an even greater challenge.[27-28] Barriers may include the academic load and motivational constraints.

4.4 Baseline stress levels

Students reported moderate to high levels of self-perceived stress, with a mean PSS score of 25.81, and no student scored below 16 at baseline. This score is higher than PSS scores ranging from 16.89 to 20.9 observed among undergraduate students,[26,28,30] and dental students (19.83). [8] Only Huberty *et al.* (2019), who established a PSS score of ≥ 14 as an entry criterion, reported higher PSS scores among control and intervention groups, with scores of 21.88 and 23.11, respectively.[27] This finding warrants investigation into factors contributing to elevated stress levels among our students, and development of interventions to address stress at individual and organisational levels.[19]

4.5 Correlation between adherence and outcome

Evidence indicates no correlation between compliance with app-based meditation protocols and stress-relief benefits among undergraduate students. Neither Zollars *et al.* (2019) nor Flett *et al.* (2019) identified any correlation between adherence levels and changes in PSS scores.[28,30] The study by Zollars *et al.* (2019) was limited in drawing correlations due to most participants showing perfect adherence.[30] While Flett *et al.* (2019) found that increased app usage during discretionary use correlated with improved college adjustment and mindfulness, but it did not affect perceived stress.[28] Bailey *et al.* (2018) showed in a community sample that increased app usage correlated with higher positive affect but not with reduced perceived stress. Each meditation session results in decreased PSS scores, though the effect is not cumulative over time.[31]

The high attrition rates and reduced adherence can be attributed to our study's extended duration, compared to Flett *et al.*'s (2019) 10-day intensive period and other studies' shorter durations,[26,29-30,34,36-37] as well as the long contact-free interval (8 weeks). Initial contact and preliminary data collection should occur early in the study.[26,28-29] However, this pilot study aimed to determine the uptake and sustainability of a self-motivated mindfulness intervention that mimics real-life interest and compliance.

4.6 Limitations

This single-arm pre–post pilot lacked a control group, limiting causal inference. The small, self-selected sample and high attrition reduce generalisability and statistical power. Outcomes relied on self-report and minimal demographic detail was collected to preserve anonymity.

4.7 Future direction

Research shows MBSR practices effectively reduce perceived stress among graduate health science students, without risks and at minimal cost.[42,44-45] Health science faculties should implement MBSR programs to enhance students' and graduates' well-being.[8,44-47] Final-year dental students benefit from stress identification and reduction techniques; however, this education should start earlier in their programme[47] and be reinforced annually.[48]

Optimally, MBSR programs should include a didactic component, guided practices, and practical homework.[44] Experienced instructors can address barriers to mindfulness-based self-help, such as negative thoughts and self-criticism, rather than leaving students to navigate these experiences alone.[49] Programs should align instruction to the student audience, maintaining engagement, and address participants' challenges.[25]

This study proposes that MBMA may be utilised as homework assignments, while addressing low engagement, superficial learning, and unresolved frustrations in class,[25] hopefully reducing high dropout rates and abandoning meditation practice.[42]

5. CONCLUSIONS

App-based mindfulness appears acceptable to some dental students, but sustained engagement was limited. Stress scores decreased numerically, but changes were not statistically significant. Larger, controlled studies with strategies to support adherence are warranted.

DISCLOSURE:

Conflict of Interest declaration: The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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ETHICS

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (REC 263/2024) and was conducted in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

CONSENT

Student participation was voluntary and anonymous, without incentives or consequences for withdrawal. Participants were provided with an information letter detailing the study requirements and indicated their informed consent by choosing to participate in the study.

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A Comparative Analysis of Traditional Dental Screening versus Smart Phone Screening

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ABSTRACT

Teledentistry has emerged as a promising solution to address oral health disparities, particularly in resource-limited settings like rural South Africa, where low dentist-to-population ratios and high costs restrict access to dental care. The present study evaluated the reliability and accuracy of smartphone-based, remote dental screening compared to traditional chairside clinical examination screening. A cross-sectional study was conducted with 145 participants (≥18 years) attending the Tygerberg Oral Health Centre. Standardized intraoral photographs were captured using an Apple iPhone XS and uploaded securely to the Vula App for remote assessment. Diagnostic tools, including the International Caries Detection and Assessment System (ICDAS) and the Decayed, Missing, and Filled Teeth (DMFT) index, were employed to ensure consistency.

The results showed an "Almost Perfect Agreement" between clinical and photographic examinations, with Cohen Kappa coefficients ranging from 0.84 to 0.95 and strong Pearson correlations (>0.90). No statistically significant differences were observed, confirming teledentistry's reliability as a diagnostic tool.

Teledentistry offers a secure, and cost-effective method to improve access to dental care, particularly for underserved populations. By overcoming geographical and economic barriers, it aligns with public health goals, including South Africa's National Health Insurance (NHI) scheme, to improve equity and quality in healthcare delivery.

Key words

Teledentistry, Remote Dental Screening, Oral Health Equity, Digital Health, National Health Insurance (NHI), Diagnostic Reliability.

INTRODUCTION

The COVID-19 pandemic fundamentally altered global health practices, necessitating innovations to adapt to safer working environments. In dentistry, the high risk of virus transmission—whether airborne, contact-based, or from contaminated surfaces—emphasizes the need for safer practices, such as the use of teledentistry.[1]

Teledentistry emerged as a key innovation during the pandemic, leveraging technology to bridge gaps between patients and healthcare professionals. Its use has increased, particularly in South Africa, where online platforms have become vital for pre-screening and consultations.[2] Teledentistry's potential extends beyond the pandemic, offering significant benefits in remote areas where access to dental care is limited .[3] It is particularly promising in the context of South Africa's upcoming National Health Insurance (NHI), which aims to provide equitable healthcare to all citizens.[4,5]

Oral diseases, including dental caries, are among the most common and preventable non-communicable diseases, affecting billions worldwide and significantly impacting quality of life.[6] Teledentistry offers a solution by facilitating remote dental consultations, thus improving access to care and potentially reducing the economic burden of oral diseases on society.[7]

Literature Review

Telehealth involves the exchange of clinical information or access to care via information technology. The global increase in internet access and smartphone use has significantly increased communication among healthcare practitioners.[8] Teledentistry, a subset of telehealth, uses telecommunications to facilitate dental consultations and treatment planning by exchanging clinical information and images over remote distances. Mobile health (mHealth), part of digital health, provides healthcare through smartphones, tablets, and wearables, with smartphones being the most frequently used device.[9]

Oral Disease Burden in South Africa

Teledentistry has significant potential to address oral health inequalities, especially in low- and middle-income countries, which face a disproportionate burden of disease. For instance, Africa, with 10% of the global population and only 3% of the health workforce, bears about a quarter of the world's disease burden.[10] In South Africa, where the Department of Health recommends a dental practitioner-to-patient ratio of 1:60,000[11], the actual ratio is far below this, leading to untreated oral diseases and delayed diagnoses.[12]

Teledentistry can bridge this gap by enabling early detection of conditions like carious lesions, reducing disease burdens and improving care access. It facilitates the remote exchange of clinical information and images for consultation and treatment planning, making the process more accessible and less stressful.[13] In underserved areas, teledentistry

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encourages professional consultations over ineffective home remedies, promoting better oral health outcomes.

Remote Dental Screening as a Tool in the NHI

Remote dental screening involves sharing photographs, radiographs, and clinical data between clinicians for diagnosis. This can be done through "store and forward" methods or in real-time via telephone or video calls. Intraoral photographs have proven to be valuable and reliable aids in diagnosing oral pathology.[14] The benefits of remote dental screening include reducing the transmission of communicable diseases, providing access to dental care in underserved areas, and allowing isolated patients to receive care. Additionally, clinicians in remote areas can consult specialists for advice on certain procedures, enhancing the quality of care.[15]

South Africa's National Health Insurance (NHI) system aims to provide high-quality healthcare to all citizens, especially those who are vulnerable and socio-economically disadvantaged. The NHI is based on principles of access, social solidarity, effectiveness, equity, affordability, and efficiency, with objectives to enhance healthcare services, pool risks and funds, procure services efficiently, and strengthen the public sector.[16,17] For the NHI to succeed, South Africa requires coherent systems that support the growth of e-health services, including remote monitoring tools, mHealth, and portal technology.[18] These technologies can streamline processes, increase efficiency, reduce waiting times, and enhance patient care by enabling healthcare workers to monitor and engage with patients remotely.[4]

Teledentistry and the COVID-19 Pandemic

The COVID-19 pandemic emphasized the importance of minimizing close contact between individuals.[19] Teledentistry aligns with social distancing rules by offering remote triaging and screening of patients. During the pandemic, suspected carriers were identified through teledentistry and advised to isolate, reducing exposure risks for healthy patients and healthcare staff while still providing emergency care.[20]

Mobile Applications and Their Utilization in Healthcare

Mobile applications are increasingly used by medical and dental practitioners to exchange sensitive patient information. However, platforms like WhatsApp, though popular, are not compliant with privacy regulations such as the Protection of Personal Information Act (POPIA), the General Data Protection Regulation (GDPR), and the Health Insurance Portability and Accountability Act (HIPAA).[21] The Vula App, developed in South Africa in offers a compliant alternative for secure communication and patient referrals. It is endorsed by the South African government and is the official referral app in the Western Cape Province.[22] The Vula App facilitates rapid patient evaluations, remote patient management, and secure data exchanges, contributing to improved healthcare quality.[23]

Several studies have investigated the diagnostic reliability of teledentistry. A study by Patterson and Botchway compared face-to-face dental screenings with intraoral image-based screenings, finding a diagnostic concordance ranging from 89% to 100%.[24] Similarly, a study by Kopycka-Kedzierawski *et al.* reported a 95% concordance in diagnosing dental caries in children using these two methods.[25] In the United Kingdom, Boye *et al.* found diagnostic concordance between visual and image-based screenings ranging from 87.8% to 95.8% in five-year-olds and 58.5% to 71.7% in ten-to-eleven-year-olds.[26] In South Africa, Bissessur and Naidoo reported a 93-98% diagnostic concordance, indicating high reliability in teledentistry.[27]

Legal and Ethical Concerns Associated with Data Sharing in Dentistry

The digitization of healthcare, including dentistry, raises important legal and ethical questions about data storage, sharing, and individual rights. In South Africa, regulatory bodies such as the Health Professions Council of South Africa (HPCSA), South African Health Products Regulatory Authority (SAHPRA), and others oversee the governance of digital health practices .[28] The South African Department of Health, aligning with the World Health Organization's definition of digital health, has yet to establish specific legislation for digital health.[29]

The Protection of Personal Information Act (POPIA), which came into effect on 1 July 2020, aims to protect individuals from data breaches, theft, and discrimination by establishing minimum requirements for processing personal information.[30] Compliance with these regulations is essential for any healthcare app used in teledentistry to ensure the protection and security of sensitive patient data.

AIMS AND OBJECTIVES

The present study determined the diagnostic reliability and accuracy of teledentistry compared to traditional clinical examinations for detecting dental caries. The objectives were to validate teledentistry as a practical, adaptive tool for improving access to oral healthcare and to demonstrate its potential in supporting public health strategies such as South Africa's NHI.

METHODOLOGY

Study Design and Population

A cross-sectional study was conducted with 158 parents or guardians (≥18 years) of children attending the paediatric dental clinic at Tygerberg Oral Health Centre. A purposive sampling technique was used, with a final sample size of 145 participants calculated using a Kappa statistic based on a positivity rating of 0.9.

Inclusion and Exclusion Criteria

Participants included those who provided verbal and written consent for their data and intraoral photographs to be uploaded to the Vula App. Off-site examiners were qualified HPCSA-registered dentists. Exclusion criteria applied to those not meeting these conditions.

Data Collection

Chairside examinations and image acquisition were conducted using an Apple iPhone XS. Intraoral photographs were captured under standardized conditions using the camera function within the Vula App and were securely uploaded for remote assessment. A pilot study involving 10 participants was conducted to refine the methodology.

Standardization and Calibration

Examiners followed WHO Oral Health Survey guidelines, with calibration exercises addressing diagnostic variability. Photographs were taken at specified angles and distances to ensure uniformity.

Data Analysis

The datasets analysed included comparisons between clinical and photographic examinations and assessments of intra- and inter-w reliability:

www.sada.co.za / SADJ Vol. 81 No.1
https://doi.org/10.17159/sadj.v81i01.21030

- Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 2) - 145 observations
- Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 1) - 145 observations
- Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 2) - 145 observations
- Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 1) - 14 observations
- Photographic Examination (Examiner 2) versus Photographic Examination (Examiner 2) - 14 observations

Statistical measures, including p-values, correlation coefficients, and Cohen Kappa coefficients, evaluated inter-rater reliability (agreement between different examiners), intra-rater reliability (consistency of a single examiner), and diagnostic accuracy. These analyses highlighted the reliability and validity of teledentistry as a diagnostic tool for dental screenings.

Utility

Chairside examinations allowed immediate patient interaction but posed exposure risks. Remote screening via the Vula App mitigated these risks and ensured secure data handling, offering a scalable solution for dental assessments in resource-limited settings.

RESULTS

Demographics

152 adults consented to participate in the present study but after excluding seven edentulous participants, the final sample comprised 145 participants, 41 males and 104 females, who were parents or guardians of children receiving dental care at the Tygerberg Oral Health Centre's paediatric dental clinic. The mean age of the participants was 40.23 years.

Table 1 summarizes the key findings of this study, providing a clear and concise overview of the results that are explained in detail in this results section.

Photographic examinations in teledentistry have demonstrated high reliability and accuracy compared to

Table 1: Results

	Results																	
	Kappa Coefficient	Agreement	DMFT Pearson Correlation	DMFT p(T<=t) two-tail	DMFT Mean Clinical Examination	DMFT Mean Photographic Examination	D Pearson Correlation	D p(T<=t) two-tail	D Mean Clinical Examination	D Mean Photographic Examination	M Pearson Correlation	M p(T<=t) two-tail	M Mean Clinical Examination	M Mean Photographic Examination	F Pearson Correlation	F p(T<=t) two-tail	F Mean Clinical Examination	F Mean Photographic Examination
Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 2)	0.846	Almost perfect agreement	0.98	0.489	12.37	12.99	0.94	0.054	3.85	4.6	1.0	1.000	7.72	7.72	0.93	0.299	0.80	0.59
Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 1)	0.94	Almost perfect agreement	0.99	0.828	12.39	12.58	0.97	0.575	3.82	4.06	1.0	1.000	7.77	7.77	0.78	0.519	0.91	0.76
Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 2)	0.88	Almost perfect agreement	0.99	0.637	12.59	13.0	0.95	0.191	4.10	4.66	1.0	1.000	7.72	7.72	0.95	0.384	0.77	0.59
Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 1)	0.95	Almost perfect agreement	1.0	0.949	12.59	13.0	0.99	0.899	4.10	4.66	1.0	1.000	7.72	7.72	1.0	1.000	0.77	0.59
Photographic Examination (Examiner 2) versus Photographic Examination (Examiner 2)	0.95	Almost perfect agreement	1.0	1.0	14.57	14.57	1.0	0.966	5.07	5.0	0.99	0.918	8.5	8.79	0.85	0.701	1.0	1.29

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traditional clinical methods, as shown in this study evaluating dental metrics (DMFT, D, M, F). When comparing clinical examinations by Examiner 1 to photographic examinations by Examiner 2, a Kappa coefficient of 0.846 indicated near-perfect agreement, with a strong Pearson correlation for DMFT (0.98). The lack of statistically significant differences, as indicated by p-values, highlights the reliability of photographic methods as an alternative to clinical assessments in remote or resource-limited settings.

Similarly, when clinical examinations by Examiner 1 were compared to photographic examinations conducted by the same examiner, the results showed an even higher Kappa coefficient of 0.94, reinforcing the near-perfect agreement between the two methods. Pearson correlation coefficients were notably high for DMFT (0.99) and perfect for "M" (1.00), with no significant differences observed in p-values. These findings validate the consistency of photographic examinations when utilized by the same examiner across different settings.

The inter-examiner reliability of photographic methods was further supported when comparing Examiner 1 and Examiner 2 using photographic examinations. A Kappa coefficient of 0.88 and a DMFT Pearson correlation of 0.99, with perfect agreement for "M" (1.00), demonstrated strong consistency between the examiners. Again, no significant differences were identified, affirming the robustness of photographic methods regardless of the examiner conducting the assessment.
Intra-rater reliability was assessed through repeated photographic examinations conducted by the same examiners. For Examiner 1, a Kappa coefficient of 0.95 and perfect Pearson correlation for DMFT, "M," and "F" (1.00) indicated exceptional consistency in assessments over time. Examiner 2 also achieved a Kappa coefficient of 0.95, with strong Pearson correlations for DMFT (1.00) and "M" (0.918). The p-values in both cases confirmed no significant differences in repeated assessments, underscoring the dependability of the photographic method.

The high Kappa coefficients (ranging from 0.846 to 0.95) across all datasets demonstrated the reliability of photographic examinations in teledentistry. Pearson correlation coefficients (0.78 to 1.00) further confirm the strong linear relationships across examiners and methods. Importantly, the lack of statistically significant differences in any of the comparisons validates the consistency of this approach, regardless of examiner or repetition. These findings highlight the potential of teledentistry as an effective, scalable, and reliable diagnostic tool, particularly in scenarios where traditional clinical assessments may be impractical. The consistent and comparable performance of photographic examinations underscores their value in modern dental practice and their capacity to expand access to care in underserved or remote areas.

DISCUSSION

Table 1 provides a detailed summary of the study's main findings, which are discussed throughout this section.
The present study evaluated the diagnostic agreement, accuracy, and reliability between traditional clinical dental screening using DMFT (Decayed, Missing, Filled Teeth) scores and teledentistry methods. The sample comprised 145 participants, with the majority being female. This gender distribution might be attributed to the common practice of mothers or grandmothers accompanying children to medical and dental appointments. The study's primary focus was to assess whether teledentistry could be a reliable alternative to conventional dental screening methods, especially in identifying dental caries, tooth loss, and restorations.

Five datasets were analysed in the study, comparing different combinations of clinical and photographic dental examinations. The first three datasets involved 145 observations each, comparing clinical examinations by one examiner against photographic examinations by either the same or a different examiner. The last two datasets involved 14 observations each, comparing repeated photographic examinations by the same examiner to assess reliability. These comparisons aimed to evaluate the consistency and agreement between traditional clinical methods and teledentistry approaches in dental diagnostics.

The Cohen Kappa Statistic was employed to measure the degree of agreement between the different examination methods and examiners. The results revealed high levels of concordance across all datasets, with Kappa coefficients ranging from 0.84 to 0.95. These values indicate a strong agreement, classified as "Almost Perfect Agreement," between the clinical and photographic examination methods. This high level of agreement suggests that teledentistry can be as reliable as traditional dental screening for diagnosing dental conditions.

Specifically, the inter-rater reliability between different examiners (Examiner 1 and Examiner 2) using clinical and photographic methods was high, with a Kappa coefficient of 0.84. This suggests that both examiners were consistent in their evaluations, regardless of whether they used clinical or photographic methods. The reliability was even higher when the same examiner conducted both the clinical and photographic examinations, as seen in the Kappa coefficient of 0.94 for intra-rater reliability. This finding implies that individual examiners maintain a high level of consistency in their assessments over time, further supporting the reliability of teledentistry.

In cases where the same examiner used photographic methods on separate occasions, the Kappa coefficients were slightly higher, around 0.95. This could indicate that within a smaller sample size, the consistency of photographic examinations might be even more pronounced. However, further research with larger samples would be necessary to confirm this observation.

The Pearson correlation coefficients, which measure the linear relationship between two sets of data, were also calculated for the various comparisons. The coefficients exceeded 0.90 for most datasets, indicating a strong correlation between clinical and photographic DMFT scores. This strong correlation further supports the reliability of teledentistry as a diagnostic tool. The study found no statistically significant differences between the clinical and photographic methods, as indicated by p-values greater than 0.05 across all datasets. This lack of statistical significance suggests that both methods are equally reliable for DMFT evaluations.

The results of this study are particularly relevant in the context of oral healthcare in Africa, where there is a high burden of oral diseases and limited access to dental care. The World Health Organization (WHO) reported that the African region had the highest increase (120%) in caries in permanent teeth

www.sada.co.za / SADJ Vol. 81 No.1
https://doi.org/10.17159/sadj.v81i01.21030

between 1990 and 2019. An estimated 480 million people in Africa, or 43.7% of the population, suffered from some form of oral disease in 2019. This burden is disproportionately borne by vulnerable and low-income populations, who often lack access to essential dental services. In South Africa, the prevalence of dental caries is alarmingly high, particularly among children. Kimmie-Dhansay et al. (2022) highlighted the increasing prevalence of dental caries in the country, particularly in underserved populations. South Africa faces significant disparities in access to healthcare, exacerbated by socioeconomic inequalities. Despite being an upper-middle-income country, with a population of 59.62 million, a large proportion of the population relies on public healthcare services, which are often under-resourced and overburdened.

The use of teledentistry presents a promising solution to address these challenges by providing remote access to dental consultations and improving the early detection of dental conditions. The present study findings suggest that teledentistry can serve as a reliable alternative to traditional dental screening methods, particularly in areas with limited access to dental care. By utilizing technology, teledentistry can bridge the gap in healthcare access, allowing for earlier diagnosis and treatment of oral diseases, which is crucial in preventing the progression of dental conditions and reducing the overall burden of oral disease. Moreover, the implementation of teledentistry aligns with the goals of South Africa's upcoming National Health Insurance (NHI) system, which aims to provide equitable access to quality healthcare for all citizens, regardless of their socioeconomic status. Teledentistry could play a vital role in the NHI's success by streamlining dental care delivery, reducing waiting times, and ensuring that dental services reach even the most remote and underserved populations. This aligns with the broader goal of universal health coverage (UHC) and the integration of oral health into primary healthcare.

The present study underscores the potential of teledentistry as a reliable and valid alternative to traditional dental screening methods. The high levels of agreement and strong correlation between clinical and photographic DMFT scores affirm its capability to accurately diagnose dental conditions, particularly in regions with limited access to dental care. In the context of South Africa's ongoing efforts to implement the National Health Insurance (NHI), teledentistry could play a pivotal role in enhancing equitable access to oral healthcare across diverse populations. By integrating technology, this approach has the capacity to transform dental care delivery, improving oral health outcomes while reducing the prevalence and burden of dental diseases in resource-constrained settings.

The findings further establish that standardized photographic methods yield accurate representations of clinical scenarios, validating teledentistry as a robust alternative for remote dental assessments. The study emphasizes the method's accuracy, consistency, and reliability, showcasing its viability for routine dental consultations, particularly in underserved areas. By employing consistent evaluation protocols, teledentistry demonstrates its effectiveness in bridging the gap between traditional care and remote access, highlighting its applicability in public health strategies aimed at improving oral health equity. These results present compelling evidence that teledentistry can serve as a scalable solution for addressing dental care disparities, offering a cost-effective, efficient, and sustainable model for delivering oral health services.

RECOMMENDATIONS

The implementation of teledentistry in South Africa presents a promising opportunity to enhance oral healthcare access, particularly in underserved and remote areas. Key recommendations for successful integration include regulatory measures, technical infrastructure, skill development, socioeconomic considerations, partnerships, funding, and incorporating teledentistry into the National Health Insurance (NHI) system.

Regulatory measures should be promulgated in collaboration with the Health Professions Council of South Africa (HPCSA) to establish legal frameworks, licensure requirements, and standards for teledentistry. Data privacy must be ensured by using secure, encrypted platforms, and quality assurance measures should cover equipment standards, data preservation, and skill training.

With regard to technical infrastructure requirements, it will be essential to begin in areas that have adequate internet access and to forge partnerships with telecommunication providers to expand services to remote regions. Reliable and user-friendly platforms, high-resolution intraoral cameras, and integration with existing electronic health records are critical. Furthermore, enhancement of technical skills is vital, and will require thorough training for dental professionals and educating patients about teledentistry services. In addition, socio-economic factors must be addressed by developing affordable service models, considering government subsidies, and ensuring cultural and linguistic inclusivity.

Collaborations and funding through public-private partnerships, domestic and international sources, and pilot programs will be essential to assess and expand the field and outreach of teledentistry. Teledentistry can be a useful tool for oral disease surveillance, providing early detection and ongoing monitoring. Integrating teledentistry into the NHI system is crucial, and healthcare facilities need to be equipped with necessary tools like smartphones and intraoral mirrors.

CONCLUSION

Teledentistry offers a ground-breaking solution to the most pressing challenges in oral healthcare, including geographic and economic barriers that limit access to care. By enabling remote screenings and consultations, it addresses delays in diagnosis, promotes early intervention, and streamlines treatment planning. The present study highlighted the transformative potential of teledentistry to revolutionize dental care delivery, particularly in underserved and resource-limited areas.

Through its integration into healthcare systems, teledentistry provides a reliable, technology-driven approach to bridging service gaps and enhancing oral health equity. By reducing logistical barriers, it ensures timely access to care, improving diagnosis and treatment outcomes for populations traditionally excluded from regular dental services.

The findings of the present study reinforce teledentistry's capacity to redefine oral healthcare delivery. By leveraging accessible and adaptable technology, it offers a sustainable pathway to enhance the efficiency and reach of dental care. In underserved areas, teledentistry holds the promise of transforming dental service provision, ensuring that critical oral health needs are met effectively and equitably. This

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innovative approach not only improves patient outcomes but also addresses systemic barriers, fostering a future where high-quality oral healthcare is universally accessible.

CONFLICT OF INTEREST

The authors declare that the manuscript was created without any commercial or financial associations that may give rise to a conflict of interest.

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www.sada.co.za / SADJ Vol. 81 No.1
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Design and Implementation of the Oral Medicine South Africa Registry: Epidemiology of Oral Lesions at three tertiary academic facilities in the Western Cape, South Africa

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ABSTRACT

Background

There is a dearth of information on the epidemiology of oral lesions in South Africa. Knowledge of the characteristics and distribution of oral lesions in South Africa has many practical and research-related implications.

Methods

This is a cross-sectional, retrospective analysis of patients presenting to the Tygerberg, Mitchells Plain, and Groote Schuur Oral Medicine Clinics from 2010- 2022. Data is obtained from collating histopathological reports and from a review of patients' folders. A REDCap® database was created for the project.

Results

A total of 2021 patients and 2085 biopsy specimens were added to the database. The average age of patients is 42.8 years with a standard deviation of 19.7 (range: 1 month-89 years). Of these, 1087/2021 (53.7%) are women and 786/2021 (38.9%) are men (male: female ratio 1:1.4). The five most observed oral conditions are fibroepithelial hyperplasia 397/2085 (19%), squamous cell carcinoma 285/2085 (13.7%), pyogenic granulomas 199/2085 (9.5%), mucoceles 175/2085 (8.4%), and benign human papilloma virus-induced lesions 120/2085 (12.2%).

Conclusion

This study assisted with the creation of the REDCap®-based database. The reported frequencies of the most prevalent diagnoses are similar to those found in studies from comparable populations. Further research could determine risk factors associated with the diverse pathological diagnoses.

Keywords

Oral lesions; Oral medicine registry; Epidemiology; Public oral health; South Africa; Clinical informatics.

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INTRODUCTION

Oral medicine (OM) is a dental specialty comprising of the clinical diagnosis and treatment of patients presenting with conditions of the oral and maxillofacial region. It includes managing medically complex patients, who present with various benign or malignant oral lesions.[1]

Studies have reported on the prevalence of oral medicine pathology, which ranges between 10-81.3%.[2, 3] Generally, malignant tumours comprise a small portion of lesions, despite, being the most researched. The prevalence rates of OM lesions have significantly varied. Additionally, lesions have often been stratified by aetiology, site or description. The lack of standardization, results in misrepresentation of the prevalence of lesions. There is a dearth of information on lesions in South Africa. Additionally, there are no standardised clinical record forms and electronic platforms.

The primary objective of this project is to develop Oral Medicine Registry of South Africa (ORMSA) database, to record the epidemiology of oral pathology. The second objective is to determine the spectrum of histological diagnoses from OM specimens taken at UWC dental faculty.

LITERATURE

The Fifth World Workshop in Oral Medicine outlined the core clinical competencies of the specialty, which include the diagnosis and management of oral mucosal diseases, salivary gland dysfunction, oral manifestations of dermatologic and systemic conditions (including HIV, gastrointestinal and rheumatologic disorders), as well as the evaluation and treatment of facial pain.[4] However, the scope of OM is geography specific. In South Africa, the scope of OM is the diagnosis and management of diseases, disorders and anomalies affecting the oral and periodontal tissues, and the manifestations of systemic diseases.[5]

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Obtaining a diagnosis in OM involves history taking, examinations, and appropriate diagnostic tests.[6] Diagnostic tests used include biopsy, radiographs salivary tests, bacterial and viral cultures, and blood tests.[7] The gold standard of diagnosing pathology is the histopathological examination of biopsies. Oral biopsy techniques include incisional, excisional, punch, and brush biopsies. The choice of technique depends on the size and location of the lesion, accessibility, and the clinician's preference.[8] In incisional biopsies, only a portion of the lesion is removed. This technique, which uses a scalpel or soft tissue punch, is preferred in large lesions or involves a critical structure.[8] In punch biopsies, a small cylindrical piece of tissue is removed.[8]

In excisional biopsies, the entire lesion is removed[8] This technique is used for small, benign and accessible lesions. In brush biopsies, cells are collected from the lesion's surface, and is used for superficial lesions or those that are difficult to access.[8] Fine Needle Aspiration (FNA) is a minimally invasive procedure, which is often done in combination with clinical evaluation, imaging, histopathology, and molecular testing of salivary gland lesions.[9] A thin needle is inserted under anaesthesia into the gland, and cells are aspirated.[9] Recent advancements in biopsy procedures, include laser biopsy and molecular techniques.

The National Health Laboratory Service (NHLS) is the largest South Africa diagnostic pathology service. TrakCare is a laboratory information system (LIS) and DisaLab is an NHLS legacy LIS (10). The Corporate Data Warehouse (CDW), is a national health repository in South Africa; containing data from DISALAB and TrakCare. Our study utilised data from CDW and REDCap® to create a real-time clinical database.

Existing literature on oral medicine epidemiology is limited in its relevance to South Africa, as most studies focus on individual conditions or lesion types, rely on clinical surveys or screening data, and are often restricted to specific age groups. A Kuwaiti study over 18 years, found that the most common diagnostic category was mucosal pathologies 205/ 697 (29.4%), odontogenic cysts 158/ 697 (22.7%) and reactive lesions 97/ 697 (13.9%).[11] The three most common histopathological diagnoses were hyperkeratosis 70/697 (10%), dentigerous cysts 48/ 697 (6.8%), and mucoceles 44/ 697 (6.3%).[11] Twenty-five malignant neoplasms were diagnosed; the majority in males. A significant association was found between the patient's age and the diagnosis ($P \leq 0.001$). The greatest incidence of oral lesions was in patients in the fourth decade and malignant lesions were more common in those >50 years.[11] The study found that the mean age per diagnostic category was (in years): malignant tumour (51), mucosal pathology (45), reactive lesions (40), connective tissue disease (40), dental pathology (36), bone pathology (34), odontogenic cysts (30), odontogenic tumour (24) years and salivary gland disease (28).[11] In a five-year Nigerian study of 242 biopsies; most oral lesions were located peripherally or centrally on the mandible and were mainly benign. The most common benign lesion was ameloblastoma 35/ 242 (14.5%), whereas the most common malignant lesion was squamous cell carcinoma (SCC) 19/ 242 (7.8%).[12]

A 2014 South African Study included 1,258 biopsies of children <16 years in the Maxillofacial and Oral Surgery (MFOS) department.[13] From the maxillofacial pathologies, pathology affecting the jaw bones made up the largest group, with odontogenic cysts and tumours predominating.[13] The remaining pathology affected the oral/perioral soft tissues, salivary glands, and oral mucosa. Of these, 4.1% were malignant, with Burkitt's lymphoma was the most prevalent.[13] In a 2022, self-administered survey of 26 South African OM specialists, respondents estimated the most frequently observed lesions were immune-mediated diseases (29.3%), and benign reactive neoplasms (26.5%). Respondents stated that chemosensory disorders, accounted for 1.5% of daily patients, and oral mucosal disease, accounted for 2.5% of lesions and conditions. There are a dearth and variability of data, within a global and within the SA context.

The primary objective of this article is to develop a REDCap® database for recording OM pathology at clinics managed by UWC. A retrospective, prevalence study will assist clinicians with differential diagnosis, specify the relative prevalence of oral pathology and allow for data extrapolation. Epidemiological information will also guide the academic curriculum and assist with health resource planning and allocation. The findings will contribute to strengthening public health prevention programmes and public health education.

METHODS

Aim

To establish a database and to determine the range and frequency of oral medicine pathology.

Objectives

1. To create an oral medicine database
2. To provide an epidemiological description of oral medicine pathology
3. To compare findings with similar studies

Design

This study was a retrospective cross-sectional analysis of patients presenting to the Oral Medicine and Periodontology department, between 1 January 2010-1 January 2022.

Sampling

The study enrolled all consecutive biopsied patients, presenting to presenting to the Oral Medicine and Periodontology department,1 January 2010-1 January 2022.

Inclusion criteria

All histological reports and patient files were included. The study sites included: Groote Schuur Hospital (GSH), Tygerberg Oral Health Centre (TBOHC) and Mitchells Plain Oral Health Centre (MPOHC) from; 1 January 2010- 1 January 2022.

Exclusion criteria

Records were excluded only when they contained almost no usable clinical information, meaning that key diagnostic, treatment, and demographic fields were missing. Records that had partial but still analysable information, for example, where at least one of the primary variables of interest was available, were retained to preserve the completeness and representativeness of the dataset. The study excluded duplicate entries.

Database/registry creation and data collection and validation
Study data were managed using UWCs REDCap® electronic data capture tool. The REDCap® platform registered the project, and the online designer tool customized the data capturing tools, as a collection of forms. These records were used to capture the required data elements once role-based access was assigned and input data was verified.

www.sada.co.za / SADJ Vol. 81 No.1
https://doi.org/10.17159/sadj.v81i01.21559

Data Analysis

Data were exported to Microsoft Excel, and were cleaned and analysed on STATA 14 *(StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.* Descriptive statistics were primarily used to summarize and present the data. Measures such as percentages, ratios, and proportions were calculated to describe the demographic characteristics, biopsy techniques, lesion types, and anatomical distribution of biopsies.

RESULTS

A total of 2021 patients were included, which was less than the total number of investigations (2085), indicating that in some cases more than one biopsy was taken for a patient. The average age of patients was 42.8 years, SD of 19.7 (range: 1 month-89 years). From the sample, 1087/2021 (53.7%) were women and 786/2021 (38.9%) were men (male: female ratio 1:1.4). The average age for females was 42.7 ± 19.6 (SD), and the average age for males was 43.3 ± 20.3 (SD). **Figure 1** shows the number of males, females and sex not recorded in the study. From the population; 1276/ 2021 (63.1%) of biopsies were taken at TBOHC, 545/ 2021 (26.9%) at GSH, and 200/ 2085 (9.9%) presented to MPOHC.

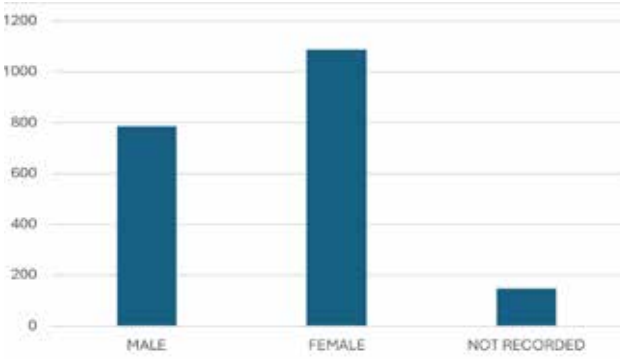

Figure 1. Males, females and sex not recorded in the study (N=2021)

The most common biopsy technique was excisional biopsy 1283/ 2085 (61.5%). The most frequent lesions observed were fibrous hyperplasia, 374/ 2085 (17.9%); and SCC 284/ 2085 cases (13.6%), pyogenic granuloma 191/ 2085 (9.1%), and mucoceles, 167/ 2085 (8%). The prevalence of the lesions according to diagnostic categories is demonstrated in **Table 1.** The majority of OM conditions were classified as inflammatory/ reactive lesions 1208/ 2085 (57.9%). Epithelial and soft tissue neoplasms constituted 388/ 2085 (18.6%) specimens and normal tissue was observed in 223/ 2085 (10.7%) specimens. Inflammatory periapical lesions were found in 11/ 2085 (0.5%) specimens, developmental lesions 6/ 2085 (0.3%), and benign bone lesions 4/ 2085 (0.2%).

Table 1. Distribution of the lesions according to diagnostic categories, N=2085

Diagnostic Category	No	%
Inflammatory/ Reactive lesions	1208	57.9
Epithelial and soft tissue neoplasms	388	18.6
Normal tissue	164	7.8
Potentially malignant lesions	123	5.8
Autoimmune lesions	87	4.2
Odontogenic tumours	54	2.6
Odontogenic cysts	24	1.2
Pigmented/ melanotic lesions	16	0.8
Inflammatory periapical lesions	11	0.5
Developmental lesions	6	0.3
Benign bone lesions	4	0.2
TOTAL	2085	100%

In our study, the gingiva 547/ 2085 (26.2%), the tongue 495/ 2085 (23.7%) and the buccal mucosa 326/ 2085 (15.6%) were the most frequently biopsied sites. The floor of the mouth was the least frequently biopsied site 31/ 2085 (1.5%) and 103/ 2085 (4.9%) biopsies did not have a site specified.

Figure 2 shows the distribution of biopsy sites.
There were 335/ 2085 (16.1%) malignant lesions of the oral cavity. The majority of malignant lesions were SCC 285/ 2085

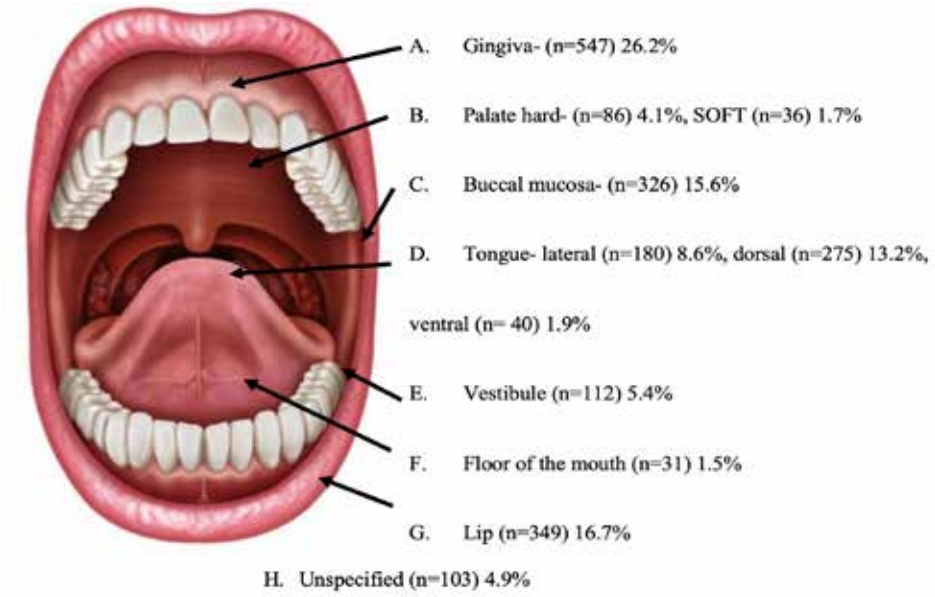

Figure 2. The intra-oral locations of biopsies taken (n = 2085), *Stock image (Luengo, 2023) †

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Table 2. Benign lesions of the oral cavity, N=977

Diagnosis	Total (n)	% group (n/N)	%total (n/2085)
Fibroepithelial hyperplasia/ polyp	396	40.5	19.0
Pyogenic granuloma	199	20.4	9.5
Total HPV induced lesions	120	12.3	5.8
Squamous papilloma's/ unspecified	96	9.8	4.6
Focal epithelial hyperplasia	16	1.6	0.8
Verruca vulgaris	7	0.7	0.3
Condyloma acuminatum	1	0.1	0.0
Lipoma	27	2.8	1.3
Peripheral odontogenic fibroma	27	2.8	1.3
Traumatic fibroma	24	2.5	1.2
Ameloblastoma	20	2.0	1.0
Giant cell fibroma	22	2.3	1.1
Haemangioma	13	1.3	0.6
Pleomorphic adenoma	10	1.0	0.5
Benign giant cell tumours	8	0.8	0.4
Post extraction granuloma (granulation tissue)	7	0.7	0.3
Neurofibroma	7	0.7	0.3
Traumatic Ulcerative Granuloma with Stromal Eosinophilia	7	0.7	0.3
Peripheral ossifying fibroma	6	0.6	0.3
Benign vascular neoplasms	5	0.5	0,2
Fibro- osseous lesions	5	0.5	0,2
Leiomyoma	5	0.5	0.2
Seborrheic keratosis	5	0.5	0.2
Cemento-ossifying fibroma	4	0.4	0.2
Melanotic macule	4	0.4	0.2
Oral focal mucinosis	4	0.4	0.2
Three occurrences: Canalicular adenoma, Denture fissuratum, Lymphangioma, Granular cell tumour, Melanotic hyperplasia, Fibromatosis	18	1.8	0.9
Two occurrences: Osteoma, Melanocytic naevus, Odontoma, Oral focal granulomatosis, Cemento osseous dysplasia, Fibrous dysplasia, pigmented incontinence, amalgam tattoo, drug induced gingival overgrowth, Odontogenic myxoma, Traumatic neuroma	22	2.3	1.1
One occurrence: Verruciform xanthoma, Schwannoma, Basal cell adenoma, Benign mesenchymal neoplasm, Myoepithelioma, Smooth muscle neoplasm, Osseous choristoma, Peripheral dentinogenic ghost cell tumour, Hematoma, Graphite tattoo, Frictional keratosis, Basaloid salivary gland neoplasm	12	1.2	0.6
TOTAL	977	100%	46.7%

www.sada.co.za / SADJ Vol. 81 No.1
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Table 3. Malignant lesions of the oral cavity, n=335

Diagnosis	Total (n)	% group (n/N)	%total (n/2085)
Squamous cell carcinoma	285	85.1	13.7
Lymphomas	12	3.6	0.6
Kaposi's sarcoma	10	3.0	0.5
Adenoid cystic carcinoma	7	2.1	0.3
Polymorphous low-grade adenocarcinoma	5	1.5	0.2
Basal cell carcinoma	4	1.5	0.2
Clear cell carcinoma	3	1.2	0.2
Carcinoma in situ	2	0.9	0.1
Mucoepidermoid carcinoma	2	0.6	0.1
One occurrence: Malignant melanoma, Malignant epithelial neoplasm, Osteosarcoma, Sarcoma, Verrucous carcinoma	5	0.6	0.1
TOTAL	**335**	**100%**	**16.1%**

(13.7%), which constituted 285/ 335 (85.1%) of malignant lesions. Lymphomas accounted for 12/ 335 (3.6%) and Kaposi sarcoma accounted for 10/ 335 (3%) of malignant lesions. Table 3 presents all malignant lesions identified in the dataset, with squamous cell carcinoma being the most frequently observed diagnosis.

There were 123/ 2085 (5.9%) Oral Potentially Malignant disorders (OMPDs). Of these, 81/ 123 (65.9%) specimens were oral lichenoid disorders. Dysplastic epithelial lesions accounted for 18/ 123 (14.6%) of lesions. Of these; moderate dysplasia accounted for 10/123 (8.1%), severe dysplasia 5/ 123 (4%) and mild dysplasia 3/ 123 (2.4%). Table 4 provides the totals and percentages of OPMD lesions found among the specimens. It was found that 18/ 2085 (1%) of biopsy specimens were labelled as being 'dysplastic'. Although epithelial dysplasia is not considered a malignancy, it is an OPMD. From these: moderate epithelial dysplasia accounted for 10/ 2085 (0.5%), severe epithelial dysplasia 3/ 2085 (0.1%) and mild epithelial dysplasia 3/ 2085 (0.1%).

There were 235/ 2085 (11.3%) cysts of the jaw and oral tissue. Of this 175/ 235 (74.5%) were mucoceles, 11/ 235 (4.7%) were radicular cysts, 8/ 235 (3.4%) were ranulas and there were 8/ 235 (3.4%) unspecified odontogenic cysts of inflammatory origin. There were 175/ 2085 (8.4%) inflammatory lesions. Non-specific ulcers accounted for 67/ 175 (38.3%) of inflammatory lesions, 33/ 175 (18.9%) were chronic inflammation and 12/ 165 (6.9%) were subacute inflammation. There were 164/ 2085 (7.8%) specimens that were normal mucosa or non-diagnostic specimens. Of this, 110/ 164 (67.1%) had a non-specific histology. There were 36/ 164 (21.9%) lesions that were classified as normal, and 18/ 164 (11%) specimens had no results.

DISCUSSION

In 12-years, 2085 specimens were biopsied OM department at three surveillance sites (174 specimens/ year). This indicates that a high volume of oral biopsies was submitted when compared with another study (64 specimens/ year). [14] The male to female ratio (1:1.4) of the study is comparable to a UK study of 44, 007 biopsies over 30 years.[15] The mean age was 42.8 years, SD of 19.7 (range: 1 month-89 years). Forty-three records were omitted due to missing clinical and TrakCare data.

In our study, the gingiva 547/ 2085 (26.2%), the tongue 495/ 2085 (23.7%) and the buccal mucosa 326/ 2085 (15.6%) were the most frequently biopsied sites. A 10-year Indian study found the most common site of lesions were

Table 4. Potentially malignant disorders, n= 123

Diagnosis	Total (n)	% group (n/N)	% total (n/2085)
Oral Lichenoid Disorders	81	65.9	3.9
Chronic hyperplastic candidiasis	12	9.8	0.6
Moderate epithelial dysplasia	10	8.1	0.5
Actinic keratosis	9	7.3	0.4
Severe epithelial dysplasia	5	4.1	0.2
Mild epithelial dysplasia	3	2.4	0.1
One occurrence: Erythroplakia, Erythroleukoplakia, Proliferative Verrucous Leukoplakia	3	2.4	0.1
TOTAL	**123**	**100%**	**5.9%**

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the tongue (18.8%), lips (15.9%) and floor of the mouth (15.5%).[16] The floor of the mouth was the least frequently biopsied site 31/ 2085 (1.5%), this may be because it is an anatomically difficult region.

Inflammatory and reactive lesions comprised 1208/ 2085 (57.9%) of lesions; due to the frequency of soft tissue injuries. A US review of 15,783 oral lesions over a period of 17.5 years found that fibromas, periapical granulomas, mucoceles, and radicular cysts were the most prevalent reactive lesions.[17] The study observed that 77% of lesions were inflammatory or reactive.[17] In a Turkish study, inflammatory hyperplastic lesions constituted 1,000/ 1,198 (57.7%) of lesions. Our proportion of inflammatory and reactive conditions to the sample was similar to other studies.

Epithelial and soft tissue neoplasms accounted for 388/ 2085 (18.6%) of lesions. This was more than was recorded in a Saudi Arabian teaching hospital 106/ 1218(8.7%) (18). This may be due to differences in regional classifications. Normal tissue was observed in 164/ 2085 (7.8%) specimens and autoimmune conditions were found in 87/ 2085 (4.2%) specimens. The prevalence of oral mucosal involvement in immune-mediated disorders varies according to the disease. Oral lichen planus, mucous membrane pemphigoid, erythema multiforme and pemphigus vulgaris were previously found to be the most common immune-mediated disorder affecting the oral cavity.[19] Interestingly, oral medicine specialists estimate that autoimmune disorders (29.3%) and benign reactive neoplasms (26.5%) are managed the most frequently in their clinics.[5] In our study, autoimmune disorders accounted for 4.2% of lesions and reactive lesions accounted for 57.9% of pathology. There could be many reasons for this discrepancy including the inclusion of private practice experiences, recall bias, regional variations and referral patterns.

There are significant regional differences in the prevalence of odontogenic tumours. While they comprise 1% of oral pathology in North America, it is 19% in African countries. [20, 21] The prevalence rates of odontogenic cysts, is region specific and ranges from 3.4%- 54.6%.[22, 23] In our study, odontogenic cysts amounted to 24/ 2085 (1.2%) of lesions. This may not reflect the true prevalence of odontogenic cysts, as lesions are often diagnosed based on clinical presentation and radiology

Pigmented/ melanotic lesions account for 16/ 2085 (0.8%) biopsies. This is similar to a retrospective cross-sectional study conducted in Thailand, where pigmented lesions were .observed in 241/ 45175 (0.5%) of lesions diagnosed over 20 years.[24] Another study found that oral pigmented lesions were present in 386/ 1275 (30.2%) patients.[25]

The relatively low numbers of inflammatory periapical lesions (11/2085; 0.5%), developmental lesions (6/2085; 0.3%), and benign bone lesions (4/2085; 0.2%) reflect the fact that these conditions are primarily diagnosed and managed by the Maxillofacial and Oral Surgery (MFOS) department rather than the Oral Medicine department.

The majority of diagnoses were benign 977/ 2085 (46.8%). Fibroepithelial hyperplasia/ fibroepithelial polyps were the most common lesions 396/ 977 (40.5%); similar to a studies that assessed histologically diagnosed oral lesions.[26] Malignant lesions accounted for 335/ 2085 (16.1%) biopsies. SCC was the most common malignancy, appearing mostly on the tongue and lower lip. In our study SCC amounted to 285/ 335 (85.1%) of malignant lesions (13.7% of total). This was higher than in another study where SCCs accounted for 5.4% in 2675 specimens.[27]

Oral lichen planus and oral lichenoid reactions were grouped as oral lichenoid diseases (OLD). OLDs accounted for 81/ 123 (65.9%) of OPMDs and 81/ 2085 (3.9%) of the total. This finding is similar to 3.5% found in 12068 participants of the Northern Finland Birth Cohort (28). Chronic hyperplastic candidiasis (CHC) was found in 12/ 123 (9.8%) of OPMDs and 12/ 2085 (0.6%) of all biopsies.

Mucoceles 175/ 235 (74.5%) were frequently observed, representing 175/ 2085 (8.6%) biopsies. A study showed that inflammatory/reactive lesions are the most common category with mucocele being the most frequent pathology. [27, 29] Radicular cysts accounted for 9/ 2085 (3.8%) of cysts; fewer than a Turkish prevalence study, which found that radicular cysts 216/ 475 (45.5%) and dentigerous cysts 77/ 475 (16.2%) were the most prevalent lesions.[30]

Non-specific ulcers accounted for 67/2085 (3.2%), chronic Inflammation 33/2085 (1.6%) and subacute inflammation 12/2085 (0.6%), respectively. There were 18/ 2085 (0.8%) nondiagnostic specimens. Reasons for non-diagnostic samples may include sampling errors, insufficient diagnostic material, obscuring inflammation, artifacts and diagnostic discordance.

Candidiasis accounted for 7/ 19 (36.8%) of cases, tuberculosis 3/ 19 (15.8%), 3/ 19 syphilis cases (15.8%) and 3/ 19 (15.8%) were non-specific fungal diagnoses. The number of candida lesions may be an underrepresented, because lesions are rarely biopsied.

LIMITATIONS

There were many constraints of the study that affected sample generalizability and representativity. We discovered that specimens from the MPOHC were grouped together with specimens from TBOHC, due to logistical arrangements. We thus could not differentiate specimens, limiting our geographic analysis of the distribution of lesions. We were also not able to access physical files from patients who attended the MPOHC and GSH OM clinic. We reported on oral pathology that may lie outside the scope of OM in South Africa, due to the grouping specimens together at facilities. We excluded oral pathology diagnosed by other departments, and other facilities.

The dental faculty keeps files for five years; thereafter files are discarded- thus it was impossible to capture records of patients who presented at the sites. Additionally, due to incomplete and missing data, patient files were excluded from the research during the data gathering procedures.

Direct comparisons of oral lesion prevalence are difficult due to regional differences in classifications, and differences in the scope or OM practitioners and MFOS. Despite the drawbacks, the results of this study are consistent with the literature.

CONCLUSION

This study led to the design of a REDCap®-based ORMSA database. Pilot results indicate that the majority of diagnoses were benign and inflammatory/. The reported frequencies of the most prevalent diagnoses were similar to those

www.sada.co.za / SADJ Vol. 81 No.1
https://doi.org/10.17159/sadj.v81i01.21559

found in studies, with minor variations. Further research could determine risk factors associated with the diverse pathological diagnoses.

This study advocates implementing the routine use of the REDCap® based ORMSA record system and computerizing patient records. It further recommends the minimum set of variables required to provide a clinic-pathological derived diagnosis.

Supporting Information
Supporting Information is available from the Wiley Online Library or from the author.

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Ethical Approval

Approval was obtained from UWCs Research and Ethics Committee (BM21/6/25), the National Health Research directorate and the National Health Laboratory Services (PR2225921).

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The authors declare no conflict of interest.

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CPD questionnaire on page 52

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

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Antibiotics in Dentistry: To Prescribe Or Not To Prescribe? That Is The Question.

SADJ FEBRUARY 2026, Vol. 81 No.1 P31-P34
Y Rampersad[1], V Premviyasa[2]

ABSTRACT

Background
Established principles form the basis of guidelines for the effective usage of antibiotics in dentistry. These standards have been demonstrated to be effective in eradicating and controlling odontogenic infections. Yet, anecdotal evidence suggests that these well-established guidelines are often ignored by dentists. This study sought to assess trends in antibiotic prescribing among dentists.

Aim
To analyse the antibiotic prescribing patterns among dentists and evaluate dentists' views on antibiotic resistance.

Methodology
This cross-sectional analysis examined antibiotic prescribing patterns among registered dentists in the Durban metro region, South Africa, in 2022. A sample size of 183 participants was calculated, and a survey was electronically distributed to 210 dentists via closed dental groups. Responses were recorded in Microsoft Forms, captured in Excel, and analysed using Stata.

Results
A survey of 210 participants yielded 91 responses. Amoxicillin was the most frequently prescribed antibiotic (48%), with clindamycin as the common alternative for penicillin allergies (58%). The majority prescribed antibiotics for at least five days, with 89% citing facial swelling as the primary indication. Over half (57%) reported no adverse effects, while 80% acknowledged their contribution to antibiotic resistance, and 71% identified unclear guidelines as a factor in inappropriate prescribing.

Conclusion
This study highlights that dentists in South Africa continue to prescribe antibiotics contrary to evidence-based guidelines. Ongoing monitoring and research are crucial for developing clear, evidence-driven guidelines that encourage responsible antibiotic use in dental practice.

Keywords
Antibiotics, dentistry, antibiotic resistance, overuse, antibiotic prescribing patterns, dental prescribing behaviour, guidelines, South Africa.

Introduction
Antimicrobial resistance (AMR) is the ability of microorganisms, including bacteria, viruses, protozoa, fungi, archaea, and algae, to resist treatment. AMR has become a global health crisis, causing approximately 700,000 deaths annually. Without effective interventions, projections suggest that AMR could result in up to ten million deaths per year by 2050.[1]

Antibiotic resistance (ABR), a subset of antimicrobial resistance (AMR), refers specifically to bacterial resistance to antibiotics. ABR is a significant global threat, leading to longer hospital stays, higher mortality rates, and difficulty managing even simple infections. This also has severe economic implications, with global losses projected at $100 trillion by 2050. The overuse and misuse of antibiotics, including their accessibility for self-medication and inappropriate prescribing by healthcare professionals, are primary drivers of resistance.[1,2]

In response, the World Health organisation (WHO) developed a global action plan in 2015 to improve antimicrobial stewardship, focusing on raising awareness of AMR, reducing infection rates, and optimizing antimicrobial use.[2] Although resistance is a natural biological process, evidence shows that excessive antibiotic use accelerates resistance, making infections such as pneumonia, gonorrhea, and tuberculosis harder to treat. This issue is further compounded by stagnation in the development of new antibiotic classes since the 1980s.[2,3]

Dentists contribute significantly to the global antibiotic burden, with an estimated 10% of all antibiotic prescriptions originating from dental practices. Alarmingly, studies indicate that approximately 80% of dental antibiotic prescriptions do not align with established guidelines. Between 2000 and 2015, global antibiotic use surged by 91%, with a particularly rapid increase in low- and middle-income countries.[4]

Although antibiotic stewardship programs are prevalent in medical settings within high- and middle-income nations, there is a paucity of data regarding antibiotic use in lower-income countries, and even less so in the dental field. Recent studies in England, for example, have shown a rise in dental

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Authors Contributions
Dr Yuvti Rampersad – Contribution: Writing of article and principal researcher: 80%
Dr Vinayagie Premviyasa – Contribution: Advisory supervisor: 20%

Conflict of interest
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antibiotic prescriptions, particularly due to the SARS-CoV-2 pandemic.[4,5]

Dentists play a critical role in combating the AMR crisis through antibiotic prescribing. While basic guidelines exist, they vary across countries. In the UK, antibiotic treatment targets therapeutic intervention, whereas in the USA, prophylactic antibiotics are commonly prescribed. The absence of standardised guidelines complicates the assessment of prescribing patterns globally, hindering international consensus on best practices.5

Antibiotic stewardship (ABS) programs are essential for monitoring dental prescribing patterns, identifying knowledge gaps, and highlighting areas for improvement. Given the rise in antibiotic resistance, evaluating the knowledge, attitudes, and prescribing behaviors of dental professionals is critical. This study, conducted in Durban, South Africa, aims to assess these factors and contribute to responsible antibiotic prescribing in dental practice.[4,5]

MATERIALS AND METHODS

Study Design and Population

Ethical approval for this study was obtained from the University of Witwatersrand Human Research Ethics Committee (Ref M210921). The study involved qualified dentists registered with the HPCSA and practicing at state owned or private institutions in the Durban metro region. A quantitative, cross-sectional study was conducted in 2022.

Data collection and analysis

The study used a pre-tested, pre-validated questionnaire adapted from a Kolkata study, constructed with Qualtrics.[6] The 15-item questionnaire covered demographics (gender, years of practice, practice type) and antibiotic prescribing trends. Data analysis was performed using IBM SPSS version 28.0, and results were presented using descriptive statistics, graphs, cross-tabulations, and figures for the quantitative data.

Results

The survey link was shared with a closed dental group of 210 participants. The response rate was 91 out of 210 participants, or 43%. Among the survey respondents, 56% were female and 44% were male. Additionally, 38.5% of the participating dentists had been practicing for 1 to 5 years post-graduation. Most respondents (75.8%) were employed in private practice settings.

Table 1: Demographic information

Gender			
	Frequency (n)	**Percent (%)**	**p-value**
Female	51	56.0	0.249
Male	40	44.0	
Total	**91**	**100.0**	
Number of years practicing after qualification			
	Frequency (n)	**Percent (%)**	**p-value**
1 – 5	35	38.5	0.512
6 – 10	26	28.6	
11 – 30	30	33.0	
Total	**91**	**100.0**	
Practice type			
	Frequency	**Percent**	**p-value**
Private practice	69	75.8	< 0.001
Academic institution	4	4.4	
Hospital dentistry	13	14.3	
Health centre	3	3.3	
Other	2	2.2	
Total	**91**	**100.0**	

Source of information on antibiotics:

The internet was the most frequently utilised source by dentists for obtaining information on antibiotics (36.3%), followed by continuous professional development (29.7%), peer-reviewed scientific literature (24.2%), and the latest editions of textbooks (9.9%), which were less commonly referenced for antibiotic-related knowledge.

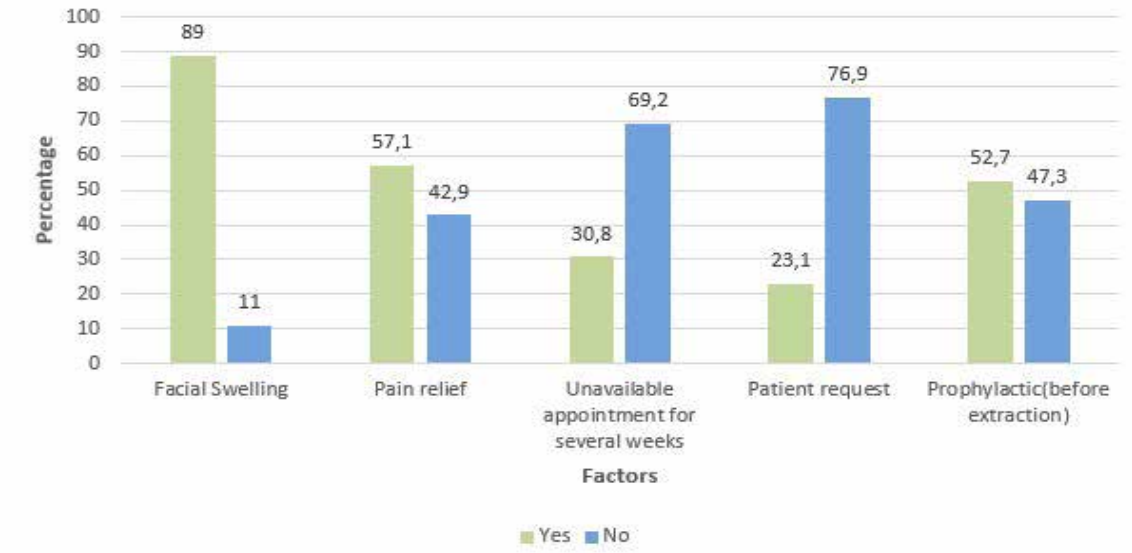

Figure I: Bar graph of reasons dentists prescribed antibiotics

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Table 2: Table of pulpal and peri-radicular conditions for prescribing antibiotics

	No		Yes		p-value
	N	N %	N	N %	
Reversible pulpitis	70	76.9%	21	23.1%	<0.001*
Irreversible pulpitis	35	38.5%	56	61.5%	0.028
Localized dentoalveolar abscess	16	17.6%	75	82.4%	<0.001*
Localized dentoalveolar abscess with draining fistula	19	20.9%	72	79.1%	<0.001*
Facial cellulitis	11	12.1%	80	87.9%	<0.001*

**p-values of <0.005 are significant.*

Most prescribed antibiotic brands; route of administration and duration:

More dentists prescribed Amoxicillin (48.4%) than Augmentin (46.2%) and fewer responders prescribed Metronidazole (2.2%) and Cephalosporins (3.3%). In patients with an allergy to Penicillin, Clindamycin was the most common drug choice (58.2%) with fewer prescribing Erythromycin (26.4%) and Azithromycin (14.3%). All dentists (100%) prescribed antibiotics orally in the form of tablets. A 5-day course was the preferred duration of prescribing antibiotics (78%), compared to 7-days (10%), 10-days (4%) and 3-days (8%).

Reasons for prescribing antibiotics:

Antibiotics were most prescribed by dentists for facial swelling (89%), followed by pain relief (57.1%) and as prophylaxis prior to extractions (52.7%). Fewer dentists reported prescribing antibiotics when appointments were unavailable for several weeks (30.8%) or when patients requested them (23.1%).

Pulpal and peri-radicular conditions for prescribing antibiotics:

Facial cellulitis (87.9%) was the condition most dentists prescribed antibiotics for, localized dentoalveolar abscess (82.4%), localized dentoalveolar abscess with draining fistula (79.1%), irreversible pulpitis (61.5%), and reversible pulpitis (23.1%) were other conditions for which antibiotics were prescribed.

Prescribing antibiotics for dental trauma:

The common trauma responders prescribed antibiotics for was Replantation of a tooth after avulsion (89.0%) fewer prescribed for Subluxation (34.1%), Extrusion (33%), Lateral luxation (30.8%), Intrusion (27.5%) and Noncontaminated dental injuries (25.3%).

Antibiotic prophylaxis:

Responders prescribed antibiotics prophylactically before treatment for patients with Previous infective endocarditis (96.7%), Cardiac transplant after valvular damage (86.8%), Mitral valve prolapse with regurgitation (72.5%), Cyanotic heart disease (51.6%), Mitral valve prolapse without regurgitation (54.9%) and Rheumatoid arthritis (30.8%).

Adverse effects reported after prescribing antibiotics

More than half of dentists did not report adverse effects after prescribing antibiotics (57.1%) with less noting adverse effects (42.9%). Of those who did observe adverse effects, most noted adverse effects were nausea, vomiting and gastro-intestinal disturbances (64%); followed by hives, itching and rash (28%); while vaginal thrush (8%) being the least reported adverse effect.

Dentists' contribution to antibiotic resistance

Majority of dentists (80.2%) believed they contributed to antibiotic resistance, while 19.8% disagreed. Antibiotic resistance contribution factors were unclear guidelines, patient requests for antibiotics, poor access to information, and incorrect prescribing duration, while some dentists cited "other" reasons.

Improving prescribing methods

Current guidelines on antibiotic prescribing for South African dentists are inadequate, with a lack of routine monitoring and insufficient studies on antibiotic efficacy for specific dental conditions. Antibiotics are often misused for conditions like reversible and irreversible pulpitis, due to incorrect diagnoses

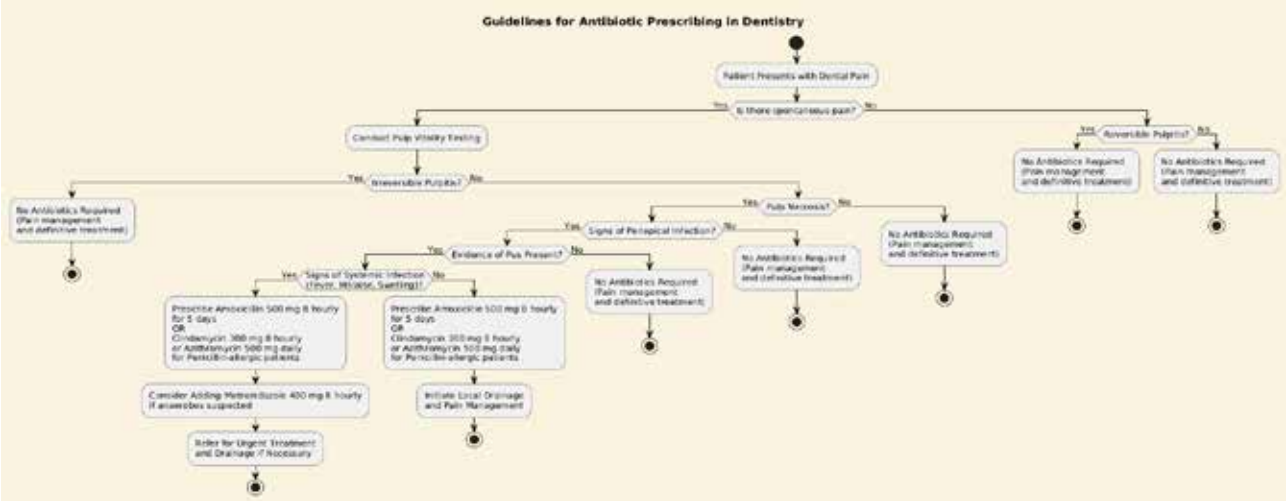

Figure II: Guidelines for antibiotic prescribing in dentistry

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https://doi.org/10.17159/sadj.v81i01.22400

and indiscriminate prescribing. This study found that 39% of dentists cited poor guidelines as a major contributor to antibiotic resistance, while 11.1% attributed incorrect pulp diagnoses. Antibiotics are not recommended for irreversible pulpitis as treatment involves root canal or extraction and antibiotics do not affect pain relief or infection resolution.[7-8] However, in this study, 61.5% of dentists prescribed antibiotics for irreversible pulpitis and 23.1% for reversible pulpitis.

A Welsh audit found 5% of antibiotics were prescribed for irreversible pulpitis. These findings align with a Saudi Arabian study showing dentists' inappropriate antibiotic use for conditions like chronic abscesses and pulpitis. Over-prescription of antibiotics, a key cause of global resistance, highlights the need for reinforced antibiotic guidelines for dentists.[7-10]

The World Health organisation (WHO) has called for national antibiotic guidelines for dentists, with easily accessible, regularly updated resources. It also recommends automatic prescription surveillance and data analysis, emphasizing the dental team's role in educating patients on antibiotics. Dentists should manage patient expectations by clarifying that antibiotics do not cure toothache, and pain relief comes from procedures, not prescriptions.[11,12] Evidence-based checklists for antibiotic prescribing are essential. For example, the Australian government developed an acronym (MINDME) to guide practitioners: Microbiology guides therapy, Indications are evidence-based, Narrowest spectrum required, Dosage appropriate, Minimize duration, and Ensure monotherapy.13 Regularly updating antibiotic prescribing knowledge is critical to combat antibiotic resistance. A guideline for South African dental students and practitioners based on established protocols has been developed to support evidence-based antibiotic prescribing, improving treatment effectiveness and minimizing inappropriate use.[14-17]

Antibiotic prescribing guidelines in dentistry vary, particularly regarding prophylactic use. Ahmadi et al. recommend antibiotics for patients with conditions such as immunocompromised patients, cancer, infective endocarditis, prosthetic joints, and valvular heart disease.[18] However, American guidelines dispute the link between dental procedures and periprosthetic joint infections, suggesting prophylactic antibiotics only for high-risk patients, such as those with poorly controlled diabetes or a history of prosthetic joint infection. [19,20] In contrast, countries like New Zealand, Canada, the Netherlands, and Australia do not recommend prophylactic antibiotics for patients with prosthetic joints.[21]

This study found that 71.4% of dentists attributed antibiotic resistance to unclear prescribing guidelines, with 47.3% citing patient pressure to prescribe antibiotics from patients. Given these inconsistencies, there is a need for internationally unified guidelines on prescribing antibiotics. Health organizations should prioritise patient education on the harmful effects of antibiotic misuse. Dentists should also inform patients about the risks and benefits of antibiotics to ensure informed consent before prescription. The latest American Heart Association guidelines on prophylaxis for patients at risk of infective endocarditis should also be considered in dental practices.[22]

CONCLUSION

Healthcare practitioners, particularly dentists, play a key role in addressing antibiotic resistance by adopting appropriate practices and educating patients. This study shows that while most dentists acknowledge their responsibility in contributing to resistance, they also cite unclear guidelines as a significant factor in inappropriate prescribing. A concerning trend is the reliance on internet resources for antibiotic prescription guidance, as well as the misuse of antibiotics for conditions like pulpitis. These practices contribute to the growing global issue of antibiotic resistance.

The study highlights the urgent need for evidence-based therapeutic guidelines in dentistry to ensure decisions are grounded in scientific evidence. Clear protocols from health authorities are necessary to encourage dentists to accurately diagnose conditions, select appropriate antibiotics, and consider patient history before prescribing. Given the rise in inappropriate prescribing, accessible, scientifically validated information should be made available to South African dentists. Further research across the country is recommended to gain a more comprehensive understanding of antibiotic prescribing patterns.

DECLARATION

There is no possible financial interest/s or incentives in products or service.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

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Biosafety practices among dental undergraduates in AIMST University: A cross-sectional study

SADJ FEBRUARY 2026, Vol. 81 No.1 P35-P39

Lim Ee Enm[1], Liew Denlee[2], Leong Suki Lew[3], Zhe Xuan[4], Vaishnavi Vedam[5]

ABSTRACT

Introduction

Biosafety practices are vital in dental education and clinical settings to prevent cross-contamination and safeguard both patients and healthcare professionals.

Aims & Objectives

This study assessed the knowledge and attitude of undergrates towards biosafety practices.

Design

A cross-sectional study was performed among 172 undergraduate dental students at AIMST University.

Methods

A self-administered online questionnaire was used.

Results

Year 5 students showed the lowest proportion of satisfactory biosafety knowledge (87.8%, n = 43), though differences across years were not statistically significant (p = 0.1638). However, only 51.0% (n = 25) demonstrated a satisfactory attitude, with a significant association between attitude and year of study (p < 0.001). This indicates a decline in constructive attitudes over time despite consistent knowledge levels. Factors such as clinical fatigue, desensitization, or lack of ongoing reinforcement may contribute to this discrepancy. The findings reveal no significant relation between biosafety knowledge and attitudes, especially among final-year students.

Conclusion

It is recommended that targeted interventions such as refresher courses, workshops, simulation-based training, and case-based discussions are regularly conducted. Biosafety education should be integrated throughout all academic years, supported by regular assessment and feedback, to ensure students maintain both competence and commitment to safe clinical practice.

Key words

Communicable disease, biosafety, cross-infection, COVID-19

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Contributions

Undergraduate students **60%** Lim Ee En Liew Denlee Leong Suki Lew Zhe Xuan Vaishnavi Vedam Supervisor guided from beginning to the end of this study in designing, conduction of study and preparation and final proofing of the manuscript **40%**

INTRODUCTION

The global outbreak of infectious diseases, particularly the COVID-19 pandemic, has had immediate and far-reaching implications for healthcare systems worldwide, with the field of dentistry being among the most severely affected. Based on *The New York Times Magazine*, while healthcare professionals were broadly recognized as being at elevated hazard of acquiring COVID-19, dental clinicians represented the most vulnerable subgroup.[1] This heightened susceptibility is primarily accredited to the dental procedures, many of them are aerosol-generating and therefore capable of dispersing infectious droplets into the clinical environment. This significantly increases the risk of transmission for both practitioners and patients. Given the intrinsic risk associated with dental interventions, the implementation of rigorous biosafety protocols and individualized assessments of patients' clinical status are essential in mitigating the potential for disease transmission.[2] To effectively disrupt the transmission chain, it is imperative that all members of the dental team possess a comprehensive understanding of infection pathways, are able to identify clinical signs and symptoms of infections, and adhere strictly to established contamination prevention and control (IPC) policies.

Since the pandemic, infection control protocols in dentistry have undergone numerous revisions in response to emerging scientific evidence.[3] The continuous updates issued by national and international health authorities have done a critical part in reducing the infection spread in both the short and long term. Nonetheless, there remains a paucity of research evaluating the extent of knowledge and awareness amongst dental undergraduate students regarding these updated biosafety measures.[4] This knowledge gap may lead to inconsistencies in the application of infection control practices, thereby posing an ongoing risk within clinical settings. In the current context, many dental undergraduates express legitimate concerns regarding their susceptibility to infection and the potential for disease transmission during clinical practice. While such concerns are well-founded, they are frequently exacerbated

by insufficient knowledge of appropriate infection control measures and biosafety protocols. Enhancing awareness and education in this domain is of paramount importance.[5-6] The present study was to assess the level of knowledge and awareness regarding biosafety practices amongst dental undergraduate students at AIMST University.

MATERIALS AND METHODS

Sample Collection

The questionnaire study was conducted at the Faculty of Dentistry, AIMST University, Kedah. A pretest was conducted randomly among 10 clinical-year students prior to the distribution of the online questionnaire. The students who participated in the pretest were able to understand and answer the questions clearly. The study targeted the undergraduate dental students from Year 3, 4 and 5. Then, the online questionnaire was randomly distributed amongst AIMST dental students currently studying Year 3, 4 and 5. A final sample of 172 was considered based on the Sample Size Calculator for One-Proportion Estimation[7] with consideration given to precision and other relevant parameters.

Data collection

The online survey consisted of different sections. Demographic information of the respondents, followed by two separate sections were taken. The demographic information included the student ID number and current year of study. The respondents' consent was obtained to ensure that the respondents were informed and understood that their participation was voluntary, and their confidentiality and privacy were protected.

The first section was used to investigate the knowledge of AIMST dental undergraduate students towards biosafety practices in dental clinics in the context of infection control. This section consisted of 25 multiple choice questions, designed in accordance with Guidelines on Infection Control in Dental Practice[8] in which the respondents had to answer with one choice from options A, B, or C. One mark was given for the most suitable option and no mark was allocated if the answer was incorrect. (Appendix I)

The second section was used to measure the attitudes of AIMST dental students towards biosafety in the context of clinical procedures. This section comprised of 20 questions that the respondents had to answer with a 6-point Likert scale based on their degree of agreement to the statements and clinical practices, ranging from score 1 to 6 (1=strongly disagree, 2=disagree, 3=slightly disagree, 4=slightly agree, 5=agree, 6=strongly agree). (Appendix II)

Data analysis

Both sections in the present study were assessed using an online questionnaire produced with Google. Knowledge related to infection control was evaluated with a quiz format, where correct answers were pre-set and automatically scored out of 25 points in the first section. Scores were interpreted as unsatisfactory (0–15) or satisfactory (16–25), with higher scores indicating better knowledge. In the second section, attitudes towards biosafety in clinical procedures were assessed using a 20-item questionnaire with a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). Total scores ranged from 24 to 144, and were categorized as inadequate (24–124) or adequate (125–144), with higher scores reflecting more positive attitudes. Scoring for the 6-point Likert-scale responses according to their options (1 point=strongly disagree, 2 points=disagree, 3 points=slightly disagree,4 points=slightly agree, 5 points=agree,6 points=strongly agree) was automated using Scorecery and all results were compiled and categorized in Excel for easier interpretation.

RESULTS

Among the 172 AIMST dental students, the reply by Year 3 dental students was 42.86% (n=72), for Year 4 dental students 29.65% (n=51), and for Year 5 dental students 28.49% (n=49). (Table I)

Table I. Distribution of respondents by year of study

Year	(n)	(%)
3	72	42.86
4	51	29.65
5	49	28.49
Total	**172**	**100**

Section 1: Assessment of knowledge of AIMST Dental Students towards biosafety practices

Table II shows assessment knowledge level of AIMST Dental Students towards biosafety in terms of percentage of total dental undergraduate students which obtain Unsatisfactory or Satisfactory score. For Year 3 Dental Students, percentage of students who obtained Satisfactory Score is 95.8% (n=69), with 4.2% (n=3) under Unsatisfactory Score Range. There are 96.1% (n=49) Year 4 Dental Students obtained Satisfactory score, 3.9% (n=2) under Unsatisfactory Score Range. To our surprise, Year 5 Dental Students have the lowest Satisfactory score percentage out of three Year of Study, which is 87.8% (n=43). Fisher's Exact Test was carried out to present a comparison between the two variables, which is Knowledge Level and Year of Study, and were found to be not significant (P= 0.1638).

Table II. Assessment of knowledge of AIMST Dental Students towards biosafety.

Knowledge Level[b]			
Year of Study	Unsatisfactory n (%)	Satisfactory n (%)	p-value[a]
Year 3	3 (4.2)	69 (95.8)	
Year 4	2 (3.9)	49 (96.1)	0.1638
Year 5	6 (12.2)	43 (87.8)	

[a]Fisher's Exact Test. [b]Unsatisfactory (0-15); Satisfactory (16-25)

Oral healthcare workers are high-risk groups exposed to pathogenic microorganisms in daily practices. Contaminated instruments, environmental surfaces or equipment could be possible sources of cross infection through indirect transmission.[9]

According to the Guideline for Disinfection and Sterilization in Healthcare Facilities 2008 (updated in May 2019) recommended by Centers for Disease Control and Disinfection (CDC), dental instruments that penetrate soft tissue, contact bone or other sterile tissue are classified as critical items, they must be heat purified or disposed after each use. Semi critical items are instruments that directly contact oral tissues but no penetration of soft tissues or bone, they should be heat sterilized or processed with high

level disinfection after each use. Non critical items (clinical contact and housekeeping surfaces) which only contact intact skin should be covered with protective barriers or disinfected with low to intermediate-level disinfectants.[10] From the responses of the questionnaire, some respondents were found to have inadequate knowledge in determining the appropriate disinfection procedure to disinfect housekeeping surfaces and dental handpieces, which could be due to lack of emphasis on biosafety practices in curriculum and inadequate infection control training in dental clinics. Failure of disinfection and sterilization of non-disposable equipment properly may contribute to incomplete removal of pathogenic microbes and increase the risks of occupational exposure to saliva and blood-borne diseases.[11]

Another finding of the survey is there was a possible lack of knowledge among participants about the appropriate disinfectants to be used for disinfecting study stone casts and cast metal removable partial dentures among AIMST dental students, which might be due to inadequate knowledge in dental material sciences and the disinfectants available. Various studies have recommended that impressions taken should be cleaned under running water to remove blood and saliva, followed by spraying or immersing in appropriate disinfectant before the impression is sent to the dental laboratory. Disinfection of casts and models using sodium hypochlorite was reported to be effective, no dimensional changes and surface details distortion were reported. On the other hand, cast partial denture to be disinfected in 2% glutaraldehyde solution for 10 minutes.[12]

Findings revealed that most respondents have adequate knowledge in hand hygiene and use of personal protective equipment (PPE) during dental practices. Most of them are aware of the sequences of donning and removing PPE, and the significance of good hand hygiene in averting the extent of infections. CDC has provided guidelines to put on PPE in the following sequence: gown, mask or respirator, eye protection and gloves. PPE is removed in the following sequence: gloves, eye protection, gown and mask. It is directed to rinse hands with soap and water or alcohol-based hand sanitizer immediately after removing PPE.[13]

Based on the findings, the respondents are found to be knowledgeable in determining the most appropriate management of needle stick injuries, which is a common percutaneous injury that can occur when giving local anesthesia, recapping and disposal of used needles. Based on the guidelines (CDC) and the National Institute for Occupational Safety and Health (NIOSH), the wound should be washed instantly with soap and running water, following which reporting the incident to the supervisor and seeking medical treatment is done. The respondents are also aware of the scoop technique which is used to recap used needles.[14]

In the aspect of virus transmission and vaccination, the knowledge level of participants can be considered to be mostly adequate for the schedule for intervals between Viral Hepatitis B (VHB) immunization doses and the route of transmission of VHB. However, there is a decrease in the right responses regarding the mode of infection spread of SARS-CoV-2 are being questioned in the questionnaire, which might indicate the knowledge level of AIMST dental students regarding SARS-CoV-2 still needs to be improved. This situation might be caused by the knowledge of VHB that was delivered well in the existing curriculum even before the pandemic, while studies of virology and effectiveness of vaccination of SARS-CoV-2 are still carried out.[15]

Section 2: Assessment of Attitude of AIMST Dental Students towards biosafety

For Question 3, the statement that PPE should be regularly worn during clinical procedures is almost universally agreed by all dental Students, except for Shoe Cap, which is disagreed by a higher percentage of students, consisting of 8.3% (n=6) of Year 3 dental Students, 5.9% (n=3) of Year 4 Dental Students, and 4.1% (n=2) of Year 5 Dental Students. Most of the students from each year of study agree on the statements that they have good understanding of infection control methods in the AIMST dental polyclinic, and good confidence in the knowledge and competence of control of infection in AIMST clinical training.

For Year 3 Dental Students, percentage of students who obtained favourable Score is 62.5% (n=45), with 37.5% (n=27) under unfavourable Score Range. There are 92.2% (n=47) Year 4 Dental Students obtained favourable score, 7.8% (n=4) under unfavourable Score Range. Year 5 Dental Students have the lowest Satisfactory score percentage out of three Year of Study, which is 51.0% (n=25). Chi Square Test was carried out to present a comparison between the two variables, which is Attitude Level and Year of Study, and were significant (P= <0.001). (Table III)

Table III. AIMST Dental Student's attitude towards biosafety by percentage of total percentage in each year of study grouped via Likert Scale score range

Attitude Level[b]			
Year of Study	Unfavorable n (%)	Favorable n (%)	p-value [a]
Year 3	27 (37.5)	45 (62.5)	
Year 4	4 (7.8)	47 (92.2)	< 0.001
Year 5	24 (49.0)	25 (51.0)	

[a] Chi Square Test. [b] Unfavorable (Score 0-124); Favorable (Score 125-144)

Dental professionals are at heightened risk due to close patient contact and routine aerosol-production. All students in the present study agreed that COVID-19 immunization, including booster doses, should be mandatory in clinical settings. This reflects a strong awareness of vaccination's role in preventing severe disease. Research from Weber State University and the University of Utah Health shows booster doses provide enhanced protection against the Delta and Omicron variants. CDC data further indicates that a third dose significantly reduces the risk of hospitalization and death.[16-17]

Some respondents disagreed with the need to treat emergency cases in negative pressure isolation rooms, possibly due to concerns about delayed care. However, current guidelines recommend postponing elective treatment for COVID-19-positive patients while allowing emergency procedures with appropriate precautions.

Hepatitis B virus (HBV) transmission, often through needle stick injuries or exposure to infected fluids, remains a concern in dentistry. All respondents supported mandatory HBV vaccination, likely reflecting early and consistent training on infection control protocols. Students demonstrated good

understanding of clinical hygiene practices, including hand hygiene, PPE use, and patient rights. There was strong agreement on the use of low-speed hand pieces, rubber dams, and high-volume suction to reduce aerosol-related risks. High-speed hand pieces, operating at 250,000–400,000 RPM, produce significantly more aerosols than low-speed tools. While most respondents prioritized key PPE components such as gloves, gowns, masks, and head caps, shoe covers were viewed as less essential–likely due to limited use in training clinics.[18-21] Questionnaire based additional studies relavant to the present study have been summarized below. (Table IV)

Table IV. Questionnaire based Studies – Biosafety practices

Aragão MG *et al*., 2022[22,]	142 Undergraduates – aware of the necessity of biosafety requirements in their routine dental practices
Halboub ES *et al*., 2015[23]	Senior dental graduates Sana'a University – low compliance with the recommended infection protocol standard, despite having an appropriate level of knowledge
Benarji KA *et al*; 2021[24]	Insufficient information and practices towards infection control and prevention protocols
El-Saaidi C *et al*; 2021[25]	Positive attitudes and behaviors toward infection prevention with poor knowledge.
Alharbi G *et al*., 2019[26]	Dental students at KSU showed high level of perception towards guidelines on infection control, despite lacking knowledge in basic infection control.
Basheer SN *et al*., 2022[27]	Dental healthcare professionals in Jazan region have a better level of perception towards COVID-19 prevention and reducing its spread.
Ataş O *et al*., 2020[28]	Students have positive attitude but inadequate knowledge towards the prevention of COVID-19 transmission.
Acosta-Gío AE *et al*., 2008[29]	Dental undergraduates are concerned about blood borne pathogens and have improper understanding due to lack of knowledge on HIV and HBV transmission.
Ehsani M *et al*., 2013[30]	Dental students from Babol University have inadequate level of knowledge and awareness towards biosafety protocols and more continuing education is required.
Ebrahimpour A *et al*., 2016[31]	Students have a adequate level of knowledge and high level of adherence towards infection control guidelines due to the mandatory university rules.
Shilpa BS *et al*., 2020[32]	Dental professionals have high level of knowledge and awareness regarding bioethics and biosafety issues and agree that biological effects of the biomaterials used should be explained to the patients before treatment procedures.
Khandelwal V *et al*., 2017[33]	Dental students have adequate level of knowledge regarding hepatitis B infection, however, almost half of the clinical year students have not received hepatitis B vaccinations, putting them at risk of infection.

The study was limited to clinical-year dental undergraduates at AIMST University, reducing generalizability. Increasing the sample size and diversity would enhance the reliability and applicability of findings.

CONCLUSION

This study found that Year 3 dental students at AIMST University demonstrated the highest level of knowledge and positive attitudes toward biosafety practices compared to students in other years. This is likely due to the enclosure with prevention and control of infection lectures in the Year 3 curriculum, which recently reinforced these principles. The findings highlight the need for continuous evaluation and training for Year 4 and 5 students to enhance their understanding and adherence to biosafety protocols. To support safe clinical practice, it is recommended that mandatory immunization programs, regular training workshops, and ongoing educational sessions be implemented. Additionally, strict monitoring of student compliance with infection control guidelines is vital to safeguard both patients and dental professional. Further research is encouraged to validate these findings and contribute to achieving infection-free clinical practice.

Declaration

None.

Conflict of interest

None.

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Ethics statement

Institutional ethics approval obtained prior to the study (AUHEC/FOD/2022/13).

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Online CPD in **6 Easy Steps**

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

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What's new for the clinician – summaries of recently published papers (February 2026)

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1. CONCENTRATED GROWTH FACTORS (CGF) FOR CLOSURE OF OROANTRAL COMMUNICATIONS AFTER TOOTH EXTRACTION: A RANDOMIZED CONTROLLED CLINICAL TRIAL

Concentrated growth factors (CGF) offer a promising autologous biomaterial for managing oroantral communications (OAC) post-tooth extraction. Oroantral communication (OAC) refers to pathological communication between the oral cavity and maxillary sinus caused by tissue defects, primarily occurring after the extraction of maxillary posterior teeth. If OAC is not appropriately managed, it may progress to an oroantral fistula (OAF), where the soft and hard tissues in the communication area fail to heal completely, and symptoms such as nasal congestion and rhinorrhea associated with maxillary sinusitis may occur. The risk of OAC progressing to OAF increases over time. Therefore, once OAC occurs, it should be closed as early as possible.

Oroantral communications arise when maxillary tooth extraction breaches the thin maxillary sinus floor, often after removing upper molars or premolars. Small defects (<5 mm) may heal spontaneously with measures like figure-of-8 suturing or oxidized cellulose, but larger ones risk oroantral fistula (OAF) formation, sinusitis, or chronic infection if unmanaged. Traditional closures use buccal advancement flaps (98.7% success) or buccal fat pads (95.8%), but these involve tension, donor morbidity, or relapse risks. Platelet concentrates like CGF address these by enhancing soft/hard tissue regeneration without synthetics.

CGF derives from venous blood centrifuged at variable speeds (e.g., 2700 rpm for 12 minutes), yielding a fibrin-rich matrix with platelets, leukocytes, growth factors (VEGF, PDGF, TGF-β), and cytokines. Unlike PRF, CGF's denser structure and higher growth factor concentration accelerate angiogenesis, osteogenesis, and epithelialization. Applied as membranes or clots in extraction sockets, CGF seals OAC, prevents sinus contamination, and fills defects to preserve ridge dimensions. Its biocompatibility minimizes inflammation, promoting granulation tissue by day 4 versus week 1 conventionally

Li and colleagues (2025)[1] employed CGF and suture methods to treat OAC and assessed the effects on soft and hard tissue repair, as well as the degree of pain experienced by patients after surgical repair. The aim of their study was to provide improved treatment options for OAC repair, particularly for cases that require implant repair after tooth extraction.

Materials and methods

This study was a prospective, randomized, controlled, single-centre clinical trial conducted in China. Between June 2024 and June 2025, 30 patients were consecutively enrolled for repair of oroantral communications following tooth extraction. Patients were randomly assigned to the control or the Concentrated growth factor (CGF) group using the envelope method, with allocation concealment performed by individuals unfamiliar with the study protocol. Blinding was limited to the evaluators. Two weeks before the surgery, all patients underwent preliminary screening to ensure they met the inclusion criteria and obtained their informed consent for participation in this study. The formal enrolment of patients was scheduled immediately after the extraction of maxillary posterior teeth and the acquisition of post-extraction beam computed tomography (CBCT) images.

The inclusion criteria were as follows: (a) maxillary premolars or molars meeting the criteria for extraction and pre-extraction CBCT revealed the tooth root entering the maxillary sinus; (b) pre-extraction CBCT and post-extraction CBCT both revealed a maximum diameter of 3–5 mm in the discontinuous maxillary sinus floor at the lesion site; (c) no acute inflammation of the maxillary sinus or chronic inflammation of the maxillary sinus was controlled; (d) no acute or chronic infectious diseases in the oral cavity; (e) the minimum vertical distance from the border point of the bone defect in the Oroantral communication (OAC) area to the crest of the extraction socket was ≥4 mm; and (f) adult patients.

The exclusion criteria were as follows: (a) oroantral communication caused by factors other than tooth extraction; (b) severe heart disease; (c) severe haematological disorders; (d) active infectious diseases that may impair routine healing; (e) hepatic or renal insufficiency/failure; (f) currently undergoing cancer treatment or within 18 months of completing chemotherapy or radiotherapy; (g) uncontrolled diabetes; (h) pregnancy or planning pregnancy; (i) smoking (>10 cigarettes/day); and (j) use of medications known to affect bone or soft tissue metabolism.

Patients who met the inclusion criteria underwent clinical, haematological, and CBCT examinations two weeks before surgery.

All surgeries were performed by the same experienced surgeon. Before tooth extraction, patients were instructed to rinse with 0.12% chlorhexidine solution for 1 min. Under local anaesthesia with lidocaine, the gingiva was separated using periotomes without flap elevation, and the affected tooth was extracted using minimally invasive extraction forceps or elevators. When necessary, a diamond fissure bur was used to section the roots, with careful protection of the surrounding hard and soft tissues. Granulation tissue on the wall of the tooth extraction socket was removed with a curette. After the defect was carefully palpated with a conventional blunt probe (diameter: 1 mm), further CBCT examination was performed. Using CBCT measurement

tools, the maximum diameter of the OAC was determined to be 3–5 mm, and the minimum vertical distance from the defect border point in the OAC area to the crest of the extraction socket was ≥4 mm.

CGF preparation

In the GCF group, approximately 18 ml of venous blood (two tubes) was collected from the patients using sterile vacuum tubes. Samples were centrifuged immediately. After centrifugation, the venous blood was separated into three layers from top to bottom: a platelet-poor plasma layer, a fibrin layer (CGF layer), and a red blood cell layer. Sterile tweezers were used to extract the CGF, and the lower red blood cell layer was trimmed off. Two CGF clots were prepared, one of which was compressed into a CGF membrane.

For the OAC repair in the CGF group: The CGF clot was placed into the extraction socket of the OAC area without compression, covered with a layer of CGF membrane, and stabilized in the extraction socket using 4 – 0 non-absorbable sutures(Johnson® 4 – 0) in a figure-of-8 suture, with no additional incisions or local soft tissue flaps applied in the surgical area.

For the Control group: Once the extraction socket of the OAC area was filled with fresh blood, the gingiva was sutured using 4 – 0 non-absorbable sutures in a figure-of-8 suture, with no additional incisions or local soft tissue flaps applied in the surgical area.

Patients were prescribed cefadroxil tablets 500 mg twice daily for 6 days and ephedrine hydrochloride and nitrofurazone 1–3 drops three times daily for 1 week. No painkillers were used. Follow-up assessments were conducted on postoperative Days 1, 3, 7, 30, and 90 to collect clinical and imaging data.

The ***primary outcome*** was the height of the newly formed bone (H). All measurements were performed by the same evaluator who was blinded to the group assignment. CBCT images taken immediately after tooth extraction and at 90 days postoperatively were converted to DICOM format and imported into Materialise Mimics Research version 21.0.

Secondary outcome measurements were also made using the Materialise Mimics Research software program to calculate New Bone Volume, New Bone Density and OAC closure rate (Closure rate at 30 days = number of closed cases/total number of cases × 100%). A modified version of the Masse Healing Index was used to assess soft tissue regeneration, maturation, and quality at 7 days and 30 days postoperatively. This index includes four parameters, each with three scoring levels: tissue colour (1 = the gingival tissue was entirely pink; 2 = less than half of the gingival tissue was red, movable, and hyperaemic; 3 = more than half of the gingival tissue was red, movable, and hyperaemic), healing tissue consistency and colour (1 = pink, close-grained; 2 = red, soft; 3 = grey-green, fragile), bleeding (1 = none; 2 = only upon palpation; 3 = spontaneous), and suppuration (1 = none; 2 = none but significant amounts of plaque around the walls of the socket; 3 = suppuration). Scores range from 4 to 12, with higher scores indicating poorer soft tissue healing outcomes.

All patients agreed not to use painkillers for 7 days postoperatively. The Visual analogue scale Visual analogue scale (VAS) was used to assess pain levels on Days 1, 3, and 7 postoperatively, with scores ranging from 0 (no pain) to 10 (severe pain).

RESULTS

A total of 40 patients were assessed for eligibility and 30 of them were randomly assigned into two groups finally. All participants completed the follow-up schedule, and no complications were reported.

For the primary outcome, New bone formation was observed in both groups at 90 days post-surgery. The **height** of new bone formation in the CGF group was approximately 3.866 ± 0.8048 mm, whereas that in the control group was approximately 2.761 ± 1.236 mm, with a statistically significant difference between the two groups ($P = 0.0033$).

Secondary outcomes

- ***New bone volume:*** The volume ratio in the control group was 0.742 ± 0.08495, while that in the CGF group was approximately 0.8153 ± 0.06556, with the CGF group significantly higher than the control group (P = 0.0132).
- **New bone density:** At 90 days post-surgery, the density of new bone in the CGF group was approximately 189.8 ± 44.74, while that in the control group was approximately.
- **OAC closure rate:** At the 30-day postoperative follow-up assessment, the defect closure rate was 100% (15/15) in both groups, with no significant difference between the two groups (P > 0.999).
- ***Modified Mass Healing Index scores:*** At 7 days post-surgery, the mean HI scores for the control group and CGF group were 6.133 ± 1.06 and 5.267 ± 0.7037 ($p = 0.0148$ At 30 days post-surgery, there was no significant difference between the two groups ($p > 0.999$).
- ***Visual analogue scale scores:*** Within 7 days postoperatively, VAS scores of both groups gradually decreased. On Days 1 and 3 postoperatively, the VAS score was significantly lower in the CGF group than in the control group (P = 0.049, P = 0.0122)

CONCLUSION

The researchers concluded that he use of concentrated growth factors (GCF) is a reliable method for closing oroantral communication. During the 90-day observation period, compared with suture repair, the CGF repair method promoted new bone formation in the extraction socket while facilitating soft tissue healing and reducing postoperative pain reactions.

Implications for practice: for almost al of the primary and secondary outcome measures, patients in the GCF group had significantly better outcomes. GCF is an important option for the repair of OAC.

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2. CLINICAL PERFORMANCE OF SHORT FIBER-REINFORCED AND INDIRECT RESIN COMPOSITES IN CLASS I AND CLASS II RESTORATIONS: A THREE-YEAR RANDOMIZED CLINICAL TRIAL

Short fiber-reinforced resin composites (SFRC) and indirect resin composites enhance durability in Class I and II restorations, addressing limitations of conventional direct composites like fracture and shrinkage.

Class I (occlusal) and II (proximal) cavities in premolars/molars endure high masticatory stresses, polymerization shrinkage, and microleakage risks. Conventional microhybrid composites show 5-10% annual failure from fractures or secondary caries, prompting innovations like SFRC and indirect systems. SFRC incorporates randomly oriented short E-glass fibers (aspect ratio >10) in a resin matrix (e.g., everX Posterior), mimicking dentin's fibrous structure to dissipate stresses. Indirect composites (e.g., SR Nexco) undergo lab polymerization for better conversion, reduced shrinkage, and precise anatomy via CAD/CAM or heat-light curing.

SFRC's fibers halt crack propagation, boosting flexural strength (150-200 MPa vs. 100-120 MPa for hybrids) and fracture toughness. Polymerization shrinkage drops to 1.5-2.5%, minimising adaptation gaps. Indirect composites achieve 70-80% conversion, superior polishability, and wear resistance (50-100 µm/year), but require multi-step cementation (e.g., Multilink N). Both excel esthetically (VITA shade matching) and bond via universal adhesives (e.g., G-Premio BOND),

Salama et al (2025)[1] reported on a split mouth trial using the PICO approach to develop the research question:P (Population): patients requiring Class I and Class II posterior composite restorations; I (Intervention): included SFRC and indirect lab composite restorations; C (Comparison): microhybrid resin composite restorations; and O (Outcome): marginal adaptation as the primary outcome, with other FDI criteria assessed as secondary outcomes. This randomized clinical trial was designed to evaluate and compare the three-year clinical performance of SFRC and indirect lab composite with that of a microhybrid resin composite placed in Class I and Class II cavities, with marginal adaptation defined as the primary outcome. The null hypothesis stated that the three restorative materials would exhibit comparable clinical performance according to FDI criteria.

Materials and method

This study was a split-mouth prospective double-blinded (including both patients and examiners), randomized controlled clinical trial, reported in a CONSORT format.

Three different restorative materials were utilised in this study: SFRC (everX Posterior), indirect lab composite (SR Nexco, Ivoclar Vivadent), and microhybrid resin composite (G-aenial Posterior). They were equally allocated into three groups, with the first two restorative materials designated as the test groups and the microhybrid resin composite serving as the control group, as follows:

- **Group 1:** Direct restorations using SFRC (everX Posterior), capped with a 1 mm occlusal layer of microhybrid resin composite (G-aenial Posterior, GC).
- **Group 2:** Indirect lab composite (SR Nexco, Ivoclar Vivadent), cemented with a universal dual-curing resin cement (Multilink N, Ivoclar Vivadent).
- **Group 3:** Direct restorations using microhybrid resin composite (G-aenial Posterior), placed incrementally.

The study included 33 patients aged 18–35 years of both genders with good oral hygiene, categorized as low to moderate caries risk based on the CAMBRA (Caries Management by Caries Risk Assessment) protocol. Eligible participants presented at least three primary occlusal or proximal carious lesions (Black Class I or II) with an ICDAS (International Caries Detection and Assessment System) severity score of 4 or 5 upon visual examination. The carious teeth had to be vital, without periapical radiolucency (confirmed by periapical radiography), and in stable occlusion. Patients were excluded if they exhibited extremely poor oral hygiene, uncontrolled systemic diseases, chronic periodontitis, or heavy bruxism. Further exclusion criteria comprised extensive cavities exceeding two-thirds of the intercuspal width, lesions requiring cusp coverage, ongoing orthodontic treatment, or inability to attend scheduled follow-up appointments.

A randomization code was generated according to the three treatment possibilities. Each patient received three different posterior restorations in a unique sequence determined by the developed random sequence plan. To ensure allocation concealment, the randomization sequence was secured using sequentially numbered, opaque, sealed envelopes, which were prepared by an independent coordinator not involved in the clinical procedures or outcome evaluation. Each envelope was opened only after confirming patient eligibility and obtaining informed consent. Blinding was implemented for both the patients and the outcome assessors; however, blinding the operator was not feasible due to the inherent differences in material composition and the distinct application techniques required for each restorative system.

The operative procedures were conducted by a sole operator. Preoperative digital photographs were taken as part of the dental screening. Patients were administered local anesthesia prior to restorative procedures in order to alleviate pain and discomfort. Fluoride-free prophylaxis paste was used for cleansing the teeth of all participants. Subsequently, the operative field was isolated using rubber dam and high suctioning.

Direct restorations

The initial cavity preparation was performed using suitably sized carbide straight fissure burs in a high-speed handpiece while maintaining a constant, copious air-water cooling system. In deep cavities where the remaining dentin thickness was estimated to be < 1 mm, pulp protection was provided using a thin layer of calcium hydroxide liner (Dycal). The liner was applied in a thin layer over the deepest part of the cavity floor and light-cured for 20 s before adhesive application.

Selective enamel etching was performed by applying 37% phosphoric acid gel to the enamel margins for 20 s prior to adhesive application, while dentin was left unetched, following the manufacturer's instructions. Each cavity was then thoroughly rinsed with water for 20 s and gently air-dried, retaining the dentin surface with a slightly moist

appearance. G-Premio BOND universal adhesive was applied to the prepared enamel and dentin surfaces and left undisturbed for 10 s. A gentle stream of air was then applied for 5 s to ensure thorough evaporation of the solvent and create a uniform adhesive film. Light curing was performed for 20 s using a light-emitting diode (LED) curing unit. In Class II preparations, the proximal wall was restored utilizing a horizontal incremental technique.

Following the manufacturer's recommendations, SFRC (everX Posterior) was applied in one increment, leaving 1 mm space for a surface layer of microhybrid resin composite, followed by 40 s of light polymerization for each. However, in the microhybrid resin composite group (G-aenial Posterior), the composite was applied incrementally, with each increment light-cured for 40 s from the occlusal aspect.

Following the removal of the matrices, all restorations were additionally light-polymerized to ensure adequate curing of the proximal margins. Polishing procedures were performed implementing a low-speed handpiece with silicon carbide impregnated cups and points under continuous water cooling, following the manufacturer's recommended sequential protocol. For Class II cavities, interdental flossing was employed to assess the tightness of proximal contacts and to ensure the absence of flashes or overhangs.

Indirect restorations

Inlay cavity preparations were performed utilizing a specialized inlay preparation kit in order to attain an estimated 10^0-12° occlusal divergence angles. A preliminary impression was obtained for each patient utilizing equal proportions of the base and catalyst of high-viscosity impression material (Presigum Putty). Afterwards, a final impression was taken for each cavity using light-viscosity impression paste (Presigum Low viscosity). Provisional restorations were applied using light-curing, eugenol-free temporary restorative material. Each impression was then delivered to the dental laboratory for casting into a die stone.

A professional dental technician fabricated all the restorations on the die stone, following the manufacturer's guidelines. Each inlay was carefully removed from the die model before being finished with fine diamonds and carbide burs under low speed and light pressure. The restorations were then polished with leather buffing wheels and Universal Polishing Paste.

Inlays cementation was conducted under rubber dam isolation and high suctioning. In order to achieve an excellent bond with the luting composite, the internal surfaces of the inlays were carefully sandblasted with 80-100 µm Al_2O_3 at 1 bar pressure, then they were conditioned by applying a thin layer of universal priming agent (Monobond N) and allowed to react for 60 s. The two primer liquids, Multilink N Primer A and B, were mixed together in equal parts on a mixing pad, then applied to the entire cavity with 30 s scrubbing, and the excess was dispersed with air until the mobile liquid film was no longer visible. Multilink N cement was applied directly to the inner surface of the restoration, then the restoration was seated rapidly in place. The excess material was removed using a foam pellet, followed by additional light curing to all margins for 20 s. Subsequently, the occlusion was assessed using articulating papers and the restorations were finished with flexible discs (Sof-Lex) using the recommended sequence.

Two blinded assessors evaluated the restorations clinically utilizing the FDI criteria. The participants were recalled for baseline evaluation after a week, followed by further assessments at 6 months, 1-year, 2-years, and 3-years. All participants adhered to the assigned treatment protocols, and no major protocol deviations occurred during the study period. The assessed criteria included functional properties such as marginal adaptation, material fracture, and the quality of proximal contact and contour. Additionally, biological properties including postoperative hypersensitivity, caries around restoration margins, and tooth integrity were also considered. Finally, esthetic properties as surface luster and texture, marginal staining, and colour matching were evaluated. Among these, marginal adaptation was designated as the primary outcome, while all other assessed FDI criteria were considered secondary outcomes.

The restorations were categorized utilizing the following ranking terms: clinically excellent or very good, clinically good, clinically satisfactory, clinically unsatisfactory, and clinically poor. Rankings of 1, 2, and 3 were designated as "clinically successful," while 4 and 5 were seen as indicative of failure. The parameters that required visual examination were conducted using a magnifying dental loupe, with a powerful attached light source. Marginal adaptation was assessed using two specialized blunt-tip probes (150 µm and 250 µm) in conjunction with dental floss for comprehensive evaluation. Postoperative sensitivity was evaluated by blowing a stream of cold air for 3 s at a distance of 2–3 cm from the restoration. Clinical intraoral photographs were taken at each follow-up appointment to monitor any visual alterations in the restorations.

RESULTS

Thirty-three patients, including 23 females and 10 males, were enrolled in this study. The mean age of the patients was 25.7 years. The study's recall rates were as follows: 100% at baseline, 93.94% at six months, 87.88% at one year, and 84.85% at both two and three years. Five patients were lost to follow-up due to loss of contact despite multiple recall attempts through phone calls and text messaging.

After a three-year follow-up, both SFRC (everX Posterior) and indirect lab composite (SR Nexco) had a 100% success rate, whereas microhybrid resin composite (G-aenial Posterior) attained a success rate of 96.43%.

Following a three-year follow-up period, the outcomes revealed no statistically significant differences among the three assessed restorative materials in terms of functional properties ($p > 0.05$). Concerning marginal adaptation, 92.9% of SFRC, 78.6% of indirect lab composite, and 85.7% of microhybrid resin composite restorations exhibited excellent marginal adaptation, scoring (1). A statistically significant difference was observed for indirect lab composite restorations between the baseline and 1-year measurements, compared to 2-year and 3-year scores. For microhybrid resin composite restorations, the significant differences were observed between baseline and 3-year measurements ($p < 0.05$). Nonetheless, no significant difference was noted between the follow-up periods for SFRC ($p > 0.05$).

Regarding material fracture and retention, at the 3-year evaluation, SFRC restorations revealed ideal performance (100% scoring 1), whereas only one indirect lab composite restoration presented with hairline crack (score 2). At the 6-month follow-up, one microhybrid resin composite restoration exhibited minor fractures that were deemed

clinically acceptable without compromising functionality, followed by another one at the two-year recall. However, by the end of the three-year duration, one microhybrid resin composite restoration was clinically unsatisfactory and required repair (score 4). The intragroup comparisons revealed no statistically significant differences between the follow-up periods for the three restorative materials ($p > 0.05$). All the restorations exhibited normal proximal contact and contour with no statistically significant differences detected at any follow-up evaluation in both intergroup and intragroup comparisons ($p > 0.05$).

No statistically significant differences were detected in biological characteristics among the three restorative materials after three years ($p > 0.05$). Similarly, intragroup comparisons demonstrated no significant differences between the follow-up durations among the assessed restorative materials ($p > 0.05$). Regarding postoperative hypersensitivity, indirect lab composite restorations revealed no sensitivity throughout the evaluation periods. However, at the 6-month evaluation, two SFRC restorations exhibited minor sensitivity, which was temporary and subsided shortly afterward. Furthermore, one microhybrid resin composite restoration revealed mild transient hypersensitivity at the 1-year follow-up, followed by two restorations at the 3-year follow-up. Concerning secondary caries and tooth integrity, no statistically significant differences were observed between the three restorative materials at any follow-up evaluation in both intragroup and intergroup comparisons ($p > 0.05$).
The three restorative materials exhibited no statistically significant differences in terms of esthetic properties after three years ($p > 0.05$).

CONCLUSION

After a three-year follow-up period, both SFRC and indirect lab composite demonstrated acceptable clinical performance, comparable to that of microhybrid resin composite, as evaluated by the FDI criteria.

Implications for practice: the 3 materials and techniques demonstrated clinical equivalence in terms of the outcomes measured. The importance clinical skill, patient selection and selection of technique are key in ensuring clinical success.

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Confidentiality – it's about trust

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By Dr Yash Naidoo, Dentolegal Consultant at Dental Protection.

Dr Yash Naidoo, Dentolegal Consultant at Dental Protection, takes us back to basics and first principles to remind readers why professional ethical rules regarding confidentiality were created in the first place, and explores some real-life scenarios in which confidentiality comes into play.

Patients must be able to trust that we will keep their information confidential. If patients have any doubt that we can keep their information secret, they may conceal certain information which they feel might embarrass them if revealed to others, alternatively, they may tell us nothing at all. The expectation of confidentiality is central to a patient's trust in not only their healthcare team, but the profession as a whole. It is no wonder, then, that the profession has taken steps to codify a set of rules and guidance dedicated to confidentiality.

LAW

Recently enacted privacy laws such as the Protection of Personal Information Act (POPIA) in South Africa have not changed the principles of confidentiality which the profession has recognised and sought to protect for a while. These laws simply codify, supplement and reinforce those principles. So, while POPIA was the buzz word a few years ago, I am quick to caution healthcare professionals not to get too distracted by the buzz and reassure them that so long as they are sticking to their ethical obligations, they probably need not be too worried by all the change. The important point is that patient information is sacrosanct in ethics and in law, and patients' confidentiality is protected by both lawmakers and the healthcare profession.

PRACTICAL CONSIDERATIONS

With countless articles, bulletins, blogs and the like regarding confidentiality (arguably including this one, but hopefully not), it is perhaps understandable that healthcare practitioners bombarded with such information may find it difficult to see the wood from the trees when faced with real-life situations in practice where confidentiality comes into play. Let us explore some examples.

It all starts in the waiting room. There may be several patients sitting quietly, staring at their mobile devices while they wait their turn. Because they are all there for the same general purpose (i.e. dental care), that does not mean that their expectation of privacy disappears and need not be protected. A receptionist or clinician can still breach a patient's privacy even in this setting – for example, by asking a patient if they are here for the large abscess drainage, in front of others. Apart from potentially embarrassing the patient, this clearly breaches their right to confidentiality and privacy. It may seem like an innocent and harmless question to a patient who is obviously there for dental treatment, but it is much more than that to the individual patient who wants their health information kept private. It need not be an abscess or something with more obvious potential to embarrass – any treatment or clinical condition ought to be kept confidential between the patient and the practice.

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GREY AREAS

As clinicians (and practice staff) we are told many things by our patients. Some information is clearly confidential; the contents of a medical history for example. However, a lot of other information may not be quite so easy to categorise. Is a patient's address confidential? Should the time that a patient attends your surgery be confidential? Is it reasonable to tell a wife, who calls to ask if her husband is having treatment at your rooms that yes, he is there, or should you say that the information is confidential? The information may seem innocuous but the reasons why it is being requested may not be.

Other situations are more complicated still.

Should you give information to someone who claims to be a schoolteacher and phones up to check on the whereabouts of a pupil on a particular day? There could be concerns for that pupil's safety.

Should you give information to the police when they enquire whether a person they suspect of a crime was having treatment on a particular date at your practice or not? This may be considered to be in the public interest.

It is these types of situations in which confidentiality ought always to be a default consideration before acting. Not all situations will have clear cut answers, but when in doubt, consult the regulator's guidance booklets, a senior colleague, or ask Dental Protection for advice.

SOCIAL MEDIA

In modern times and with the rise of the social media influencer, it may seem as if patients want the opposite of privacy when it comes to their dental treatment – particularly cosmetic treatments. There are patients who ask if they can record or take photos of their clinical journey to post on a website or social media profile. This does not mean that all patients want their information or photos to be posted online.

The HPCSA clearly understands this, and has stated in their ethical guidelines on social media *(booklet 16)* that practitioners *must* obtain the written consent of the patient before publishing photographs about them in media to which the public has access, whether or not the practitioner believes that the patient can be identified by the photograph.

This again takes us back to the fundamental issue of trust. Patients need to trust that if they attend our practices, we will

not post photos of them (whether anonymised or otherwise) without their written permission. Many patients research a clinician or practice online before visiting, and it would be useful if the photos which they come across online have captions assuring the public that the photos were taken and posted with the patient's written consent.

IT'S A ONE-WAY STREET

It is worth mentioning the following because from time to time we are asked about it. The confidentiality is the patient's, not the clinician's. When patients consult with us, it is their clinical/personal information that they disclose to us, which is deemed by the regulator and lawmakers as worthy of protection. As the professional in the relationship, we have the obligation to keep the patient's disclosures confidential – the patient has no such reciprocal obligation.

This query comes up often in the context of audio recordings of consultations. The safest attitude for a clinician to adopt is to assume that all patients are recording everything that happens during the confines of a consultation room. It is their confidential information being recorded, and it is likely that they can do with that as they please.

Which takes me to the next important point, along the lines of recording information: our clinical notes. Always remember that the information contained in the patient's records is their information and they are entitled to access that information on request. So, when making notes, it is useful to always bear in mind that the notes are not only for your records, but may someday be seen by the patient and anyone they choose to disclose it to, such as a colleague for a second opinion, a lawyer for investigating a potential claim, or a judge in court if a claim ever materialises. The importance of keeping factual, dispassionate notes which are relevant to the patient's clinical care, cannot be overemphasised.

CONCLUSION

Being a healthcare professional gives us many privileges. Perhaps the most important is the right to ask our patients questions of a confidential nature, and to expect truthful answers.

However, this privilege also imposes upon us an ethical (and legal) obligation to treat any information obtained as completely confidential.

Confidentiality is central to the relationship of trust between you and your patient. In general, it is a straightforward concept, but there are situations which may require guidance from the regulator and as always, if you are in doubt, you can always ask Dental Protection for advice.

The important thing is that the concept should always be borne in mind in practice. There are resources covering professional ethical rules regarding confidentiality, available on the Dental

Protection website here.
(https://www.dentalprotection.org/south-africa/publications-resources)

Online CPD in 6 Easy Steps

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

The use of hand-held X-ray equipment among Dentists and Dental Specialists in Gauteng Province

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B Walsh,[1] LJ Hazell,[2] PL Mokoena,[3] K Tshite[4,]

ABSTRACT:

Introduction

Handheld intraoral x ray units were created for use where fixed units are impractical. Their global popularity has grown; however, there are concerns about exposure times, scattered radiation and inadequate safety practices. Limited South African research prompted this study to bring awareness and safe usage of hand-held X-ray equipment by dental clinicians.

Aims and Objectives

To investigate the use of handheld x ray equipment and determine if they are being operated correctly and safely.

Design

A quantitative, descriptive, cross-sectional study.

Methods

The study was conducted in public and private dental clinics in Gauteng, South Africa. General dentists and dental specialists were recruited through non-probability sampling. Data were collected using a self-administered online questionnaire. Statistical analysis was performed using the IBM-STSS statistical software, including frequencies, descriptive statistics, and cross-tabulation to compare categorical variables.

Results

There were 144 responses, giving a response rate of 19.02%. 6,3% of dentists used handheld X-ray units. No correlation was noted between dentists' years of experience and the type of intraoral X-ray unit used.

Conclusion

This study highlights handheld X-ray use. Ongoing education, strict adherence to radiation safety protocols, and regular compliance monitoring are essential to ensure the safety of patients and operators.

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Key words

Hand-held X-ray equipment; SAHPRA; intra-oral X-ray units; radiation safety

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Author contributions:

Brigitte Walsh	30%
Lynne Hazell	23,3%
Louisa Mokoena	23,3%
Koketso Tshite	23,3%

INTRODUCTION

Intraoral X-ray units are widely used in dentistry and are acknowledged to be the gold standard for the detection of periapical lesions[1]. In Gauteng, the wealthiest province in South Africa, 93% of dentists are equipped with intraoral X-ray units[2,3]. The first portable intraoral X-ray equipment was developed in 1993.[4] It was designed to be used in areas where fixed intraoral X-ray units could not be used.[5] A portable unit has multiple areas of application, including forensics, nursing homes, prisons, outreach programmes, remote areas, immobile patients and in emergencies such as mass fatalities.[6,7]

The portability of the handheld X-ray units (Figure 1) has led to their use becoming increasingly popular worldwide. However, due to the longer exposure time required by handheld X-ray units, concerns have been raised regarding the increase in radiation scatter and the lack of appropriate radiation safety measures by dentists when using these units.[5] Furthermore, many literary debates have arisen over the quality of intraoral radiographs taken using a fixed-mounted intraoral X-ray unit in comparison to a handheld X-ray unit; however, the main concern amongst users of this equipment is the level of scatter radiation emanating from handheld X-ray units.[6] The matter of holding an intraoral receptor by any member of the dental team during exposure is of significant concern, as it results in a large amount of scatter radiation affecting the hands of the operator, caused by backscatter and scatter from the patient's head.[8] The portability of these units has also raised security and equipment safety concerns due to the ease with which they can be dropped or fall off a counter.[9]

The advantage of handheld intraoral X-ray units is that they are easily accessible, cost-effective, cordless, and allow for flexibility, as one unit can be used in multiple surgeries.[5] With the appropriate use of intraoral positioning devices, which assist in reducing radiation dose, the operator can stay in the room during the X-ray procedure. This can be advantageous when handling paediatric patients and patients who are anxious [5].

Figure 1: Handheld X-ray camera[10]

In South Africa, there are stringent regulations governing the usage of handheld X-ray units.[11] According to the South African Health Products Regulatory Authority (SAHPRA), handheld X-ray devices may only be operated by dentists or diagnostic radiographers, and regardless of the level of exposure, both the operator and patient must wear radiation protective apparel[11]. This is due to the non-standardised patient positioning techniques that are often required to improve radiation safety when using handheld X-ray units. Dosimeters are mandatory for radiographers and dentists who perform more than 100 intraoral radiographs per week using fixed installations.[11] This legislation also states that dosimeters must always be worn when operating a handheld X-ray device, regardless of the number of exposures obtained. Notwithstanding the legislation, there is little published material on the usage of handheld X-ray units in South Africa. There is a lack of research on handheld X-ray units in South Africa; therefore, this study aimed to explore the types of X-ray equipment, specifically handheld X-ray units used by general dentists and dental specialists, to provide radiation guidelines for the use of handheld X-ray units by SAHPRA.

METHODS

Research Setting

This study was conducted in both public and private dental clinics in Gauteng, South Africa, where general dentists and dental specialists were actively practising.

Research Design

A quantitative, descriptive, and cross-sectional design was adopted to explore the radiographic imaging methods employed by dentists and dental specialists in the region. At the time of data collection, approximately 2,739 dentists were registered in Gauteng, comprising 2,459 general dentists and 280 dental specialists.[12] A non-probability convenience sampling approach was used within a quasi-experimental framework.[13] In consultation with a university-affiliated statistician, a minimum sample size of 100 participants was determined to achieve statistical significance.

Data Collection

Data was collected using a self-administered online questionnaire, adapted from validated instruments in previous studies.[14–17] The questionnaire was distributed via email and social media platforms (e.g., WhatsApp®), targeting dental practitioners and professional associations. Contact details were obtained from online directories and peer networks.

Initially, the survey was hosted on REDCap®,[18] a secure electronic data capture system. However, due to a low response rate and feedback regarding usability, the survey was reformatted and reissued via Google Forms®. While Google Forms offered greater accessibility, it raised data privacy concerns; therefore, the survey was closed once the desired sample size was reached.[19]

A pilot study was conducted with three participants: two public-sector general dentists (one academic, one service-focused) and a dental specialist working in both sectors. The pilot aimed to assess the survey's functionality across various devices. Minor issues related to grammar, layout, and response scale formatting were identified. The comments and feedback from the pilot study were used to amend and improve the survey. Data from the pilot were excluded from the main analysis.

Data analysis

The REDCap® platform yielded 66 responses. After transitioning to Google Forms®, an additional 122 responses were collected, resulting in a total of 188 submissions. The survey data were encoded as continuous values (e.g., Yes = 1, No = 2) and processed using the survey platform's data management system. Incomplete questionnaires with no responses were excluded, while partial responses (n = 12) were retained due to their informative value, resulting in a final sample size of 144. Statistical analysis was performed using the IBM-STSS statistical software. The statistical analysis included frequencies, descriptive statistics, and cross-tabulation to compare categorical variables.

Ethical approval for this study was obtained from the University of Johannesburg Research Ethics Committee (REC-1769-2022). Subsequent permission to conduct the research among dentists and dental specialists employed by the Gauteng Department of Health was granted by the National Health Research Database (NHRD) (Reference: 2022_10_0222)

RESULTS

There were 144 responses received, giving a response rate of 19.02%. All general dentists and dental specialists who are currently practising in the public and/or private sector in Gauteng were invited to participate in the study. The current number of practising dentists in Gauteng was estimated to be 2739.[12] The dental specialities included community dentistry, maxillofacial and oral surgery, oral pathology, orthodontics, prosthodontics, oral medicine, and periodontology. All dentists and dental specialists who were not practising in Gauteng were excluded from this study. In this study, 96.6% of respondents confirmed that they were dentists and were currently practising in Gauteng, and the remaining 3.4% of respondents confirmed that they were not dentists or were not practising in Gauteng. Responses from the latter group were discarded.

Table I: Demographic data

		Frequency	Percentage
Age Category of Dentists	Less than 30 years	19	13.2%
	31 - 40 years	44	30.6%
	41 - 50 years	31	21.5%
	51 - 60 years	30	20.8%
	61 and over	20	13.9%
	TOTAL	**144**	**100.0%**
Sex of Dentists	Male	75	52.1%
	Female	68	47.2%
	Prefer not to say	1	0.7%
	TOTAL	144	100.0%

The largest group, including 30.6% of the dentists, fell between the ages of 31 and 40. Additionally, 13.9% of the dentists were over the age of 60. Of the dentists, 52.2% were male and 47.2% were female.

Table II: Business Practices of Dentists

		Frequency	Percentage
Type of Business	Public Sector	36	25.0%
	Private Sector	86	59.7%
	Both	22	15.3%
	Total	**144**	**100.0%**
Type of Practice	Individual	68	42.0%
	Group	53	32.7%
	Teaching Institution	40	24.7%
	Other	1	0.6%
	Total	**162***	**100.0%**
Type of Dentist	General Dentist	112	77.8%
	Specialist	32	22.2%
	Total	**144**	**100.0%**
Years of Professional Experience	Up to 5 years	21	14.6%
	5 – 10 years	30	20.8%
	11 – 20 years	38	26.4%
	More than 20 years	55	38.2%
	Total	**144**	**100.0%**

The majority of respondents worked exclusively in the private sector (59.7%). A quarter of the dentists were employed exclusively in the public sector, while 15% of them were engaged in both the public and private sectors. *The number of responses regarding the type of practice is higher, as some dentists work in more than one practice and were therefore not limited to only denoting one response. The largest proportion of dentists (42%) was employed in individual practices, while 32.7% worked in group practices and 24.7% were affiliated with teaching institutions. The study found that 77.8% of the respondents were classified as general dentists, while the remaining 22.2% were categorised as dental 51 specialists. A total of 35.4% of the dentists reported having 10 years or less of professional work experience as dentists, compared to 38.2% of the dentists who indicated having worked in the profession for more than 20 years.

Table III: Type of Intraoral X-ray Unit

		Frequency	Percentage
Type of Intraoral X-ray Unit	Fixed/ mounted X-ray unit	118	93,7%
	Handheld X-ray unit	8	6,3%
	Total	126	100,0%

A small minority, 6,3% of dentists, use handheld X-ray units. The majority (93,7%) of dentists used fixed-mounted intraoral X-ray units.

Table IV: Type of Intraoral X-ray Used According to Years of Professional Experience

			Type of Intraoral X-ray Unit		
			Fixed/ Mounted X-ray Unit	Handheld X-ray Unit	Total
Years of Professional Experience	10 years or younger	Count	43	3	46
		Percentage	93,5%	6,5%	100,0%
	More than 10 years	Count	75	5	80
		Percentage	93,8%	6,3%	100,0%
	Total	Count	118	8	126
		Percentage	93,7%	6,3%	100,0%

There was no correlation noted between the dentists' years of experience and the type of intraoral X-ray unit that they use (phi=1.000). Most dentists (>93%) in both cohorts preferred fixed/ mounted intraoral X-ray units.

DISCUSSION

South Africa has a large rural population and challenging access to dental radiography. Thus, handhold X-ray equipment could be advantageous although this is not reflected in the current study where only a very small percentage of participants identified using handheld equipment. Despite these practical advantages, radiation safety remains one of the most significant concerns surrounding the use of handheld X-ray units. Previous studies conducted in South Africa have highlighted the low levels

of radiation safety awareness among dentists and dental experts [20]. International patterns of handheld X-ray use appear to reflect regulatory influences. In both Australia and the United States, the use of handheld X-ray units continues to grow, while in Europe, adoption remains limited due to stringent radiation safety regulations.[21,22] In Korea, 15% of dentists report using handheld units, compared with 11.9% in Morocco.[2,23] Previous studies in Korea and Morocco have raised concerns regarding the lack of radiation awareness among dentists in Korea and Morocco, respectively. In line with these findings, participants in the current study also identified radiation dose as a significant concern.[2,23]

In this study, only 6.3% of Gauteng dentists reported using handheld X-ray units, with the overwhelming majority (93.7%) relying on fixed intraoral units. A possible explanation for this could be the strict regulatory environment established by SAHPRA,[11] which requires both the patient and operator to wear lead aprons when using handheld X-ray units. In South Africa, dentists are required to wear radiation dosimeters when performing more than 100 intraoral radiographs per week when using fixed intraoral X-ray units. In the case of handheld units, however, radiation dosimeters must be worn at all times, irrespective of exposure frequency.[11] These legal stipulations, combined with inherent safety and security risks, may help explain the limited uptake of handheld X-ray units in this study population.

SAHPRA further specifies that fixed intraoral units may be operated by dentists, radiographers, and oral hygienists, whereas handheld units are restricted to dentists and radiographers.[11] This restriction likely reflects concerns around the lack of standardised positioning techniques needed to optimise radiation safety during handheld use. Evidence regarding the safety of handheld X-ray devices is mixed. Some studies indicate that they can be used safely provided that all recommended precautions are followed.[21] Other studies, however, report that while patient equivalent dose is lower with handheld X-ray units, operator exposure tends to be higher than with wall-mounted intraoral X-ray units.[22,24,25] Despite the small difference in radiation dose to the operator between the two types of X-ray units, handheld X-ray units should only be used where the use of a fixed intraoral X-ray unit is not possible and should never be used in place of a fixed X-ray unit.[5,7,24,26] This supports the very small percentage of uptake of handheld X-ray devices seen in the present study.

Further testing across 14 handheld models has shown that operator exposure varies depending on the device's structural design.[27] Another critical factor is the operator's positioning relative to the unit.[28] To minimise radiation dose, the central ray should be aligned along the horizontal plane, perpendicular to the image receptor and close to the area of interest.[27] The device should also be held as far away from the operator as possible.[29] Over time, operator fatigue may cause the arms to bend, thereby reducing the distance between the operator and the device.[27]

LIMITATIONS

The study was only conducted in the Gauteng province; a South African study across all nine provinces would be valuable. The response rate for the study was low. Specific questions were not asked regarding why handheld devices are not a popular choice of equipment in Gauteng.

RECOMMENDATIONS:

- Conduct further research into the uptake of handheld devices and their challenges to direct future training.
- Expand the research to include all nine provinces.
- Consider a qualitative research study to address the factors affecting the use of handheld devices in individual interviews.

CONCLUSION

This study provides important insights into the use of handheld X-ray units among dentists in Gauteng. The findings reveal that only 6.3% of dentists utilise handheld devices, while the overwhelming majority (93.7%) rely on fixed intraoral units. The low uptake of handheld X-ray equipment appears to be influenced by strict regulatory requirements set by SAHPRA, which mandate the use of lead aprons for both operator and patient, restrict operation to dentists and radiographers, and require the consistent use of dosimeters. These stipulations, combined with the recognised risks of non-standardised positioning and operator radiation exposure, likely contribute to the reluctance to adopt handheld units in clinical practice.

The demographic and professional profile of respondents further contextualises these findings. Dentists across a range of age groups, genders, practice settings, and years of experience demonstrated a clear preference for fixed installations, with no correlation observed between experience and device choice. This suggests that external regulatory and safety considerations, rather than professional background, are the primary drivers of equipment selection.

Although international studies have demonstrated safe use of handheld X-ray units when strict protocols are followed, evidence also indicates increased operator exposure compared to wall-mounted units. Taken together, these findings highlight that handheld X-ray units may be valuable in specific scenarios where fixed installations are impractical or unavailable, but they should not replace fixed equipment in routine practice. Ongoing education, strict adherence to radiation safety protocols, and continued monitoring of compliance remain critical to ensuring both patient and operator safety.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest related to any aspect of this research project.

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Online CPD in 6 Easy Steps

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

CPD questionnaire

The Evolution and Efficacy of Disinfection Methods in Dental Practices: From Traditional to Advanced Technologies – A Review Article

1. **Select the CORRECT option. What is the primary goal of mechanical disinfection in dental settings?**
   A. To increase the efficacy of chemical disinfectants
   B. To eliminate microorganisms through chemical reactions
   C. To reduce the microbial load by removing visible debris and contaminants
   D. To sterilize all surfaces and instruments

2. **Choose the CORRECT answer. Which disinfectant is commonly used in endodontics for root canal disinfection?**
   A. Hydrogen Peroxide
   B. Sodium Hypochlorite
   C. Quaternary Ammonium Compounds
   D. Ethanol

3. **Which option is CORRECT. What is a key advantage of using disinfectant wipes in dental practices?**
   A. They are less effective than sprays
   B. They reduce chemical exposure and ensure proper coverage
   C. They are more costly than sprays
   D. They are not suitable for high-touch surfaces

4. **Which answer is CORRECT. Which type of disinfection method involves the use of high-pressure steam to kill microorganisms?**
   A. UV-C Radiation
   B. Plasma Sterilization
   C. Steam Sterilization
   D. Ozone Treatment

5. **Select the CORRECT statement. What is a challenge associated with the use of chlorine-based disinfectants in dental clinics?**
   A. They are less effective against bacteria
   B. They can be corrosive to metals and release toxic gases when mixed with ammonia
   C. They have a long shelf life and high cost
   D. They are ineffective against viruses

Feasibility of a Digital Mindfulness Intervention for Stress Reduction Among

Dental Students: A Pilot Study

6. **Which tool was primarily used in this study to assess perceived stress among dental students?**
   A. Depression, Anxiety and Stress Scale (DASS-21)
   B. General Health Questionnaire (GHQ)
   C. Perceived Stress Scale (PSS-10)
   D. Beck Depression Inventory (BDI)

A Comparative Analysis of Traditional Dental Screening versus Smart Phone Screening

7. **Choose the CORRECT answer. What was the primary aim of the present study on teledentistry conducted at Tygerberg Oral Health Centre?**
   A. To compare different mobile applications for dental care
   B. To evaluate the diagnostic reliability and accuracy of teledentistry compared to traditional clinical dental screening
   C. To analyze the economic benefits of teledentistry in South Africa
   D. To explore the role of intraoral cameras in cosmetic dentistry

8. **Which option is CORRECT. What diagnostic tools were used in the study to ensure consistency?**
   A. Visual analog scales and radiographic imaging
   B. The International Caries Detection and Assessment System (ICDAS) and the Decayed, Missing, and Filled Teeth (DMFT) index
   C. Cone-beam computed tomography (CBCT) and periodontal probes
   D. Fluorescent imaging systems and bite-wing radiographs

9. **Select the CORRECT answer. Which platform was utilized for securely uploading and assessing intraoral photographs in the study?**
   A. WhatsApp
   B. Vula App
   C. Google Drive
   D. Microsoft Teams

10. **Which option is CORRECT. What level of agreement was observed between clinical and photographic dental examinations in the study?**
    A. Moderate agreement with a Kappa coefficient of 0.50-0.70
    B. Substantial agreement with a Kappa coefficient of 0.70-0.80
    C. Almost perfect agreement with a Kappa coefficient ranging from 0.84 to 0.95
    D. Low agreement with a Kappa coefficient below 0.50

11. **Choose the CORRECT statement. How does teledentistry align with South Africa's National Health Insurance (NHI) goals?**
    A. By reducing the cost of cosmetic dental procedures
    B. By providing equitable access to quality oral healthcare for underserved populations
    C. By limiting the role of technology in healthcare delivery
    D. By focusing solely on urban populations

Biosafety practices among dental undergraduates in AIMST University. A cross-sectional study

12. **Which option is CORRECT. The primary purpose of using personal protective equipment (PPE) in dental procedures is**
    A. To improve comfort during procedures
    B. To prevent contamination and protect both patients and staff from infectious agents
    C. To avoid exposure to dental materials
    D. To comply with patient preferences

13. **Select the CORRECT answer. Critical item in dental instruments, requiring sterilization after each use is**
    A. X-ray aprons
    B. Dental mirrors
    C. Surgical forceps
    D. Light handles

14. **Which answer is CORRECT. Sharp instruments, like needles and scalpel blades should be disposed**
    A. In a regular trash bin
    B. In a biohazard bag
    C. In a puncture-resistant sharps container
    D. By rinsing and reusing

Design and Implementation of the Oral Medicine South Africa Registry: Epidemiology of Oral Lesions at three tertiary academic facilities in the Western Cape, South Africa

15. Choose the CORRECT answer. What was the most frequently observed oral lesion in the study?
A. Squamous cell carcinoma
B. Pyogenic granuloma
C. Fibroepithelial hyperplasia
D. Mucocele

16. Select the CORRECT answer. Which ethical practice was followed by excluding hospital records with insufficient data?
A. Ensuring informed consent
B. Protecting patient confidentiality
C. Maintaining research integrity
D. Promoting equitable inclusion

17. Which answer is CORRECT. What electronic platform was used to create the ORMSA database?
A. TrakCare
B. REDCap®
C. DisaLab
D. Corporate Data Warehouse (CDW)

Antibiotics in Dentistry: To Prescribe Or Not To Prescribe? That Is The Question

18. Choose the CORRECT option. In the case of a dental abscess with systemic involvement (e.g., fever, swelling), what is the recommended duration of antibiotic therapy to complement drainage and debridement?
A. 3 days
B. 5 days
C. 10 days
D. 14 days
E. 1 day

19. Which option is the INCORRECT indication. When should antibiotics NOT be prescribed for a dental infection?
A. The infection presents with localized swelling and pain
B. The infection is associated with systemic symptoms such as fever
C. There is evidence of cellulitis
D. There is difficulty breathing or swallowing
E. The infection has spread to surrounding tissues

20. Choose the CORRECT answer. A 35-year-old patient presents with localized swelling, pain, and pus drainage associated with a mandibular first molar. The tooth is diagnosed with a necrotic pulp and a chronic periapical abscess. The patient has no systemic signs of infection (e.g., fever, malaise). What is the most appropriate clinical management regarding antibiotic use?
A. Prescribe antibiotics and schedule root canal treatment
B. Perform incision and drainage, schedule root canal treatment, and manage the infection locally without prescribing antibiotics
C. Prescribe antibiotics and extract the tooth immediately
D. Refer the patient to an oral surgeon without prescribing antibiotics
E. Prescribe antibiotics for 7 days before performing any dental procedure.

Ethics: Confidentiality – it's about trust

21. Select the CORRECT statement. ou are approached by a broker to complete life insurance forms for a former patient who has recently demised. What do the Ethical Rules of Conduct for Practitioners Registered Under the Health Professions Act say about such a situation?
A. You cannot disclose the patient's information to the broker because you did not have the patient's prior consent to do so while they were alive
B. You can simply fill in the forms without concern, because the dead do not have any right to privacy or confidentiality
C. You can complete the forms if you have the written consent of the deceased's next-of-kin or the executor of the deceased's estate
D. You may only complete the forms if the broker has provided you with a court order to that effect

22. Which option is CORRECT. According to the HPCSA's Guidelines for Good Practice in the Healthcare Professions (booklet 5 – Confidentiality: Protecting and Providing Information), where a practitioner is asked to provide information about a patient, they should
A. Wherever possible, seek the consent of the patient, whether or not the patient can be identified by the disclosure
B. Anonymize data where unidentifiable data will serve the purpose of the disclosure
C. Keep disclosures to the minimum necessary
D. All of the above

23. Select the CORRECT statement. According to the HPCSA's Guidelines for Good Practice in the Healthcare Professions (booklet 5 – Confidentiality: Protecting and Providing Information), if a practitioner is asked to write a report about or examine a patient for a third party such as an insurance company, what should the practitioner do if the patient wishes to see the report written about them before it is disclosed?
A. The practitioner should always check whether the patient wishes to see their report unless the patient has previously, clearly and specifically stated that they do not wish to do so.
B. Disclosures to a relevant third party without the patient's consent can only be justified in exceptional circumstances, for example when it is necessary to do so to protect others from risk of death or serious harm. Ideally, all such disclosures should only be done after having obtained consent.
C. All of the above.
D. None of the above.

24. Which of these statements is CORRECT. Health records contain patients' special personal information which must be protected and kept confidential. What do the HPCSA's Guidelines on the Keeping of Patient Health records (booklet 9) say about retention, ownership, and access to the records?
A. A patient health record is owned by the patient who is therefore always entitled to the original records.
B. A patient is only entitled to access extracts of their records which are deemed relevant by the practitioner, therefore some notes made by the practitioner, such as those which might offend the patient, need not be disclosed to the patient.
C. If practitioners in private practice decide to close their practice for whatever reason, they must as soon as possible, hand over the original records to the patient for safekeeping.
D. A patient health record is owned by the health practitioner or the entity generating such a patient health record, should ideally be stored indefinitely, and a patient is entitled to have access to and obtain the information contained in such a record.

25. Select the CORRECT answer. According to the HPCSA's Ethical Guidelines on Social Media (booklet 16), which of the following is true?
A. Practitioners can share clinical photographs of patients on social media provided that the patient was made aware that the photograph might be used on social media and the patient did not object to this.
B. Practitioners can share clinical photographs of patients on social media without consent, provided that the patient can't be identified by the photograph.
C. Practitioners can share clinical photographs of patients on social media provided that they have the patient's oral consent and the practitioner believes that the patient cannot be identified by the photographs.
D. Practitioners can share clinical photographs of patients on social media provided that they have the patient's written consent whether or not the practitioner believes that the patient can be identified by the photographs.

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All articles must be submitted in English. Spelling should be in accord with the Shorter Oxford English Dictionary.
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Clinical trials should conform to the Consort Statement (Consolidated Statements of Reporting Trials) and Reviews to the PRISMA checklist (Preferred Reporting Items for Systematic Reviews and Meta Analyses) (http://www.equator-network.org).

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To be kept as brief, clear and unambiguous as possible.

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The abstract shall consist of not more than 200 words.
For research articles, the summary should be structured under the following headings: Introduction, Aims and Objectives, Design, Methods, Results and Conclusions. Do not include references in the Abstract.

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Continuing Professional Development
Please supply 4-5 Multiple-choice Questions (MCQ's) with 4 or 5 options per question related to your article. Questions must have only one correct answer, and indicate this correct answer clearly.

References

- References should be set out in the Vancouver style and only approved abbreviations of journal titles should be used (consult the List of Journals Indexed in Index Medicus for these details at: http://www.nlm.nih.gov/tsd/serials/lji.html).
- References should be inserted seriatim in the text using superscript numbers and should be listed at the end of the article in numerical order.
- A reference in the text should appear as indicated: "...as the results of a previous study showed.23"
- Where there are several papers referenced, the superscript numbers would appear as: "...previous studies have shown. [3,5,7,9-12,14]"
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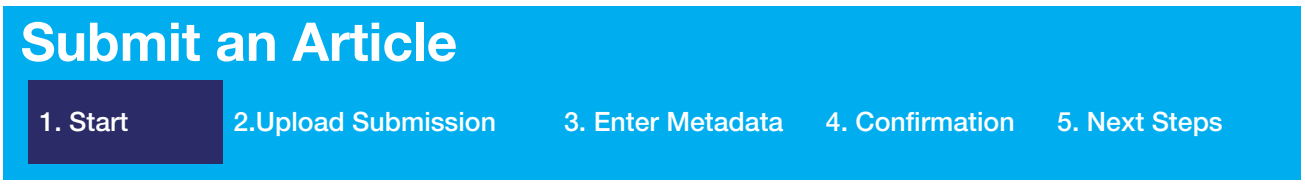

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