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Antibiotic prescribing patterns among dentists in the Durban metro region, South Africa

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ANTIBIOTIC PRESCRIBING PATTERNS AMONG DENTISTS IN THE DURBAN METRO REGION, SOUTH AFRICA

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Science in Dentistry.

Johannesburg, 2024

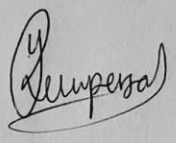
DECLARATION

I, Yuvti Rampersad declare that this research report is my own work.

It is being submitted for the degree of Master of Science in Dentistry at the University of Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination at this or any other university.

.....04..... day of.....JUNE.....2024



DEDICATION

Dedicated to my Divine Masters, Sri Swami Sivananda and beloved Pujye Swami Sahajananda,

And to the loving memory of my grandmother, Jamandree Baijnath.

ACKNOWLEDGEMENTS

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ACRONYMS

ABR –	Antibiotic resistance
ABS-	Antibiotic stewardship
AHA-	American Heart Association
AMR-	Antimicrobial resistance
BCS-	British Cardiac Society
BRICS-	Brazil, Russia, India, China, South Africa
BSAC -	British Society for Antimicrobial Chemotherapy
DNA-	Deoxyribonucleic Acid
HPCSA –	Health Professionals' Council of South Africa
PTF-	Penicillin therapeutic failure
RNA-	Ribonucleic acid
SADA-	South African Dental Association
SMAC-	Standing Medial Advisory Committee
SPSS-	Statistical package for the social sciences
WHO-	World Health Organization

ABSTRACT

Antibiotic resistance is a rising global phenomenon which challenges the delivery and efficacy of both simple and complex medical treatments. While the development of resistance is a natural progression for organisms, evidence suggests that there is a correlation between misuse and overuse of antibiotics and the subsequent development of resistant organisms. The aim of this study was to analyze the antibiotic prescribing patterns among dentists in the Durban-metro region.

Methods

This was a cross-sectional analysis of the antibiotic prescribing patterns among dentists in the Durban metro region, South Africa in 2022.The inclusion criteria adopted in this study were qualified dentists in the Durban metro region who are currently registered with the HPCSA. A sample size of 183 participants was calculated. The survey was sent to dentists on a closed-dental groups of 210 participants. Ninety-one responses to the survey were received. The survey was distributed on Microsoft forms and responses were recorded and captured in excel and exported to Stata for analysis.

Results

Amoxicillin was the most prescribed antibiotic (48%) while the most common antibiotic prescribed for patients who are allergic to penicillin was Clindamycin (58%). Seventy one out of ninety-one dentists prescribed antibiotics for a 5-day course (78%).

The most common reason for prescribing antibiotics was facial swelling 89% (81/91 dentists). More than half of dentists did not report any adverse effects after prescribing an antibiotic to a patient (57%). Seventy-three out of ninety-one dentists believed that dentists are contributing to antibiotic resistance (80%). Of the 80% that believe that dentists are contributing to antibiotic resistance, sixty-five out of ninety-one (71%) stated the most common reason for dentists contributing to antibiotic resistance to be unclear guidelines on antibiotic prescribing.

Conclusion

Most dentists in the study had a fairly good knowledge on how to prescribe antibiotics. However, a significant number of dentists (62%) incorrectly prescribed antibiotics for irreversible pulpitis. There was an overall good attitude towards antibiotic resistance with more than half of the dentists being aware that dentists are contributing to antibiotic resistance (80%).

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Antimicrobial resistance (AMR) is the resistance of micro-organisms to different treatment regimes, which includes the microbial species of bacteria, viruses, protozoa, fungi, archaea and algae. AMR is an escalating global crisis which is the cause of approximately 700,000 deaths every year. If interventions to prevent resistance are not implemented, AMR is predicted to result in ten million deaths yearly by the year 2050 (World Dental Federation, 2020).

Antibiotic resistance (ABR) is a sub-category of AMR and it describes the resistance of bacteria to antibiotics (World Dental Federation, 2020). ABR poses a world-wide threat due to longer hospital stays from prolonged illnesses, increased mortality, and difficulty with eradicating simple bacterial infections. Cumulatively, this will have a negative impact on the economy and is estimated to cause a collective global economic output cost of 100 trillion US dollars in 28 years' time (World Dental Federation, 2020). Easily accessible over-the counter self-medication, incorrect usage of antibiotics as well as unnecessary antibiotic prescribing by health-care professionals, promotes the development of antibiotic resistance (World Dental Federation, 2020).

The World Health Organization recognized the threat that antimicrobial resistance poses to human health along with the economy and thus developed a global action plan on antimicrobial resistance in 2015. Some of the aims of the global action plan involve improving knowledge on antimicrobial resistance, decreasing the prevalence of infection, and refining the use of antimicrobial agents (Mendelson and Matsoso, 2015).

While the development of resistance is a natural progression for organisms, evidence suggests that there is a correlation between how often and for how long antibiotics are used and the subsequent development of resistant organisms. Antibiotic resistance is accelerated by the misuse of antibiotics. With the development of more resistant bacteria, infections such as pneumonia, gonorrhea and tuberculosis are becoming increasingly difficult to treat, exacerbated by little to no development of new classes of antibiotics since the 1980's (Harahan *et al., 2021;* Mendelson and Matsoso, 2015).

Antibiotics are routinely prescribed for odontogenic infections by dentists who are responsible

for approximately 10% of antibiotic prescriptions worldwide. However, an estimated 80% of dental antibiotics are not being prescribed within guidelines (Böhmer *et al.,* 2021).

Between the years 2000 and 2015, there has been a global increase of 91% in the use of vital antibiotics which continues to escalate especially in low- and middle-income countries (Böhmer *et al.,* 2021). There are several antibiotic stewardship interventions in medical settings in high- and middle-income countries, however there is negligible data on antibiotic usage in lower income countries and to a lesser extent in the dentalenvironment (Thompson *et al*., 2022). Recent studies from England also noted increased dental antibiotic prescriptions due to the SARS-CoV-2-pandemic (Böhmer *et al.,* 2021).

Given that dentists have been recognized for numerous daily prescriptions of antibiotics, they are pivotally placed to make an impact on the ABR crisis. While basic guidelines for antibiotic prescribing exist, these are known to differ amongst countries. In the UK antibiotic treatment for infections is therapeutically focused. In the USA, prophylactic antibiotic prescription that aims to prevent the spread of infection to distant areas of the body, is common practice. Due to considerable inconsistencies among guidelines for dentists on antibiotic prescribing it remains a challenge to assess consistent prescribing data across countries. This poses difficulties in establishing an international consensus on dental antibiotic prescribing (Thompson *et al*., 2022).

Therefore, antibiotic stewardship (ABS) programs which monitor dental antibiotic prescribing patterns play a vital role in highlighting deficits in knowledge and defining areas of prescribing that require improvement (Thompson *et al*., 2022).

1.2 Literature review

1.2.1 Antibiotics

Antibiotics can be classified as either bacteriostatic or bactericidal and are used to treat and prevent infections. Bactericidal antibiotics destroy bacteria by preventing cell wall synthesis, protein synthesis, and inhibiting RNA and DNA synthesis, while bacteriostatic antibiotics prevent bacterial growth and reproductions. As there are multiple variables to be considered such as pharmacologic and host-specific factors, the selection of antimicrobial therapy for patients with odontogenic infections may be complex (Aidasani, Solanki and Khetarpal, 2019; Holmes and Pellecchia, 2016). Antibiotics are classified according to classes namely: penicillin's, cephalosporins, macrolides, lincosamides, tetracyclines, fluoroquinolones and imidazole's. Hartshorne (2020) summarized the classes of antibiotics, their mechanism of action and side effects in the following table.

Table 1: The classification of common antibiotics in dental practice (Hartshorne, 2020).

Class	Mechanism of action	Side-effects
Penicillin	Inhibits cell wall synthesis (bactericidal)	Diarrhea Vomiting Hypersensitivity reactions
Cephalosporins	Inhibits cell wall synthesis (bactericidal)	Diarrhea Vomiting Nausea Hematologic toxicity
Macrolides	Prevents protein synthesis (bacteriostatic)	Liver toxicity Diarrhea Nausea Vomiting
Lincosamide	Prevents protein synthesis (bacteriostatic)	Pseudomembranous colitis Clostridium difficile Hypersensitivity reactions
Tetracycline	Prevents protein synthesis (bacteriostatic)	Nausea Diarrhea Vomiting Tooth discoloration
Fluoroquinolones	Inhibits DNA synthesis (bactericidal)	Toxic effect on chondrocytes resulting in tendon fractures. Cannot be used during pregnancy
Imidazoles	Inhibits DNA synthesis (bactericidal)	Hepatotoxicity Incompatible with alcohol use

As depicted in Table 1 above, there are numerous classes of antibiotics which may precipitate various side-effects. It is critical for dentists to be able to distinguish between patients presenting with side-effects specific to a drug they have prescribed and the symptoms of an antibiotic allergy. While antibiotics are one of the most common drug classes used by dental health care professionals today, numerous studies depict that overprescribing of antibiotics

without necessary indication or concurrent dental treatment is a worldwide occurrence. Along with antibiotic stewardship, antibiotic sensitivity testing may play a pivotal role in assisting dental health care practitioners administer the most effective therapeutic regime for their patients (Hartshorne, 2020).

1.2.2 Antibiotic resistance

Antibiotic resistance (ABR) is defined as the alteration of bacteria once it has been exposed to an antibiotic. This results in the ineffectiveness of antibiotics that were previously able to eradicate the bacteria (World Dental Federation, 2020). Antibiotics are considered to play a pivotal role in the evolution of modern medicine yet, their excessive and incorrect usage results in many short and long-term adverse effects on the patient and society collectively. While antibiotics are a beneficial tool for clinicians, they also pose global complications such as ABR.

A study conducted in 2019 in the United States, reported that annually two million people may be affected by antibiotic-resistant infections, and approximately 23,000 deaths occur due to these infections (Tampi *et al*., 2019). Furthermore, antibiotic resistant infections are not the only adverse effects associated with antibiotics. Hypersensitivity reactions, peripheral neuropathies with metronidazole usage, hepatotoxicity and adverse drug interactions are some of the other side-effects that may be precipitated by antibiotic usage (World Dental Federation, 2020). Changes in commensal flora of the body, which is not always completely reversible, can result in *C. difficile* diarrheal infections and the development of fungal infections in the mouth and vagina (Stein *et al*., 2018; Holmes and Pellecchia, 2016). Antibiotics are administered daily by health care practitioners as well as dentists, who therefore have the responsibility to administer antibiotics in an ethical manner.

While the usage of antibiotics during the years 2000 to 2010 had escalated globally by 40%; during the recent Covid-19 pandemic more health care practitioners were prescribing antibiotics to patients online without obtaining accurate clinical diagnosis due to lack of face-to-face medical and more specifically dental consultations.

Dentists who fail to acquire a concise patient history, appropriate diagnosis and are unsuccessful in executing the most effective therapeutic intervention for the patient may be contributing to antibiotic resistance (Hartshorne, 2020). One of the primary causes of antibiotic resistance is "the inappropriate and unnecessary prescription of antibiotics by health care professionals" (Hartshorne, 2020). The BRICS countries (Brazil, Russia, India, China, South Africa) are

estimated to be responsible for three quarters of the global antibiotic consumption (Bhuvaraghan *et al*., 2021). In developing countries such as South Africa ABR also places a huge economic strain due to increasing challenges in eradicating multi-drug resistant infections such as Tuberculosis (Hartshorne, 2020).

In the global action plan on AMR published by the World Health Organization (WHO) in 2015, healthcare workers were recognized to play a pivotal role in maintaining the continual efficacy of antibiotics. The WHO further outlined that the misuse of antibiotics by healthcare professionals and prescription of antibiotics in circumstances where they are not warranted, can lead to a further rise in ABR. Factors such as the "most effective duration and dosage of a prescribed antibiotic, along with identification of the type of organism that has most likely caused the infection; are crucial aspects that healthcare workers must consider" to prevent antibiotic resistance. Other factors that play a role in the development of antibiotic resistance includes a lack of patient compliance and knowledge in correctly completing an entire course of antibiotics (WHO, 2015).

The suggestions emerging from the AMR global action plan advocates for "the use of antimicrobials in only vital and therapeutically effective situations to ensure they remain valuable in the future". Antibiotic stewardship programs further aim to deliver sustainable access to healthcare while simultaneously decreasing unsuitable and unnecessary prescribing by healthcare workers (WHO, 2015).

1.2.3 Antibiotic stewardship

Antibiotic stewardship (ABS) defines concise actions which aims to "improve and promote the correct use of antibiotics. These programs are targeted at the analytical, behavioral, and prescribing stages involved in infection management" (World Dental Federation, 2020). ABS assists in ensuring that the correct clinical protocols of antibiotic dosage, usage and prophylaxis are adopted by health care professionals. Antimicrobial stewardship has been defined by the Infectious Disease Society of America and the Society for Health Care Epidemiology of America as "an activity that included appropriate selection, dosing, route and duration of antimicrobial therapy" (Hartshorne, 2020).

Antibiotic resistance due to improper use, decreases the efficacy of antibiotics while concurrently increasing the incidence of infections which are costly to treat. An article by Hartshorne published in the African edition of the International Dentistry magazine in 2020, indicated that antibiotics are incorrectly used in 75% of cases involving dental conditions. With growing resistance and misuse of antibiotics, more research and analysis of antibiotic

prescribing patterns among dentists is required. Other authors have also identified incorrect antibiotic usage by dentists worldwide due to inconsistency in antibiotic guidelines, therefore clearly defined evidence-based antibiotic prescribing guidelines for dental health care professionals are a compulsory intervention (Hartshorne, 2020; Lalloo *et al*., 2017; Mainjot *et al.,* 2009).

There is a dire need for refined antibiotic stewardship programs orientated towards the prescription and usage of antibiotics only when strictly necessary. It is imperative that antibiotics are prescribed in an empirical nature only when required to eradicate a present bacterial infection (Hartshorne, 2020, Mansour *et al*., 2018). The development of government policies defining clear guidelines along with continual surveillance will be highly beneficial tools for healthcare practitioners in aiming to reduce the burden of ABR (World Dental Federation, 2020).

1.2.4 The role of dentists in antibiotic resistance

Dentists play a pivotal role in the management of odontogenic infections. These infections are caused mainly by normal oral bacterial flora including aerobic and anaerobic gram-positive cocci and anaerobic gram-negative rods (Lalloo *et al*., 2017). Dentists are positioned to promptly diagnose odontogenic infections, which usually present as dental pain in the early stages and to provide the most appropriate treatment. Furthermore, they are involved in effectively making a profound impact in the prevention of dental infections. This is achieved through detailed patient education, reinforced oral health care instructions at each visit and timeous interceptive treatment when patients present with dental problems such as dental caries, gingivitis and periapical infections (Tampi *et al*., 2019).

Guidelines for antibiotics usage (based on established principles) in oral surgery exist in the literature, and appropriate antimicrobial prophylaxis and therapy have been demonstrated to be effective in preventing and controlling infections (Termine *et al.,* 2009). These guidelines by Oberoi *et al* (2015) and Dar-Odeh *et al* (2010) include the following:

1.2.4.1 The use of antibiotics in treating acute and chronic infections that may be either odontogenic or non-odontogenic in nature as prophylaxis prior to dental treatment to prevent focal infection in risk patients due to systemic diseases such as endocarditis, congenital heart disease and artificial heart valves.

1.2.4.2 To reduce local infection and systemic spread in patients who require surgical dental treatment such as surgeries for impacted third molars, periapical and implant surgery (Oberoi *et al*., 2015; Dar-Odeh *et al.,* 2010).

Anecdotal evidence, however, suggests that these well-established guidelines are often ignored. Antibiotic selection is often haphazard and based on personal preference. Antibiotics are often initiated at an inappropriate time and continued beyond the required time to be influential on reduction of infection rates (Hartshorne, 2020). Also, there are vast inconsistencies amongst clinicians as to which clinical situations are appropriate to prescribe antibiotics for prophylactic reasons. All these factors may have a role in the emergence of antibiotic resistance.

The fundamental treatment of odontogenic infections is surgical in nature and is based on the removal of the causative agent through definitive dental intervention like filling, root canal treatment or tooth extraction. However, adjunctive antibiotic treatment in very specific clinical cases may be necessary (Balaji and Balaji, 2018). Research detailing specific clinical situations which dentists are presented with and the instances in which they would prescribe antibiotics, will be highly beneficial in assuring that drugs are appropriately prescribed. Antibiotic stewardship programs (ABS), aimed at attempting to reduce antibiotic resistance by both healthcare professionals and the public, are extremely necessary if the efficacy of antibiotics is to be maintained in years to come.

The most common pathology that patients present to the dentist or dental specialist, are orofacial infections primarily caused by caries and inflammatory periapical pathology that manifest clinically as swelling and pain. The source of odontogenic infections is tooth-related, endodontic or periodontal in nature and may include a necrotic pulp from a carious tooth or severe periodontitis (Lalloo *et al*., 2017).

The nature of odontogenic infections is known to be that of mixed origin, being a combination of aerobic and anaerobic bacteria, with Streptomyces species the most common source of abscess and orofacial cellulitis. Aerobic bacteria such as *Streptococcus viridans*, *Streptococcus milleri* group series, coagulase-negative *staphylococci* and beta-haemolytic *streptococcus* have been isolated from odontogenic infections, while pathogens such as *Peptostreptococcus*, *Prevotella*, *Porphyromonas*, *Elkenella*, *Fusobacterium* and *Bacteriodes* are the anaerobic bacteria cultured from areas of chronic abscess formation (Holmes and Pellecchia, 2016).

The primary treatment of odontogenic infections is centered around “establishing drainage of the abscess and removal of the causative factor through primary dental procedures such as extraction, performing endodontic therapy on the tooth or surgical drainage procedures”. However, antibiotics may be used as an adjunct therapy to primary treatment, only if there is evidence of regional or systemic manifestation of infection. This presents as pronounced oedema, cellulitis, trismus, tachycardia, dysphagia, general malaise and fever (Hartshorne, 2020). If, however, the infection begins to extend beyond the alveolus of the jaws and into the

surrounding tissues, prompt surgical incision and drainage by an oral and maxillofacial surgeon is prudent to prevent patient morbidity and compromising of the airway (Balaji and Balaji, 2018).

According to Flynn *et al*., 2006 the adjunctive nature of antibiotic therapy in treating odontogenic infections cannot be understated. When antibiotics are used alone as a means of treatment the infection will only be partially subdued with the possibility of the recurrence of a more severe infection than the previous one.

As an odontogenic infection moves into the soft tissues, it manifests in four phases namely: inoculation (oedema), cellulitis, abscess, and resolution of the infection. The inoculation stage marks the infiltration and establishment of aerobic bacteria occurring in the first three days of onset. Oedema is defined as the "accumulation of interstitial fluid from adjoining infected tissues andis characterized by a soft, diffusely indurated, doughy erythematous swelling which is slightlytender to palpation". A minor increase of the surface temperature is apparent with minimal to no loss of function (Balaji and Balaji, 2018).

As the infection proceeds between day 3-5, the cellulitis stage occurs which is characterized by ill-defined diffuse erythematous swelling which is painful to palpation. This is because of the severe inflammatory response produced by the mixed aerobic and anaerobic flora. Cellulitis is defined by the "spread of bacteria into a space with interstitial fluid build-up resulting in a lesion that is large, diffuse and firm in nature. This is supplemented by moderate to severe loss of function and malaise with the addition of serosanguineous fluid accumulation" (Balaji and Balaji, 2018).

As infection continues to evolve, anaerobes begin to dominate the infected tissue resulting in liquefaction with the formation of purulence, marking the abscess stage. An "abscess is described as a well-defined and limited collection of pus caused by the breakdown of liquefactive necrosis within the tissues". It is clinically characterized by a small to large well-demarcated lesion that is painful with centralized fluctuance. Severe loss of function is noted with malaise and elevated surface temperature (Balaji and Balaji, 2018).

A periapical abscess occurs when infection from the pulp reaches beyond the apex of the tooth, while a dentoalveolar abscess occurs when periapical infection spreads beyond the dentoalveolar bone and into the vestibular space (Balaji and Balaji, 2018). When an infection is drained by surgical or spontaneous drainage, the affected bacteria are destroyed by the hosts defense mechanism resulting in the beginning of healing and the stage of resolution. In this stage, the involved region is firm in nature due to the removal of necrotictissue by macrophages

and an interchanging repair mechanism (Balaji and Balaji, 2018). While most odontogenic infections are caused by aerobic and anaerobic bacteria, antibiotics should only be prescribed if a patient presents with a well-established infection accompanied by clear regional or systemic manifestations (Fluent, Jacobsen and Hicks, 2016; Flynn *et al.*, 2012).

The justification of antibiotic usage for dental infections requires the nature of the infection to be severe and persistent. Other symptoms should include a fever above 37 degrees, lymphadenopathy, trismus, cellulitis, malaise, osteomyelitis, or persistent infection. Conditions in which there is pain without any of the above-mentioned symptoms of infection, necrotic pulp systems and radiolucency, teeth with a sinus tract and localized fluctuant swellings do not require the use of antibiotics (Balaji and Balaji, 2018).

An antibiotic stewardship study in South Africa conducted in 2017 on the prescription of antibiotics by dentists after tooth extractions analyzed more than 50 000 extraction events and reported that there was no consistency in prescribing patterns. It concluded that the dental practitioners in the study did not appear to follow a coherent set of indications or guidelines for antibiotic use (Lalloo *et al*., 2017). A study in the UK monitoring antibiotic prescriptionsin an emergency dental unit, reported that 57% of patients out of 500 were prescribed antibiotics without a clinical indication for their prescription (Lewis, 2008).

Antibiotic prophylaxis is often prescribed by dentists before surgical and non-surgical treatments with the aim of protecting certain at-risk patients from microbial infection or the spread of oral bacteria systemically. In a United Kingdom report of the Standing Medical Advisory Committee (SMAC), it is estimated that the number of antibiotic prescriptions by dentists is 3.5 million a year, of which a third of these are prescribed prior to treatment. The report recommends reducing the risks associated with antibiotic prophylaxis. These include the benefits of prescribing the drug for the shortest therapeutic interlude possible to lessen adverse effects, as well as prescribing the suitable dosage that will ensure adequate absorption at the site of treatment. (Termine *et al.*,2009).

There are clinical guidelines from the four most expert associations; namely the American Heart Association (AHA), The British Cardiac Society (BCS) the British Society for Antimicrobial Chemotherapy (BSAC) and European Society of Cardiology. However, despite these guidelines being available, dentists continue to incorrectly prescribe prophylactic antibiotics (Lisboa *et al.*, 2015; Oberoi *et al.*, 2015; Termine *et al.*, 2009).

A study regarding the knowledge of dentists in usage of antibiotics in pulpal and periapical

disease, published in an Iranian Endodontic journal, reported that only 29% of the participants presented with a full knowledge of the correct usage of antibiotics. It was concluded from the study that there exists generally a poor knowledge among dentists with regards to justification of valid indication of the type, prescription, duration and dosage of antibiotics (Nabavizadeh *et al*., 2011).

1.2.5 Knowledge and attitude of dentists towards antibiotics

Knowledge and attitude are two factors that have a significant role in describing how dentists prescribe antibiotics. According to research, dentists in the Middle east are heavily influenced by patient demand for antibiotics and limited available time to treat patients. Antibiotics may be inappropriately prescribed to limit postoperative infections if an adequately sterile environment cannot be created (Mansour *et al*., 2018). Ramadan and others (2019) conducted a study in Sudan which suggested that there are shortfalls in dentists' knowledge of clinical conditions which are appropriate for antibiotic prescription.

Research highlights that in many countries despite sufficient knowledge on antibiotics, dentists are prescribing antibiotics inappropriately. These studies depict that overprescribing is common in countries where longer durations, incorrect dosages and broader spectrum antibiotics are prescribed (Mansour *et al*., 2018). Similar conclusions were drawn from a study in Northern Morocco which depicted a lack of knowledge among dentists on the correct indications, dosages and durations for which antibiotics are to be prescribed (Khalifa *et al*., 2022). The lack in dentists' knowledge on correct antibiotic prescribing necessitates the monitoring of prescriptions, stewardship and the generation of awareness on antibiotic resistance in dentistry.

There are few indications for the use of systemic antibiotics in dentistry and consequently, diagnostic codes with their associated prescriptions are seldom written into paperwork. This presents a difficulty in accurately pinpointing when antibiotic prescriptions are inappropriately prescribed by dental health care professionals (Hartshorne, 2020; Fluent *et al*., 2016). It is also important to gauge dentists' attitude to antibiotic resistance. As dentists prescribe antibiotics daily, they are strategically positioned to prescribe antibiotics in a judicious manner based on evidence-based outcomes and to inform patients on the harmful effects of antibiotics.

1.2.6 Resistant species

In order to reduce antibiotic resistance, it is important to comprehend the etiology of odontogenic infections and monitor the patterns and outlooks of health-care professionals towards the development of resistant species. The dynamic and complex nature of microflora in odontogenic infections as shown in a study by Flynn *et al* (2012) depicted an extensive range

of 25 bacterial species, 24% of which have not yet been cultivated. In most cases, species that are not typically associated with odontogenic infections namely *Dialister pneumosintes* and *Eubacterium brachy*, were discovered.

The most common species associated with facial swelling and those that are usually detected in odontogenic infections are *Prevotella* and those of the *Streptococcus milleri* group. However, no *streptococci* were detected in the cases within the study. The study outlined the value for patients in tests conducted by clinicians for the rapid recognition of pathogens. Antibiotic sensitivity profiles, of which few exist in the dental environment, would serve to improve the treatment of severe odontogenic infections; owing to the ever-changing dynamics of oral microflora (Flynn *et al.*, 2012). The source of odontogenic infections may be tooth-related, endodontic, or periodontal in nature,or from trauma to the oral cavity (Lalloo *et al.*, 2017). Most odontogenic infections are caused by aerobic and anaerobic *streptococci, peptostreptococci, prevotella, fusibacterium and bacteriodes* (Flynn *et al*., 2012).

A retrospective study that evaluated the bacteriology of odontogenic infections in 100 patients discovered the following as depicted in Table 2 and 3 below.

Table 2**:** Number and types of aerobic bacteria isolated in the culture smears

Organism	**% of organisms isolated in 100 samples**
Streptococcus viridians	45
Staphylococcus aureus	20
Coagulase negative *staphylococci*	10
Corynebacterium species	5
Pseudomonas aeruginosa	5

(Bahl *et al.*, 2014)

Table 3: Number and types of anaerobic bacteria isolated in the culture smears

Organism	**% of organisms isolated in 100 samples**
Bacteroides	30
Prevotella	30
Peptostreptococcus	20

Porphyromonas	5

(Bahl *et al.*, 2014)

Table 2 above shows that out of five aerobic bacterial isolates of microbial cultures, *Streptococcus viridans* was the most prevalent bacteria in 45% of cultures.

Table 3 depicts that four anaerobic bacteria were isolated, with *Bacteriodes* and *Prevotella* being the most prominent bacteria with 30% each of the cultures (Bahl *et al*., 2014). While these (*Streptococcus viridans, Bacteriodes, Prevotella)* are considered the most common bacteria that are found in odontogenic infections currently,the microflora within the oral cavity is dynamic with an extensive range of bacterial species that are constantly evolving (Flynn *et al.* ,2012). The complexity of the oral microflora necessitates the continual appraisal of clinical guidelines for prescribing antibiotics to ensure the substantial treatment of odontogenic infections.

The most used class of antibiotic in dental practice is known to be penicillin's and more particularly amoxicillin (Dar-Odeh *et al.*, 2010). A study by Flynn and others (2006), evaluated the efficacy of penicillin in hospitalized patients with severe odontogenic infections. They noted a drastic increase in the isolation of one or more penicillin resistant strains. In the cases that received penicillin along with Microscopy, Sensitivity and Culture testing (MCS), a 60% failure of penicillin was noted.

Penicillin therapeutic failure (PTF) is defined as "the suspension of penicillin due to an allergic reaction, the development of necrotizing fasciitis in the patient, or when no clinical improvement is noted following 48 hours or more" (Flynn *et al.*, 2006). The increase in the rate of PTF due to the growing rate of penicillin resistance among pathogens of odontogenic infections warrants the monitoring of antibiotic prescriptions of dentists and their contribution to PTF (Flynn *et al*., 2006).

In a seven-year retrospective study on patients who required intravenous antibiotics for odontogenic space infections, *Streptococcus* species was noted in 70% of patients with a 23% penicillin resistance rate. The study recognized that severe orofacial infections are polymicrobial in nature and require broad spectrum antibiotics. As only a 5% resistance to Clindamycin was noted in comparison to 23% to penicillin, the study further concluded that Clindamycin is a good empiric antibiotic to treat severe odontogenic space infections due to its broad effectiveness against gram positive cocci and anaerobic gram-negative bacilli (Rifkind *et*

al., 2013).

In a more recent study conducted in 2019 on the microbial analysis of odontogenic infections an alarming rate of resistance to Amoxicillin was detected in 28 / 29 (97%) aerobic organisms and 31 / 36 anaerobic organisms (86%) (Sebastian *et al*., 2019). The antibiotic prescribing habits of health care professionals can have an influence on patternsof antibiotic resistance. The main factors associated with the development of antibiotic resistance are the dosage of the drug prescribed and the duration of the therapy which are both controlled primarily by a health care professional. Resistant bacterial strains can remain in an individual for approximately three months post antibiotic use and as a result, these individualshave a high level of antibiotic resistance in the general population (Lewis, 2008).

The continuously evolving nature of the microflora present in odontogenic infections, PTF and an increase in the resistance of bacteria to penicillin-based antibiotics necessitates the constant appraisal of clinical guidelines for dentists. It is important that data is collected on whether dentists are sending patients for antibiotic sensitivity testing if they return for the same odontogenic infection. A survey conducted in the UK of over 6000 general dentists showed that antibiotics were prescribed by 40% of dentists at least three times a week (Lewis, 2008). When the number of prescriptions of antibiotics in dentistry is decreased, the selection of resistant strains should occur less frequently.

There is a paucity of data on the prescribing patterns of dentists in South Africa. It is prudent to analyze how dentists are prescribing antibiotics and their subsequent involvement in the rapidly growing global problem of antibiotic resistance. In various studies conducted across the world, it was noticed that dentists were prescribing antibiotics to patients for scenarios that did not warrant antibiotic usage (Mansour *et al*., 2018; Stein *et al.,* 2018; Mainjot *et al.,* 2009; Epstein *et al.,* 2000). This necessitates the need for continuous assessment of dental antibiotic prescribing patterns. This will allow for the creation of explicit guidelines for judicious prescribingpractices for dentists.

While the most commonly identified microorganisms for odontogenic infections have remained consistent over the years, recent studies have shown a modification in the prevalence or ability to isolate and classify them, along with a change in the susceptibility of isolated organisms (Holmes and Pellecchia, 2016). A study evaluating the efficacy of prescribing penicillin to hospitalized patients with severe odontogenic infections noted a drastic increase in the isolation of 1 or more penicillin resistant strains. In the cases that received penicillin along with culture and sensitivity testing, 60% failure of penicillin was noted (Flynn *et al.,* 2006).

This study aimed to highlight the prescribing patterns of dentists in Durban South Africa and determine whether there is a need for explicit and more prudent guidelines for the use of antibiotics in the dental environment. It is envisaged that this study will act as a baseline for future studies with the aim of implementing stewardship programs among dentists to monitor and improve prescribing, thereby reducing antibiotic resistance and promoting a high standard of health-care in our country.

CHAPTER 2

AIM AND OBJECTIVES

2.1 Aim

The aim of this study was to analyze the antibiotic prescribing patterns among dentists' in the Durban-metro region.

2.2 Objectives

The research study focused on the following objectives – To:

2.2.1 Determine dentists' knowledge and attitude about antibiotic resistance.

2.2.2 Record the clinical conditions for which dentists are prescribing antibiotics.

2. 2.3 Record the type and number of days for which antibiotics are commonly prescribed.

2.2.4 Record any reported adverse events associated with prescribed antibiotics.

2.2.5 Determine if there is an association between demographic variables (age, years in practice, type in practice) and knowledge, attitude and prescribing patterns.

CHAPTER 3

MATERIALS AND METHODS

This study was a quantitative, cross-sectional study of antibiotic prescribing patterns among dentists in the Durban-metro region in 2022.

3.1 Study Population

3.2 Exclusion criteria and Inclusion criteria

Participants who were retired and those who were longer in practice were excluded from the study. Some participants were excluded on the basis that they did not answer all the questions. The inclusion criteria for the population in this study was qualified, practicing dentists in the Durban metro region, South Africa who were registered with the HPCSA.

3.3 Sample size

According to a statistician that was consulted on this study, the sample size calculation assumed a total population of 350 dentists of which 50% of them were assumed to prescribe within the approved antibiotic guidelines assuming a 5% level of significance. The minimum estimated sample size was 183 participants.

3.4. Sample method

The study instrument was a questionnaire that was used to collect data and was distributed to dentists in the Durban-metro region electronically. The research instrument consisted of 15 items (including demographic questions) with a level of measurement at a nominal level. The survey covered the basic demographics of the participants namely gender, number of years practicing after completion of their degree and practice type. The questionnaire used in this study was adapted from a study in Kolkata which was pretested, pre-validated and constructed using Qualtrics (Qualtrics Pvt. Limited Provo, Utah) (Kaul *et al*., 2018).

3.5 Study design

The study was based on quantitative research methodology using the survey technique as the primary tool. A cross-sectional study was conducted with dentists who were working either in state-owned or private institutions.

3.6 Research Instrument

The survey was the instrument used to collect responses from the sample of dentists. Data was obtained electronically. There was no contact between the sample population and the

researcher. The survey consisted of the following types of questions:

1) Demographic information of dentists – these asked the gender, number of years in practice and the type of practice that dentists work in.
2) The prescription of antibiotics by dentists for pulpal, peri-radicular and prophylactic conditions.
3) The different types of antibiotics prescribed by dentists and the duration that these antibiotics must be taken by the patient.
4) The observed adverse conditions that patients present with after using antibiotics.
5) The dentist's knowledge of and attitudes towards the role of antibiotics in dentistry.

3.7 Ethics

Complete anonymity was ensured through a numbering system whereby each completed survey was allocated a number by Microsoft forms, no names or personal details were recorded. A written consent form to participate in the study along with information regarding the study was sent along with the survey, which guaranteed responders anonymity. Surveys were created on the online survey platform Microsoft forms and were then posted on a closed dental WhatsApp group called "Young dentists in KZN" with 210 participants. Ethical clearance was requested and obtained from the Human Research Ethics Committee- Appendix B. Ethical clearance number: M210921.

3.8 Data analysis

The data collected from the responses was analysed with IBM SPSS version 28.0. The results were presented using descriptive statistics in the form of graphs, cross tabulations and other figures for the quantitative data that was collected. Inferential techniques included the use of the chi square tests and Kruskal Wallis 1-way Anova tests, which were interpreted using the p-values. The traditional approach to reporting a result requires a statement of statistical significance. A p-value is generated from a test statistic. A significant result is indicated with "$p < 0.05$" (Kaur, Stoltzfus and Yellapu, 2018). A binary logistic model was done to determine the odds of various independent variables on a bivariate dependent variable. Various non-parametric tests were performed to determine whether there was any relationship between gender, number of years practicing after qualification and practice type, with each of Knowledge and Attitude scores.

3.9 Analysis of categorical variables Knowledge and Attitude

The two categorical variables: "Knowledge" and "Attitude" were assessed as follows:
"Knowledge" has two categories namely, "Inadequate" and "Adequate." A knowledge score was constructed using Question 5 to 10 (see appendix A for survey). These questions were graded as follows: 'Inadequate" was given the symbol of 0 while "Adequate" was given the symbol of 1. The knowledge of responders to these questions was assessed based on evidence-based principles and guidelines in selected published literature. "Attitude" also has two categories which are "Negative" and "Positive". Questions 12.1 and 12.2 in Appendix A were used to construct an attitude score. These two questions were graded as "Negative" given the symbol of 0 and "Positive" the symbol of 1. The attitude of responders was evaluated.

The study entailed the collection of nominal and categorical data, with the purpose of determining how the different forms of data pertaining to knowledge and attitudes of dentists to antibiotics relate to each other. Hence a Chi-Square test was applicable to the study since a goodness of fit test among variables, population variance and independence of variables was investigated. The Chi-Square test was useful for testing a hypothesis when variables are nominal. It provides information on statistically significant observances of relationships and provides information on categories that are linked or differ (McHugh, 2013). Therefore, the various forms of data collected were represented in table form. The table lists the options for one variable on rows and the other option for the other variables as columns. The method of analysis of tables is referred to as cross tabulations. Cross tabulation is useful in determining if there is an association between variables and where it is statistically significant (Moore *et al.*, 2013). A p-value less than or equal to the significant level of 0.05 (p less than 0.05) rejects the null hypothesis.

Related to the Chi-Square test value is the binary logistic regression model. Logistic regression is useful for situations in which the presence or absence of a characteristic or values of a set of variables is done (Srimaneekarn *et al.*, 2022). It examines whether the observed proportions of events are in line with the expected values. As a confirmation of the findings, the Z-test was adopted. The Z-test is a statistical method that examines the variances between two populations to measure if they are equal. This is applied if data of the sample and the normal population are independent of one another (Almarashi and Aslam, 2021).

CHAPTER 4
RESULTS

4.1 General results:

The survey was sent to a closed group with 210 participants. After 3 months, there were responses from 67 participants. A reminder was then sent and 2 months later 24 more participants responded, thus the response rate was 91/210 (43%).

This section indicates the demographic characteristics from questions in the survey. Table 4 summarizes the demographics of the responders namely, gender, number of years practicing after qualification and practice type.

Table 4: Demographic characteristics of dentists

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	
6 – 10	26	28.6	0.512
11 – 30	30	33.0	
Total	91	100.0	

Practice type

	Frequency	Percent	p-value
Private practice	69	75.8	
Academic institution	4	4.4	
Hospital dentistry	13	14.3	< 0.001
Health center	3	3.3	
Other	2	2.2	
Total	91	100.0	

The ratio of females to males is approximately 5:4 (56.0%: 44.0%). The difference in the

composition by gender is not significant (p >0.05). Three-quarters of dentists in this study were in private practice (n=69; 75.8%), with 14.3% based at a hospital. The remaining categories combined, constituted 10% of the practice type (p < 0.001).

4.2 Results as per objectives

The following section outlines the results from the study as per the FIVE Objectives:

Objective 1: **Dentists' knowledge and attitude**

Table 5 below provides a summary of the statistical analysis that was performed on results pertaining to "knowledge" and "attitude".

Table 5: Table of knowledge and attitudes of dentists to ABR

		Frequency	Percentage	p-value
Knowledge	Adequate	84	92.3	<0.001
	Inadequate	7	7.7	
Attitude	Positive	59	64.8	0.005
	Negative	32	35.2	

Knowledge

This variable had two categories: "Adequate" and "Inadequate." The "Frequency" column indicated the number of respondents falling into each category. There were 84 respondents (92.3%) who had adequate knowledge. There were 7 respondents (7.7%) who had inadequate knowledge. The "p-value" column typically represents the result of a statistical test comparing the differences between the two categories. In this case, the p-value is less than 0.001, which suggests a highly significant difference between the two knowledge levels. This indicated that the difference in knowledge between those with inadequate knowledge and those with adequate knowledge is statistically significant.

Attitude

This variable also had two categories: "Positive" and "Negative." The "Frequency" column showed the number of respondents belonging to each attitude category. There were 59

respondents (64.8%) with a positive attitude, while 32 respondents (35.2%) may be categorized with a negative attitude. The "p-value" for attitude is 0.005, indicating that there is a statistically significant difference in attitudes between those with a negative attitude and those with a positive attitude.

Overall, this table presents data that shows the distribution of respondents' knowledge and attitudes. It suggests that there were statistically significant differences in both knowledge and attitude between the groups being compared, as indicated by the p-values. The percentages provide a sense of the proportion of respondents in each category relative to the total sample size. The overall central scores for both dimensions are greater than 50%.

Primary source of information on antibiotics

The following bar graph suggests that the internet is the most popular source of information on antibiotics:

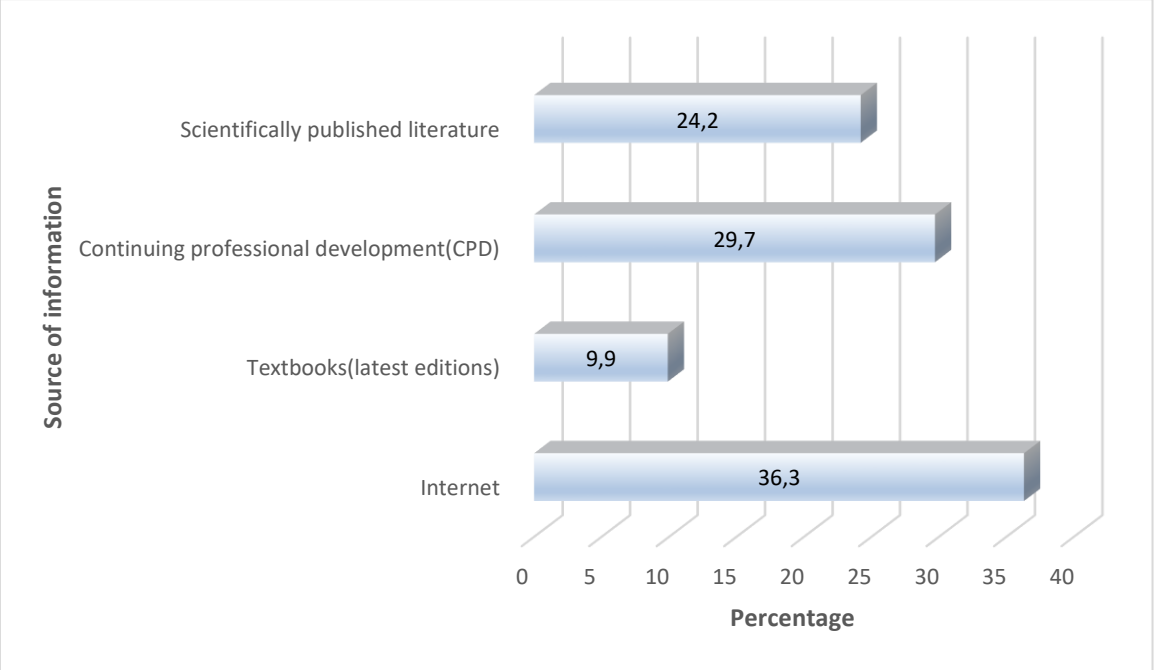


Figure 1: Bar graph of primary source of information on antibiotics

According to Figure 1, most responders used the internet (n=27; 36.3%) as their primary source of information on antibiotics. Continuous professional development (CPD) with (n=27;29.7%), scientifically published literature (n=22; 24.2%) and latest edition of textbooks (n=9; 9.9%) were the second, third and least used sources, respectively.

Objective 2: Clinical conditions

Pulpal and peri-radicular conditions for which antibiotics are prescribed.

Table 6 presents the number and percentage of dentists that prescribed antibiotics "Yes" for the listed conditions, as well as those who did not prescribe for these conditions "No".

Table 6: Table of pulpal and peri-radicular conditions for which antibiotics are prescribed

	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 is significant*.

Facial cellulitis (n=80; 87.9%) was the condition for which the highest percentage of antibiotics was prescribed, followed by localized dentoalveolar abscess (n=75; 82.4%), localized dentoalveolar abscess with draining fistula (n=72; 79.1%), irreversible pulpitis (n=56; 61.5%), and reversible pulpitis (n=21; 23.1%), respectively. There were significantly more antibiotics prescribed (Yes) for all conditions except for reversible pulpitis which had significantly fewer prescriptions written.

Factors affecting the prescription of antibiotics.

The following graph and table show the percentages and reasons for which antibiotics were prescribed, namely, facial swelling (n=81; 89 %), pain relief (n=52; 57.1%), as prophylaxis (n=48; 52.7%) before an extraction, unavailable appointment for several weeks (n=28; 30.8%), and patient request (n=21; 23.1%).

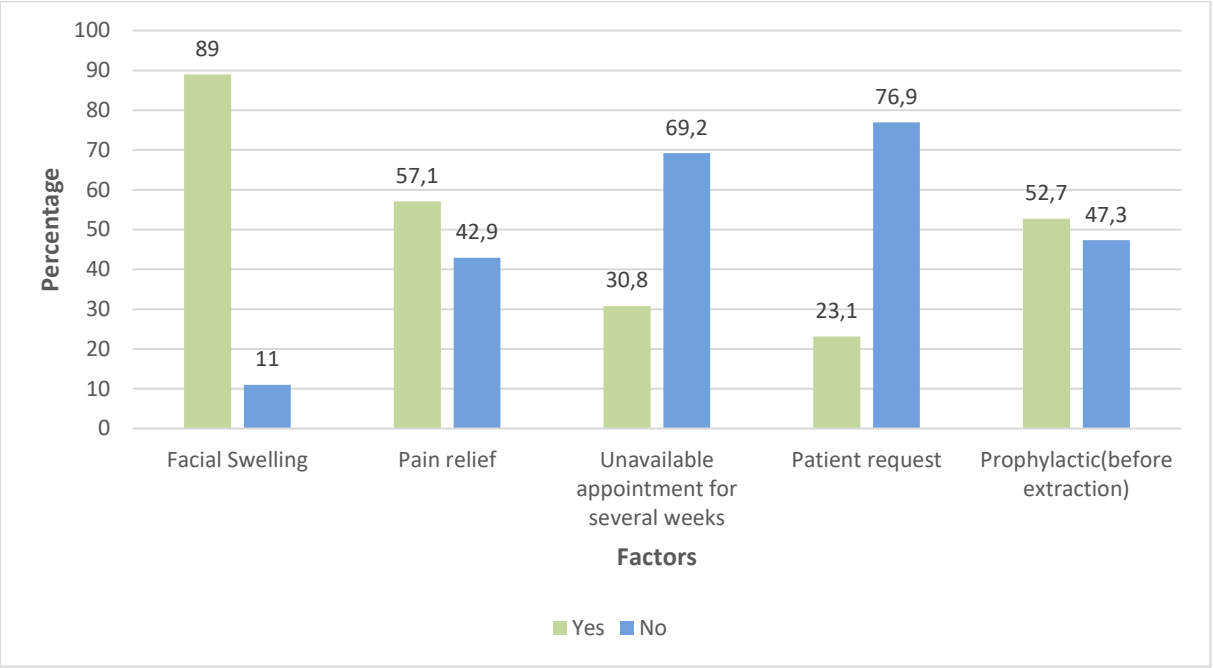


Figure 2: Bar graph of factors that influence antibiotic prescribing

Table 7 presents the frequency and percentage for certain conditions for which dentists prescribed antibiotics:

Table 7: Frequency and percentage for conditions which dentists prescribed antibiotics.

	No		Yes		p-value
	Frequency	Percent	Frequency	Percent	
Patient request	70	76.9	21	23.1	***<0.001**
Unavailable appointment for severalweeks	63	69.2	28	30.8	***<0.001**
Pain relief	39	42.9	52	57.1	0.173
Prophylactic (before extraction)	43	47.3	48	52.7	0.600
Facial swelling	10	11.0	81	89.0	***<0.001**

**p-value is significant if <0.005.*

More dentists prescribed antibiotics due to facial swelling (Yes = 89.0%) ($p < 0.001$). The p-values are chi-square goodness-of-fit tests values. These provide the significance for the row data comparisons per variable option (as in Table 7). That is, the difference between the number who indicated Yes compared to those who indicated No, was being compared. An analysis of the prescription rate only (the 'yes") does indicate that after facial swelling, antibiotics were commonly prescribed for pain relief and as a prophylactic.

The essential trends from this table indicate significant differences in the scoring patterns (Yes

vs No) for facial swelling, unavailability of appointments and patient requests. The evidence from this sample shows that there was a significant difference in the distribution of dentists' preference in prescribing antibiotics for facial swelling, unavailability of appointments and patient request. However, there were no significant differences for pain relief or prophylactic treatment before extraction. The p-values in this table indicate how well the observed data aligns with the expected distribution for each category. A low p-value as is seen for prescribing antibiotics for facial swelling, unavailability of appointments and patients requesting antibiotics, indicates a significant deviation from the expected distribution.

Antibiotics prescribed for prophylaxis

Along with the use of antibiotics to treat specific dental conditions, these medications are also prescribed prior to dental treatment as a cover for infective endocarditis in patients with specific medical conditions. Five such conditions were described in this survey namely, previous infective endocarditis, cardiac transplant after valvular damage, cyanotic heart disease, mitral valve prolapse with and without regurgitation and rheumatoid arthritis. Responders selected the conditions for which they prescribe antibiotic prophylaxis. The following bar graph provides a summary of the responses.

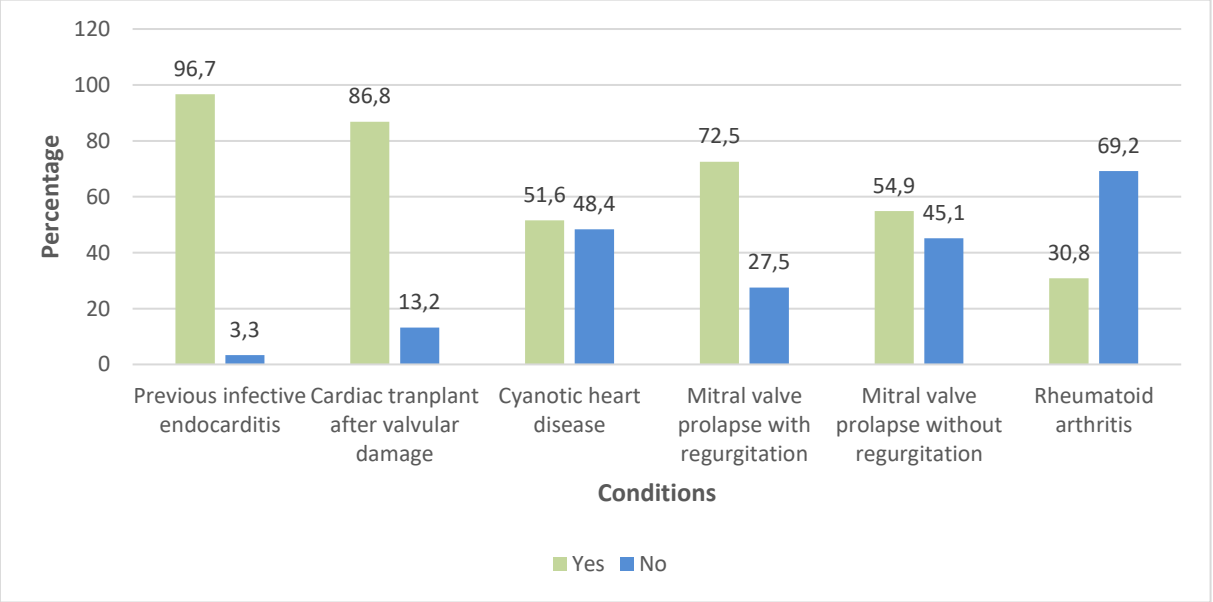


Figure 3: Bar graph of antibiotic prescriptions for prophylaxis

Most dentists prescribed antibiotics for patients with previously infective endocarditis (n=88; 96.7%). Cardiac transplant after valvular damage (n=79; 86.8%), mitral valve prolapse with

regurgitation (n=66; 72.5%) and rheumatoid arthritis (n=28; 30.8%) were other conditions for which antibiotic prophylaxis was prescribed.

Antibiotics prescribed for dental trauma.

The following bar graph presents these results

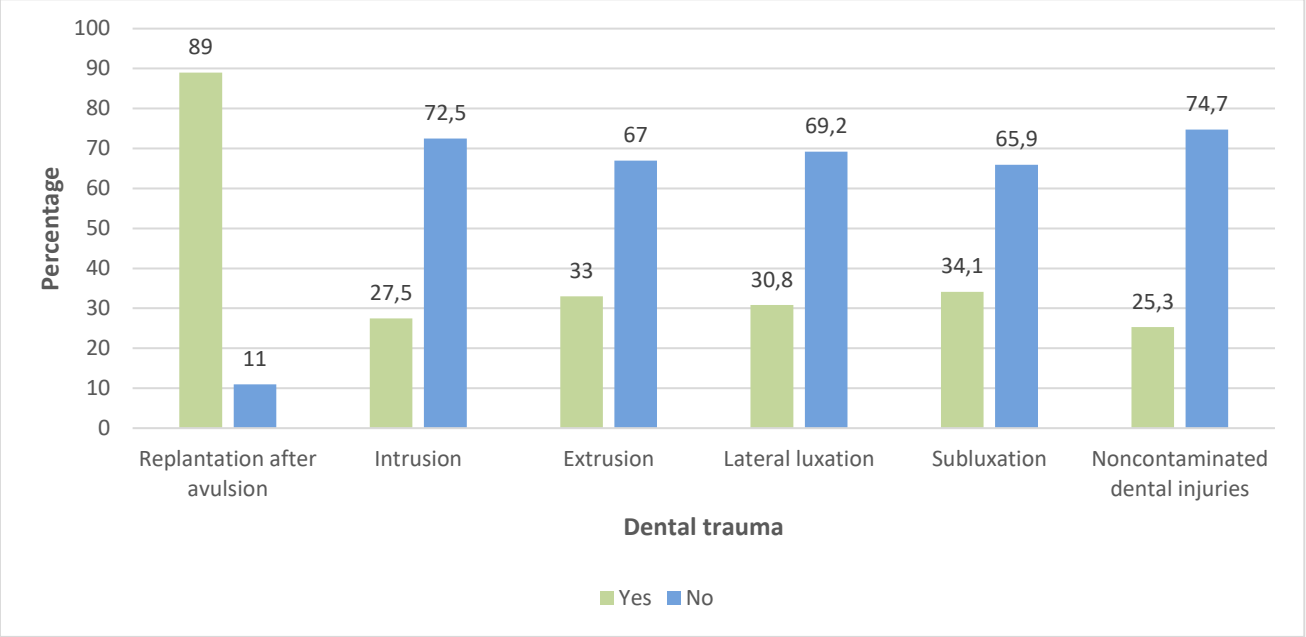


Figure 4: Bar graph of antibiotics prescribed for dental trauma

More dentists prescribed antibiotics for replantation after avulsion (n=81; 89.0%) ($p < .001$). Fewer dentists prescribed antibiotics for the remaining trauma incidents. It is noted that the prescription rate was similar. Fewer dentists prescribed for subluxation (n=31; 34.1%), extrusion (n=30; 33%), lateral luxation (n=28; 30.8%), intrusion (n=25; 27.5%) and noncontaminated dental injuries (n=23; 25.3%) respectively.

Objective 3: Type and duration of antibiotic prescribed.

The results from Objective 3 were for the most common type of antibiotic prescribed, the antibiotic prescribed to patients with a penicillin allergy and the minimum number of days an antibiotic is prescribed. The following bar graph shows the results for the most prescribed antibiotic in this study.

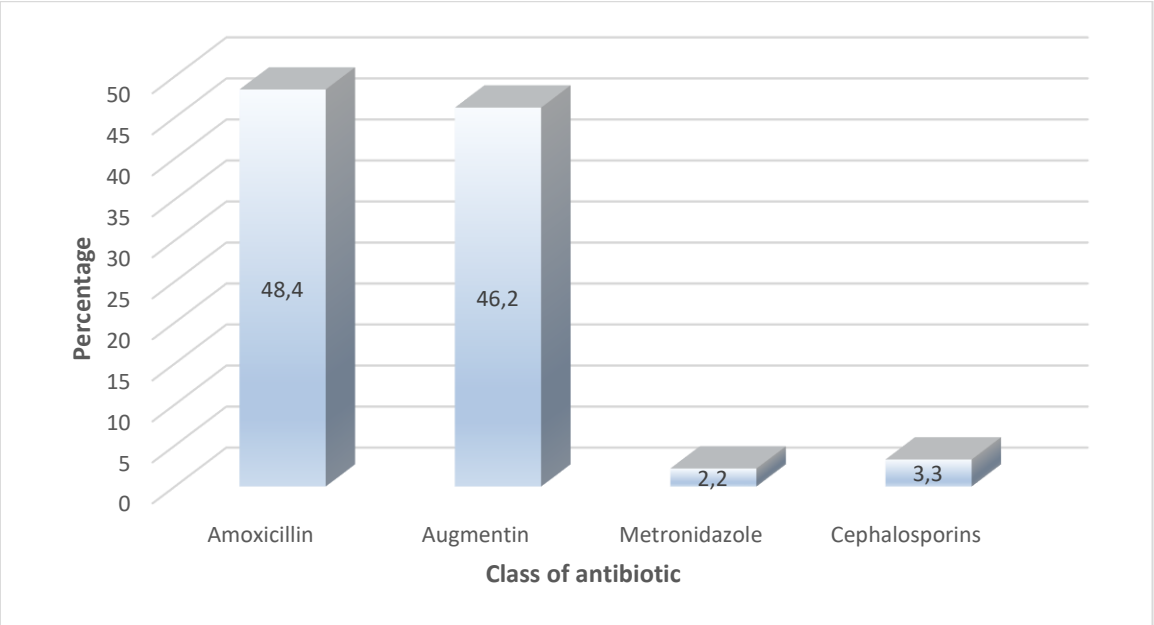


Figure 5: Bar graph of commonly prescribed antibiotic

More dentists prescribed Amoxicillin (n=44; 48.4%) than Augmentin (n=42; 46.2%) and fewer responders prescribed Metronidazole (n=2; 2.2%) and Cephalosporins (n=3; 3.3%).

Antibiotics for patients with a penicillin allergy

The dentists in this study were given 3 options of non-penicillin-based antibiotics and their preferences were recorded. The following bar graph (Figure 6) presents these results.

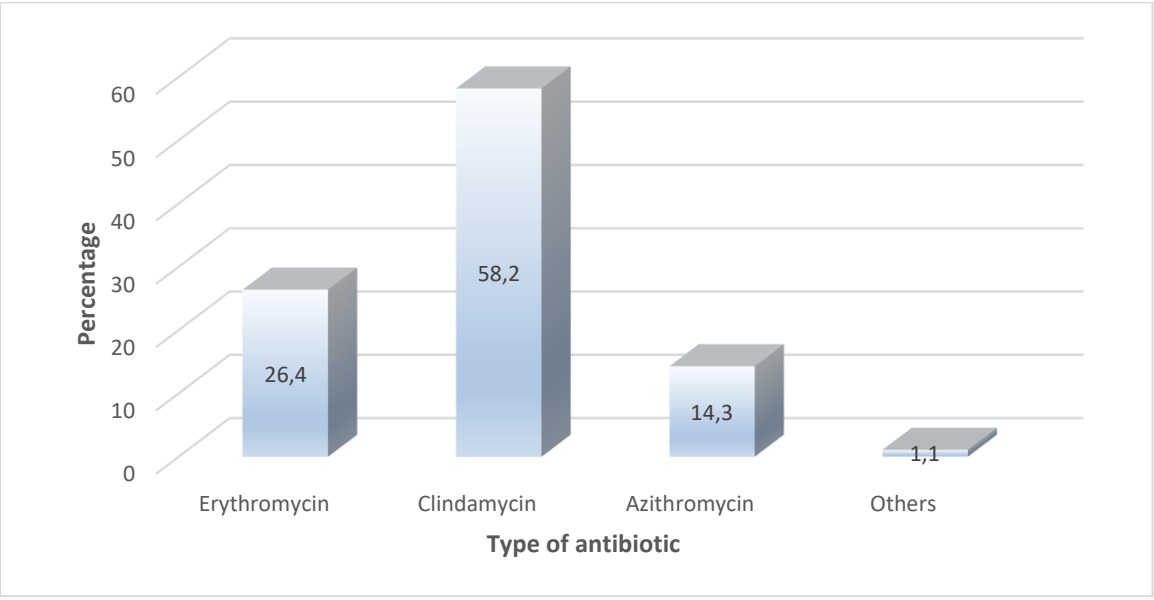


Figure 6: Bar graph of antibiotic prescribed for patients with penicillin allergy

As an alternative to penicillin-based medication, more than half of the dentists prescribed Clindamycin (n=53; 58.2%) ($p < 0.001$). Other common alternatives were Erythromycin (n=24; 26.4%) and Azithromycin (n=13; 14.3%).

Most common route of administration

Antibiotics may be administered either orally in the form of tablets or intravenously. Intravenous antibiotics are mostly administered in a hospital setting due to the availability of equipment required. All of the dentists in this study indicated that the prescribed antibiotics were only administered orally in the form of tablets.

The duration of prescribing an antibiotic

The following pie chart shows the duration that dentists in this study prescribe antibiotics.

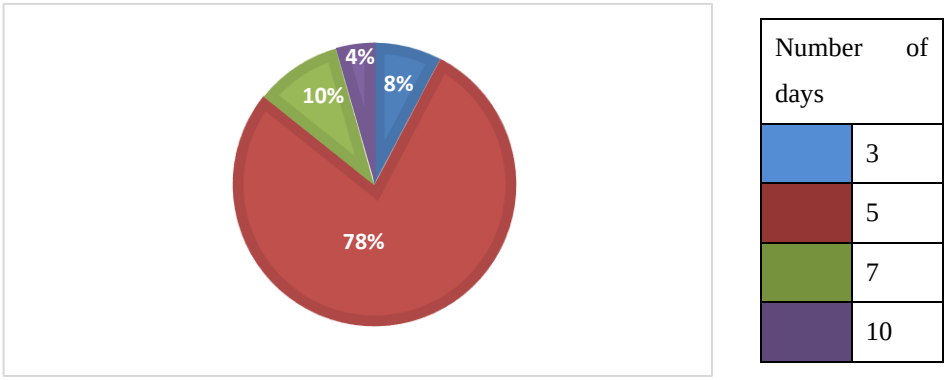


Figure 7: Pie chart of duration for prescribing antibiotics

The 5-day course was most prescribed by dentists at (n=71; 78%), compared to 7-days (n=9; 10%) and 10-days (n=4; 4%). The 3-day course of antibiotics were prescribed by (n=7; 8%).

Objective 4: Adverse effects of antibiotics

Table 8 shows the frequency of dentists in this study who recorded adverse effects versus those who did not report adverse effects.

Table 8: Table of adverse effects after administering antibiotics

	Frequency	Percent
No	52	57.1
Yes	39	42.9
Total	91	100.0

There was no significant difference in the number of patients that reported adverse effects as compared to those that did not ($p>0.05$). Of those who reported adverse effects in patients the most common effects noted were nausea vomiting and gastro-intestinal disturbances (n=25; 64%). Hives, itching and rash (n=11; 28%) were the second most common symptoms reported and vaginal thrush (n=7; 8%) was the least reported adverse effect.

Objective 5: Demographics and Knowledge vs Attitude

Dentists attitude to antibiotic resistance

The dentists in this study were questioned if they believe that dentists contribute to antibiotic resistance. The results from this are presented in the following table.

Table 9: Table of dentists' role towards antibiotic resistance

	Frequency	Percent
No	18	19.8
Yes	73	80.2
Total	91	100.0

**p-value is significant if < 0.005.*

Significantly more dentists (80.2% vs 19.8%) believed that dentists are contributing to antibiotic resistance. Those who were aware of dentists influence on antibiotic resistance (n=73; 80.2%) were given reasons for dentists' contribution to antibiotic resistance. These results are presented in Table 10 and Figure 8 below.

Table 10: Reasons that dentists are contributing to antibiotic resistance.

	No		Yes		p-value
	Count	Row N %	Count	Row N %	
Unclear guidelines on antibiotic prescribing	9	12.3%	64	87.7%	**< 0.001***
Patients requesting antibiotics	29	39.7%	44	60.3%	0.079
Poor access to information on antibiotics	34	46.6%	39	53.4%	0.558
Incorrect duration of prescription ofantibiotic	43	58.9%	30	41.1%	0.128
Other	54	74.0%	19	26.0%	**< 0.001***

**p-value is significant if < 0.005*

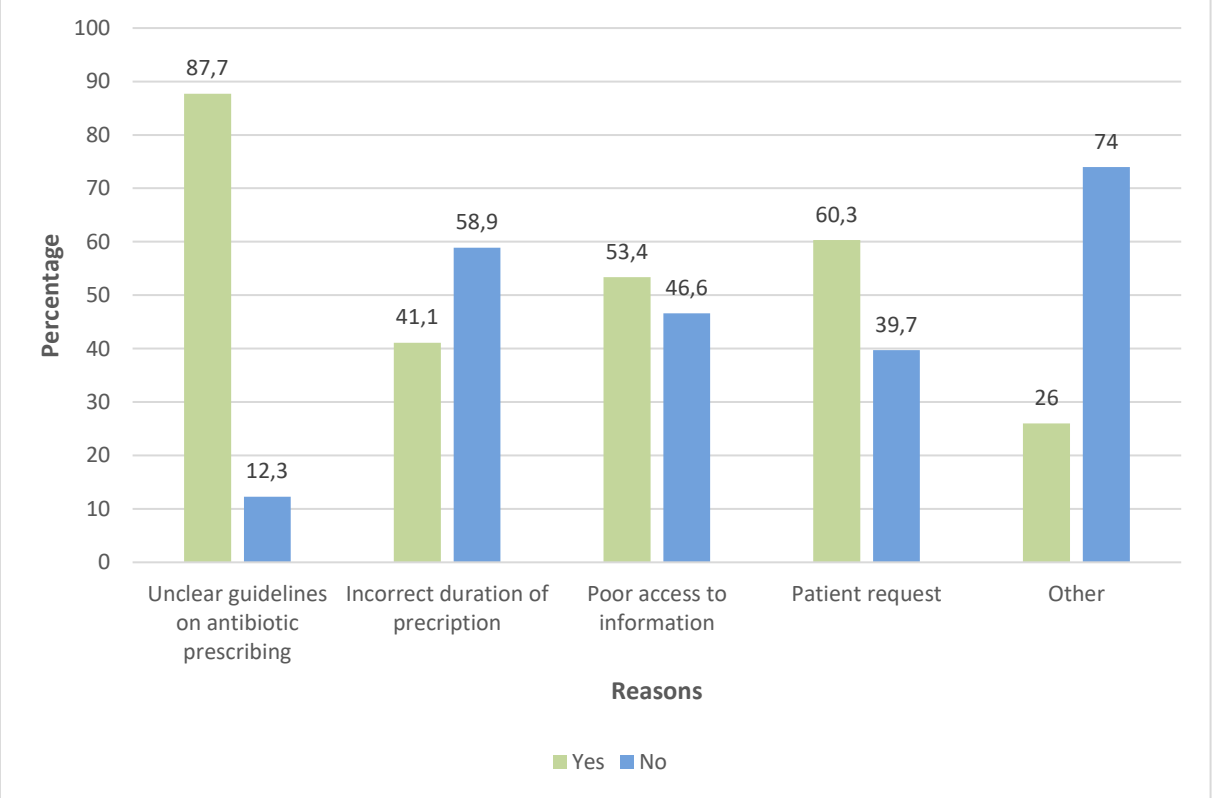


Figure 8: Bar graph of reasons that dentists are contributing to antibiotic resistance

The following patterns are observed in the table and graph above:

1) **Unclear Guidelines on Antibiotic Prescribing:**

A substantial trend emerges, with (n= 64; 87.7%) of cases responding "Yes" to unclear guidelines on antibiotic prescribing, while only (9; 12.3%) responded "No." This highly significant difference (p-value < 0.001) underscores a prevalent issue regarding the perception of ambiguous antibiotic prescribing guidelines.

Incorrect Duration of Prescription of Antibiotic:

Although a slight majority (n= 43; 58.9%) reported "No" for incorrect duration, a noteworthy (n=30; 41.1%) reported "Yes." The p-value of 0.128 suggests that there is no statistically significant difference between the responses for the incorrect duration of prescribing antibiotics.

2) **Poor Access to Information on Antibiotics:**

The data reveals that (n=39; 53.4%) of cases responded "Yes" to poor access to information on antibiotics, while (n=34; 46.6%) responded "No." The relatively high p-value of 0.558 implies that there is no statistically significant difference between Yes and No responses.

3) **Patients Requesting Antibiotics:**

A slight majority (n=44: 60.3%) indicated "Yes" for patients requesting antibiotics, with (n=29; 39.7%) responding "No." The p-value of 0.079 suggests that there is no statistically significant difference between patients requesting and not requesting antibiotics.

4) **Other:**

Approximately 26% (19 responders) selected “other”. Within this group who selected “other” the following were the responses:

- there are poor guidelines on antibiotics for South African dentists and a lack of monitoring of prescriptions (n=7; 38.9%).
- there are not enough studies on the efficacy of antibiotics in specific dental conditions (n=3; 16.7%).
- antibiotics are being prescribed for non-infection related conditions such as reversible pulpitis (n=3; 16.7%).
- patients request antibiotics due to a previous dental practitioner stating that the patient needed antibiotics prior to treatment (n=2; 11.1%)
- incorrect diagnosis of pulp conditions made by dentists (n=2; 11.1%).
- antibiotics are prescribed due to easy access and convenience for dentists if there is no available appointment for a long period of time (n=1; 5.5%).

In summary, the most prominent trends related to the perception of unclear guidelines on antibiotic prescribing exist among the group who selected “other”.

5) Demographic variables and prescribing antibiotics for unavailable appointments

More females (n=51; 56%) responded to this study than males (n=40; 44%).

Dentists in this study were given conditions for which they prescribe antibiotics and “unavailability of appointment for several weeks” was one of the options. The following table depicts the results of demographics and antibiotics prescribed for unavailable appointment.

Table 11: Demographics and antibiotics prescribed for unavailable appointment.

	(n)	Antibiotics prescribed for unavailable appointment (Yes)
Males	40	42.5%
Females	51	21.6%
Total	91	

It is noted that there were nearly twice as many male dentists who agreed (Yes) to prescribing antibiotics for unavailability of appointments for several weeks (42.5%), compared to females (21.6%). These results indicate that males in this study were more likely to prescribe antibiotics to patients if there is no appointment available, than females were.

CHAPTER 5

DISCUSSION

Introduction

This study on antibiotic prescribing patterns aimed to determine dentists' knowledge and attitude about antibiotics and to record the most common type of antibiotic, clinical conditions and duration for which dentists are prescribing. This study also reported on the adverse events that dentists encounter when prescribing antibiotics. It was also an aim of this study to determine if there is an association between demographic variables and knowledge and attitude of dentists to antibiotics. In summary, the research study examined the emerging current trends by dentists in prescribing antibiotics and whether dentists' beliefs and knowledge of antibiotics influenced their practice. The response rate of dentists to the survey was 91/210 (43%). The poor response rate may have been due to the surveys being distributed during the Covid-19 Pandemic, limited time for health care professionals to respond to surveys, internet connection difficulties or lack of interest in the study.

Demographic conditions

More females (56%) responded to the survey than males (44%) with a total number of 91 responses to the survey. Most of the dentists in this study were recently qualified with 1-5 years of experience after qualification (n=35; 38.5%), with the smallest group of responders being those with 6-10 years of experience after qualification (n=26; 28.6%). The most common practice type was private practice (n=69; 75.8%) with the least common practice type being responders from Health centers (n=3; 3.3%). It is to be noted that in future studies, the specification of what is classified as a "Health center" in South Africa should be more clearly outlined.

Antibiotic prescribing trends

Most dentists in this study use the internet (n=33; 36%) as their primary source of information on antibiotics. Continuous professional development (29.7%) was the second most common source of information and less of the responders use scientifically published literature (24%). The least common source of information was the latest edition of textbooks (9%). These results are most likely due to ease of access and the readily available nature of the internet as a result of advances in technology. Despite the positives of technology, it is unclear whether dentists are using reliable and scientifically appropriate sources for information on antibiotics.

Few dentists used continuous professional development as a source of information on antibiotics. Perhaps if seminars on antibiotic prescribing for dentists are made mandatory on an

annual basis, more dentists will get information on antibiotic prescribing from reliable scientific sources relayed by experts in the field.

A study by the University of Illinois Chicago depicted the success of implementing an Antibiotic Stewardship Program which assisted dentists through a clinical decision support tool, weekly email updates on mindful prescribing of antibiotics and routine tracking of prescribing. A 72.9% decrease in antibiotic prescribing in urgent care visits was reported after the Antibiotic Stewardship Program was implemented (Gross *et al*., 2019).

In this study, the most prescribed antibiotic was Amoxicillin (48%) with Augmentin (46%) being the second most common antibiotic that was prescribed. Cephalosporins (3%) e.g., Ceftriaxone or Cephalexin and Metronidazole (2%) were not as commonly prescribed as Amoxicillin. The results from this study were in line with other studies which reported that Amoxicillin is the most prescribed antibiotic by dentists (Sebastian *et al.*, 2019; Kaul *et al*., 2018).

Amoxicillin is penicillin based. Penicillin is regarded as the "gold standard" of treatment for odontogenic infections based on its low-cost, availability and low incidence of side-effects. However, recent studies indicate that approximately 70% of the bacteria that was isolated and tested from odontogenic infections were resistant to Penicillin (Ahmadi, Ebrahimi and Ahmadi, 2021; Prakash, 2013). The increase in penicillin resistance lends suggestion to the importance of dentists considering MC & S (microscopy, culture and sensitivity) testing of advanced odontogenic infections if the integrity of penicillin in treating dental infections is to be preserved in the future.

In patients with a penicillin allergy, responders in this study mostly prescribed Clindamycin (58%) with Erythromycin (26%) being the second most prescribed. Less dentists prescribed Azithromycin (14%) with only 1% prescribing unspecified others. Clindamycin is a viable antibiotic for odontogenic infections as it has the ability to "eradicate facultative bacteria and anaerobes, has significant oral absorption, along with good penetration of alveolar bone" (Prakash, 2013; Dar-Odeh *et al*., 2010).

All dentists in this study administered antibiotics through an oral route with none prescribing intravenous antibiotics. This indicates that dentists in hospital settings (14%) are not administering intravenous antibiotics either due to either a lack of knowledge, limited resources, or funding in the hospital environment.

Duration and conditions for prescribing antibiotics

Most of responders prescribe antibiotics for a 5-day course (78%), with less prescribing

antibiotics for 7 days (10%), 3 days (8%) and 10 days (4%). Dar-Odeh and others (2010) reported that long courses of antibiotics have a "negative impact on symbiotic flora that is pivotal in the maintenance of overall gut health. 21-day courses of antibiotics may cause isolation of resistant strains which hampers the ability of the oral cavity flora to prevent bacterial colonization". This in turn may lead to infections by multi-drug resistant bacteria that prove difficult to eradicate. As a result, short courses of antibiotics of 5 days are most effective. This is also dependent on the correct diagnosis of the bacterial organism causing the infection, the optimal dosage of the antibiotic which should be administered at the most appropriate time.

In this study, while most dentists prescribed antibiotics for the optimal duration of 5 days (78%), some dentists prescribed antibiotics for longer courses that is 7 days (10%) and 10 days (4%). This shows that there is still a need to update dentists' knowledge on the optimal duration for antibiotics to be most effective as well as to reduce the formation of resistant strains. Antibiotic monitoring, which will reveal the duration that antibiotics are being prescribed by dentists, will be beneficial in supervising and improving antibiotic prescribing among dentists. The prolonged use of antibiotics is one of the factors that contributes to the development of antibiotic resistance and is thus an area of prescribing that requires precise monitoring (Abraham *et al*., 2020).

The main reasons that responders in this study prescribed antibiotics for were facial swelling and pain relief. This was followed by prophylaxis before extraction. Some dentists prescribed antibiotics if there is no appointment available for several weeks, while others also prescribed antibiotics if patients requested them. Factors such as affordability, availability and popularity were also considered. Facial cellulitis and localized dentoalveolar abscess were consistent dental conditions among most dentists. Many dentists prescribed antibiotics for irreversible pulpitis and for facial cellulitis, while the condition for which antibiotics was prescribed for the least was reversible pulpitis (n=21; 23.1%). More dentists prescribed antibiotics for irreversible pulpits (62%) in this study as compared to findings from other countries such as in Saudi Arabia (42%) of dentists prescribed antibiotics for irreversible pulpitis, while in America a 2016 survey showed (8.1%) of dentists prescribing antibiotics for irreversible pulpitis.

For dental trauma conditions, dentists in this study prescribed antibiotics mostly for replantation of a tooth after avulsion (n=81; 89%). Fewer responders prescribed antibiotics for subluxation (n=31; 34%), extrusion (n=30; 3%), lateral luxation (n=28; 31%), intrusion (n=25; 27.5%) and the least prescribed antibiotics for noncontaminated dental injuries (n=23; 25.3%). Antibiotic prescribing for lateral luxation (31%) in this study was less than antibiotic prescribing among

dentists in Israel and Kolkata where 37.75% and 32% of dentists prescribed antibiotics for lateral luxation, respectively (Kaul *et al*., 2018; Rubanenko *et al*., 2021). This difference may be due to more dentists in this study being in private practice (75.8%) with patients visiting hospitals for facial trauma, instead of a private dental surgery for treatment.

Dentists' knowledge on antibiotics

In the present study, the results show that 92.3% of responders have adequate knowledge on antibiotic prescribing. While most dentists from this study appear to be knowledgeable on antibiotic prescribing, it is evident that inappropriate prescribing of antibiotics for dental conditions such as pulpitis does frequently occur. Irreversible pulpitis is a localized infection for which antibiotics usage is not advocated. The standard treatment for irreversible pulpitis should involve the removal of the causative agent through incision and drainage by root canal treatment or extraction only (Agnihotry *et al*., 2019.; Marra *et al*., 2016.; Dailey and Martin, 2001).

Antibiotics also have no noted effect on the consequences of pain relief or resolution of the infection for irreversible pulpitis (Marra *et al*., 2016). A Welsh national audit discovered (5%) of antibiotics prescribed for irreversible pulpitis (Agnihotry *et al*., 2019). The results from this study were in line with a similar study in Saudi Arabia by Alzahrani and others (2020) which depicted that dentists were inappropriately prescribing antibiotics for conditions such as chronic apical abscess, pulp necrosis and reversible and irreversible pulpitis. In a study on antibiotic prescriptions for emergency dental treatment published in the British Dental Journal in 2001, three quarters of patients were inappropriately prescribed antibiotics for pulpitis by dentists (Dailey and Martin, 2001). Kaul and others (2018) from a study conducted in India reported that 56% of dentists prescribed antibiotics for a localized dentoalveolar abscess when such conditions with no systemic symptoms requires definitive dental treatment instead of antibiotics. Conclusively, there appears to be over-prescription of antibiotics by dentists for localized abscess, reversible and irreversible pulpitis. Over-prescription of antibiotics is said to be one of the primary causes of antibiotic resistance world-wide which emphasizes the need for re-enforcement of correct antibiotic guidelines for dentists (Agnihotry *et al*.,2019; Sutherland, 2005).

While the results from this study may depict that dentists (South Africa) may be inappropriately prescribing antibiotics for localized dentoalveolar abscess, irreversible pulpitis and reversible

pulpitis; it is to be noted that the sample size in this study was limited. This was most likely due to poor response to the survey during the period of the Covid-19 pandemic. Thus, further research into the clinical conditions that dentists in South Africa are prescribing antibiotics is necessary to obtain a more accurate analysis of dentists' knowledge on antibiotics.

Antibiotics prescribed for infective endocarditis prophylaxis.

There appears to be a good understanding of treatment of patients with cardiac complications. Most dentists prescribed antibiotics prior to treatment in patients with previously infective endocarditis, for patients with cardiac transplant after valvular damage and for mitral valve prolapse with regurgitation. Less dentists prescribed antibiotics for mitral valve prolapse without regurgitation than with regurgitation. Approximately (n=47; 51.6%) of responders in this study prescribed prophylactic antibiotics for cyanotic heart disease while the lowest percentage for rheumatoid arthritis (n=28; 30.8%).

Adverse effects to antibiotics

Most dentists in this study did not report any adverse effects (57%) after prescribing antibiotics to a patient while (43%) did note adverse reactions after prescribing antibiotics to patients.

Of those who reported adverse effects in patients the most common was nausea vomiting and gastro-intestinal disturbances (64%). Hives, itching and rash (28%) were the second most common symptoms reported and vaginal thrush (8%) was the least reported adverse effect.

Dentists attitude to antibiotic resistance

More dentists in this study believed that dentists are contributing to antibiotic resistance (80%) than those who did not (20%). Of those who were aware of dentists' contribution to antibiotic resistance, the main reason was unclear guidelines on antibiotic prescribing (71.4%) with the second most common reason being patients requesting antibiotics (47.3%). Other dentists in this study thought that poor access to information on antibiotics (44%) and incorrect duration of prescribing (34%) also contribute to dentists' role in antibiotic resistance.

There are poor guidelines on antibiotics for South African dentists and a lack of monitoring of prescriptions. There are not enough studies on the efficacy of antibiotics in specific dental conditions. Antibiotics are being prescribed for non-infection related conditions such as reversible pulpitis. There still exists incorrect diagnosis and prescribing antibiotics

injudiciously. From these results it is evident that most dentists in this study believe that unclear guidelines on antibiotic prescribing is one of the main contributing factors to antibiotic resistance in the dental environment.

Guidelines for antibiotic prescribing in clinical conditions in dentistry differ worldwide. It is recommended that acute odontogenic infections be treated primarily with penicillin in the United Kingdom and United States, however Australian guidelines suggest a broad-spectrum combination of penicillin along with metronidazole. (Teoh *et al.*, 2021).

In Italy, the Ministry of Health recommended the use of antibiotics in dentistry for "tooth replantation, systemic side effects after pediatric oral surgery, orthograde endodontic therapy to control pain, side effects of acute apical abscess" and for severe periodontitis (Guerrini *et al.*, 2019). The European Society of Endodontology suggested antibiotic usage in the following situations: "Acute apical abscess in medically compromised patients and if systemic involvement is evident, progressive infections, replantation of avulsed teeth and soft tissue trauma requiring treatment" (Guerrini *et al.*, 2019).

While there are differences in the clinical conditions that warrant antibiotic usage in these countries, both Italian and European guidelines are similar in suggesting antibiotic usage for the conditions of:

1) Acute apical abscess if there are side effects and systemic involvement,
2) Replantation of avulsed teeth.

European guidelines further recommend antibiotics be strictly avoided for conditions of:

1) Symptomatic irreversible pulpitis,
2) Pulp necrosis
3) Symptomatic apical periodontitis
4) Chronic apical abscess
5) Acute apical abscess without systemic involvement" (Guerrini *et al.*, 2019).

According to the guidelines depicted above, dentists in this study inappropriately prescribed antibiotics for localized dentoalveolar abscess (n=75; 82.4%) and irreversible pulpitis (n=56; 62%). Along with differences in conditions for which antibiotics should be prescribed, there are also inconsistencies in research surrounding the prophylactic usage of antibiotics in dentistry. Ahmadi and others (2021) suggest several conditions for which antibiotics should be prescribed. These conditions include if "patients are immunocompromised, have a history of

cancer, infective endocarditis, prosthetic joints, valvular heart disease, hypertrophic cardiomyopathy, in patients who have prolapse of the mitral valve and prosthetic heart valves".

Conversely, American guidelines suggests that there is no correlation between dental procedures and the incidence of periprosthetic joint infections (Guerrini *et al.*, 2019). Therefore, the American Dental Association along with the American Academy of Orthopedic Surgeons suggests that appropriate antibiotic prophylaxis should be for patients with "hemoglobin A1C >8, who are severely immunocompromised, or who has a history of prosthetic joint infection requiring operation". It was further indorsed that dentists and orthopedic surgeons should use a risk calculator to assess patients' risk for prosthetic joint infections. As such, only patients with the highest risk of infection should be provided prophylactic antibiotics prior to dental treatment (Goff *et al*., 2020).

Contrary to American guidelines, authoritative organizations countries such as New Zealand, Canada, the Netherlands and Australia do not recommend that patients with prosthetic joint infections be prescribed antibiotics prior to dental treatment (Katz *et al*., 2021). As is depicted in the above research on guidelines for antibiotic prescribing in dentistry; there are vast inconsistencies in the suggested clinical conditions that dentists should prescribe antibiotics as well as for prophylaxis.

In this study the most common reason that responders considered in dentists' contribution to antibiotic resistance was unclear guidelines on antibiotic prescribing (n=64; 71.4%). Dentists in this study also felt that pressure from patients to prescribe antibiotics (n=43; 47.3%) is contributing to antibiotic resistance while (n=21; 23%) of responders prescribed antibiotics due to patient request. The results from this study along with the variations in literature on antibiotic prescribing, necessitate the creation of internationally coherent guidelines for all dentists to follow when prescribing antibiotics. Awareness and education of patients and the public on the harmful effects of inappropriate usage of antibiotics should be made a priority of health organizations. Dentists should also educate patients on the harmful effects of antibiotics to an individual and society at large. It would be beneficial for dentists to educate on the detrimental effects of antibiotics as a manner of informed consent before prescribing antibiotics to the patient. This would ensure that the risk versus benefit of antibiotic usage is fully explored by the dentist and the patient.

In this study there were responders who were not aware of the role of dentists to antibiotic resistance (20%). There are reports that depict an increase in the incidence of *Clostridium difficile* infections due to dental prescribing of antibiotics. These infections are known as antibiotic related colitis and may be life-threatening, more so in the elderly and medically

compromised populations. Clindamycin is related to fatal adverse drug reactions due to Clostridium difficile infections (Thompson *et al*., 2020). It is significant to note that despite the adverse reactions related to clindamycin; in this study clindamycin was the most common antibiotic prescribed by dentists for patients with a penicillin allergy (58%).

Antibiotic resistance is a complex global threat that is increasing annually. Awareness among health care practitioners such as dentists is imperative in the attempt to reduce resistance worldwide. Appropriate prescribing is linked to awareness of dentists in their contribution to antibiotic resistance on a global scale. Judicious antibiotic prescribing in dentistry will not only intensify patient safety by lowering the risk of adverse reactions but will also ensure that the possibility of dental infections becoming resistant to antibiotics is reduced.

Number of years practicing and antibiotic resistance

The statistical analysis of demographic category "number of years in practice" and likelihood to overprescribe was investigated in this study. It was found that dentists who have many years of practice (11 – 30 years) are 3.5 times more likely to contribute to antibiotic resistance than newly practicing dentists (1 – 5 years).

Our results were in accordance with a study conducted in the UAE in 2020 on the antibiotic prescribing patterns of dentists for endodontic infections, which also depicted an association between the number of years a dentist has been practicing and the frequency with which they prescribe antibiotics. The results of their study depicted that dentists practicing for a longer period were more likely to prescribe antibiotics at a more frequent rate than those who had been practicing for a shorter time. The frequency of prescribing antibiotics may be proportional to an increase in antibiotic resistance. Dentists who are newly qualified or practicing for a few years may have more recent,updated knowledge on antibiotics than those who have qualified many years ago (Abraham *et al*., 2020). Teoh and colleagues (2019) conducted a study in Australia which showed similar results to our study in that the years of practice was the main demographic factor which influenced antibiotic prescribing. Dentists who had recently graduated (0-5 years) tended to have better scores of antibiotic prescribing than older graduates.

In this study, the higher frequency of antibiotic prescribing in those practicing for more than 11 years, may translate to overprescribing amongst older dentists, as the frequency of antibiotic prescribing is one of the factors related to the development of antibiotic resistance. Younger

dentists whohave recently graduated might have more current knowledge on the dynamic nature of bacterial microbiology and thus a different attitude towards antibiotic resistance. Therefore, this study clearly outlines the dire need for mandatory continual professional development programs in antibiotics, more research into how dentists are prescribing antibiotics and frequent antibiotic stewardship programs. This would ensure that all dentists regardless of the number of years practicing after qualification have updated and accurate knowledge on prescribing antibiotics.

Antibiotic resistance and patient demand

Analysis of the results from this study depicted that the odds of dentists contributing to antibiotic resistance was 21.9 times greater when patients who requested antibiotics from dentists had prescribed them, than those who were not given antibiotics when they were requested. Almost half of the dentists in this study felt that they were under pressure from patients to prescribe antibiotics. However, some dentists still prescribed antibiotics if they were requested by patients. This conveys that while dentists may be aware that patient demand is not an appropriate factor to consider when prescribing antibiotics, antibiotics were still prescribed by dentists in this study based on patient expectations and demand.

Teoh *et al* (2019) discovered in a study in Australia that 82% of dentists recorded having seen patients who requested antibiotics instead of treatment, which was more than noted in our study. More recently Thompson *et al* (2022) suggested that due to patients receiving remote consultations during the first year of the COVID-19 pandemic, 78% of dentists in England reported that patients were requesting antibiotics more than previous years. As face-to-face consultations and certain dental treatments were not recommended worldwide during the pandemic, antibiotics were often prescribed by dentists to delay treatment to a later stage. This practice may still be influencing patient expectations today who may request antibiotics to delay dental treatment.

The results convey that along with monitoring the manner in which dentists are prescribing antibiotics, educating patients and the general public on the benefits and risks of antibiotics should be made a priority, especially since it was noted that more antibiotics were prescribed to patients during the COVID-19 pandemic.

In the objectives from the World Health Organization which were written in response to the steady rise of antibiotic resistance worldwide, it was suggested that national antibiotic

guidelines for dentists be established with readily available updated guidelines for dentists to refer to daily. Automatic surveillance of prescriptions and the electronic analysis of data captured should occur on a regular basis. The immense importance of the dental team in educating patients and the public on antibiotics was outlined. It was reiterated that dentists should manage patient expectations around antibiotics through perception altering statements such as “antibiotics don’t cure toothache” and “pain relief is best achieved through procedure not prescription” (Thompson *et al*., 2020).

Dentists should develop a checklist based on evidence-based principles for prescribing antibiotics. One such checklist was developed by the Australian government. They developed an acronym for practitioners to follow (MINDME) as a guiding principle or creed for antimicrobial prescriptions:

- M- “Microbiology guides therapy wherever possible,
- I- Indications are evidence based.
- N- Narrowest spectrum required.
- D- Dosage which is appropriate according to the site and type of infection.
- M- Minimize duration of therapy.
- E- Ensure monotherapy in most cases” (Bansal *et al.*, 2019).

It is extremely important that dental health care practitioners ensure that regularly updating themselves on judicious and effective antibiotic prescribing becomes a priority to reduce the growing threat of antibiotic resistance.

While most dentists in this study were considered to have adequate knowledge on antibiotics, there are limitations to this study in that only a small number of dentists responded to the survey thus it may not present an accurate depiction of the dentists in Durban. The online system used for the survey also did not permit responders to answer only some questions thus half completed surveys were not recorded. In the survey there are some questions which don’t have the option of “other” for responders to select which may present as shortfalls in the results.

CHAPTER 6

CONCLUSION

Healthcare practitioners like dentists play a pivotal role in creating awareness, adopting correct clinical practices and educating patients about antibiotic resistance. Most dentists from this study are aware of their contribution to antibiotic resistance. They also indicated that unclear guidelines are the main contributing factor to antibiotic resistance in dentistry in South Africa. The emerging trends from this study portray that there are a significant number of dentists who use the internet as a guide to prescribe antibiotics. Also, there were many dentists who inappropriately prescribed antibiotics for conditions such as irreversible pulpitis and reversible pulpitis. The prescribing of antibiotics incorrectly for clinical conditions may contribute to antibiotic resistance which is an increasing complication challenging the medical community worldwide.

Due to the paucity of globally cohesive guidelines for dentists on antibiotic prescribing, there is a necessity for well-defined therapeutic guidelines in the field of antibiotics in dentistry. Such guidelines will promote accurate diagnosis and decisions based on evidence rather than external factors such as patient request or lack of available appointments.

The current trend of inappropriate antibiotic prescription by dentists in this study emphasizes the necessity of health bodies to provide guidelines and protocols to dental practitioners. This awareness and knowledge may lead dentists to carefully analyze factors such as accurate diagnosis, duration, type, and patient history prior to prescribing antibiotics. The emergence of overprescribing tendencies by dentists lends urgency to the provision of easily accessible, scientifically approved information on antibiotics to South African dentists.

This study highlights the rising trend of inappropriate and injudicious prescribing of antibiotics by dentists. Therefore, there is need for antibiotic stewardship and monitoring of antibiotic prescribing among South African dentists**.** Furthermore, concise guidelines on antibiotic prescribing will ensure that odontogenic infections are treated accurately to minimize re-infection, antibiotic resistance, and multi-drug resistant infections.

As this study was conducted with a small population of dentists in the Durban metro region, it is proposed that further antibiotic stewardship studies be conducted across the nine provinces

of South Africa namely Eastern Cape, Free State, Gauteng, Kwazulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West and Western Cape. A larger population group will confer a more accurate representation of the population of dentists in South Africa, their antibiotic prescribing patterns and attitude towards antibiotic resistance.

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Appendix A: Data Instrument

SURVEY

Demographic questions:

1. Gender:

ϒ Male Female

2. Number of years practicing after qualification:

ϒ 1-5 years 6-10 years 11- 30 years

3. Practice type:

Private practice
Academic institution
Hospital dentistry
Health center
□ Other

Please tick your answers to the following questions:

(1) **What is your primary source of information on antibiotics? (Tick one)**

□ Scientifically published literature

□ Continuous professional development (CPD) and conferences

□ Textbooks (latest editions)

□ Internet

(2) Most commonly prescribed antibiotic: (Tick one)

□ Amoxicillin

□ Augmentin

□ Metronidazole

□ Cephalosporins, eg. Ceftriaxone or Cephalexin

(3) If a patient is allergic to penicillin, which antibiotic do you usually prescribe? (Tick one)

□ Erythromycin

□ Clindamycin

□ Azithromycin

□ Others

□ Oral

□ Intravenous

(5) Minimum number of days for prescribing antibiotic: (Tick one)

□ 3

□ 5

□ 7

□ 10

(6) Most common determinant for prescribing antibiotics:

□ Facial swelling

□ Pain relief

□ Unavailable appointment for several weeks

□ Patient request

□ Prophylactic (before extraction)

(7) Which of the following factors do you consider primarily while prescribing particular brand of antibiotics? (Tick one)

□ Popularity of the brand

□ Availability of the brand

□ Affordability of the brand

(8) In which of the following pulpal and peri-radicular conditions do you prescribe antibiotics? (tick all that you prescribed antibiotics for)

□ Reversible pulpitis

□ Irreversible pulpitis

□ Localized dentoalveolar abscess

□ Localized dentoalveolar abscess with draining fistula

□ Facial cellulitis

(9) In which of the following conditions would you prescribe antibiotics in case of dental trauma? (tick all that you prescribe antibiotics for)

□ Replantation after avulsion

□ Intrusion

□ Extrusion

□ Lateral luxation

- □ Subluxation
- □ Noncontaminated dental injuries

(10) Mention the conditions under which you give infective endocarditis prophylaxis: (tick all that you prescribe antibiotics for)

- □ Previous infective endocarditis
- □ Cardiac transplant after valvular damage
- □ Cyanotic heart disease
- □ Mitral valve prolapse with regurgitation
- □ Mitral valve prolapse without regurgitation
- □ Rheumatoid arthritis

(11) Have your patients reported any adverse effects after prescribing an antibiotic to a patient? If yes, what did you report?

- □ Yes
- □ No

If yes:_____

(12.1) Do you believe that dentists are contributing to antibiotic resistance?

- □ Yes
- ϒ No

(12.2) If you answered yes to the above, what are the reasons that dentists are contributing to antibiotic resistance?

- ϒ Unclear guidelines on antibiotic prescribing
- ϒ Incorrect duration of prescription of antibiotic
- ϒ Poor access to information on antibiotics
- ϒ Patients requesting antibiotics
- ϒ Other. List other reasons:_____

Thank you for your time

Appendix B: Ethical clearance certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R49 Dr Y Rampersad

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M210921

NAME: (Principal Investigator)	Dr Y Rampersad
DEPARTMENT:	School of Oral Health Sciences Department of Maxillofacial and Oral Surgery Dental School University
PROJECT TITLE:	*Antibiotic prescribing patterns among dentists in the Durban metro region, South Africa*
DATE CONSIDERED:	2021/10/01
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Dr V Premviyasa
APPROVED BY:	CB Penny Dr CB Penny, ~~Chairperson~~ HREC (Medical)
DATE OF APPROVAL:	2021/11/24

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in September and therefore reports and re-certification will be due in the month of **September** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

2021/11/24
Date

Appendix C: Letter of permission

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

Department of Maxillo-Facial and Oral Surgery
011 717 2130
Liza.huygen@wits.ac.za

25 August 2021

TO WHOM IT MAY CONCERN

RE: DR Y RAMPERSAD – STUDENT NO 812690

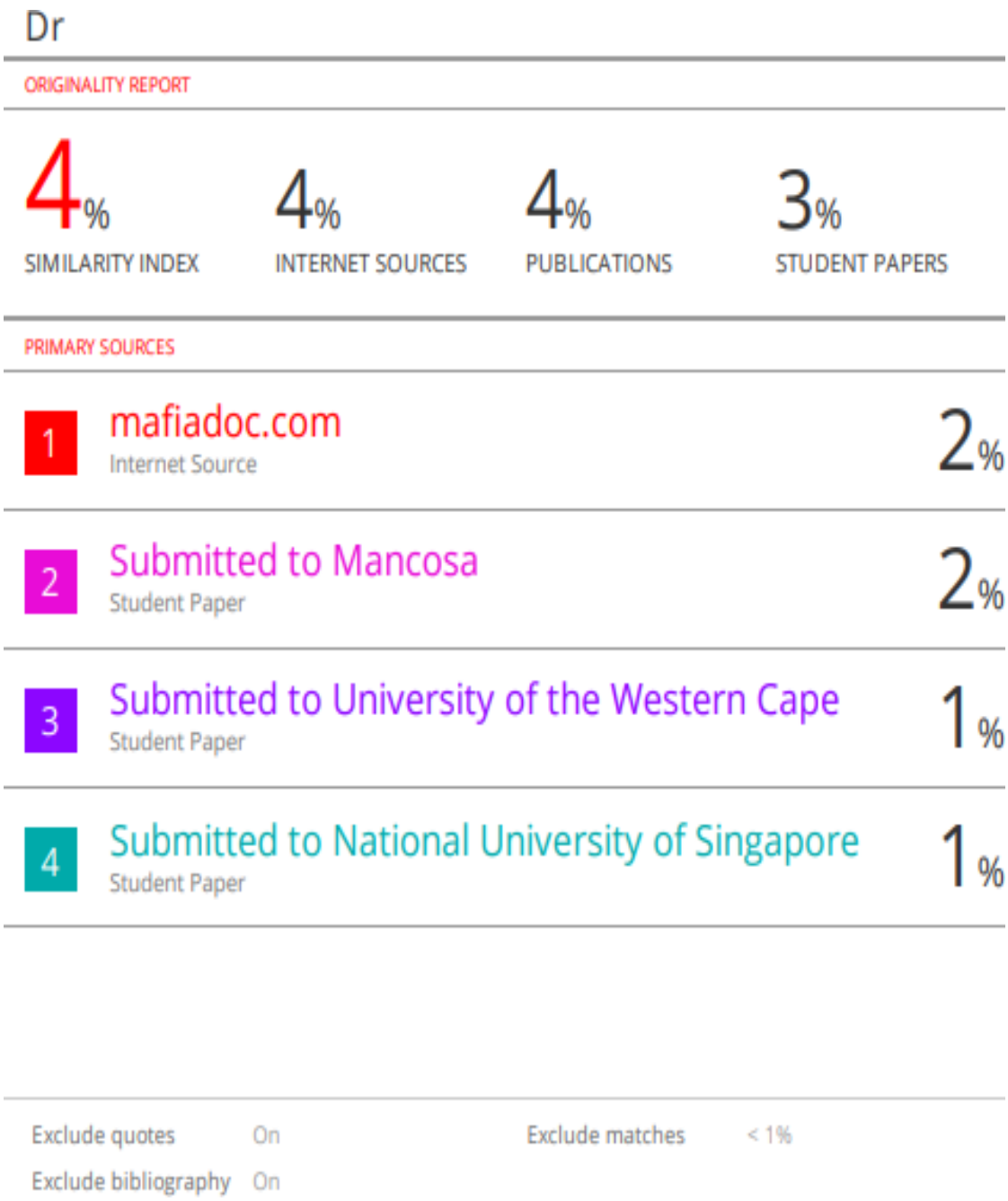
This letter serves to confirm that Dr Rampersad is registered as an MSc Student in the Department of Maxillo-Facial and Oral Surgery.

She will be conducting her research entitled "A cross-sectional analysis of the Antibiotic prescribing patterns among dentists in Durban, South Africa" through the Department

Yours sincerely,

Prof RE Rikhotso

Appendix D: First submission Turnitin report



Dr

ORIGINALITY REPORT

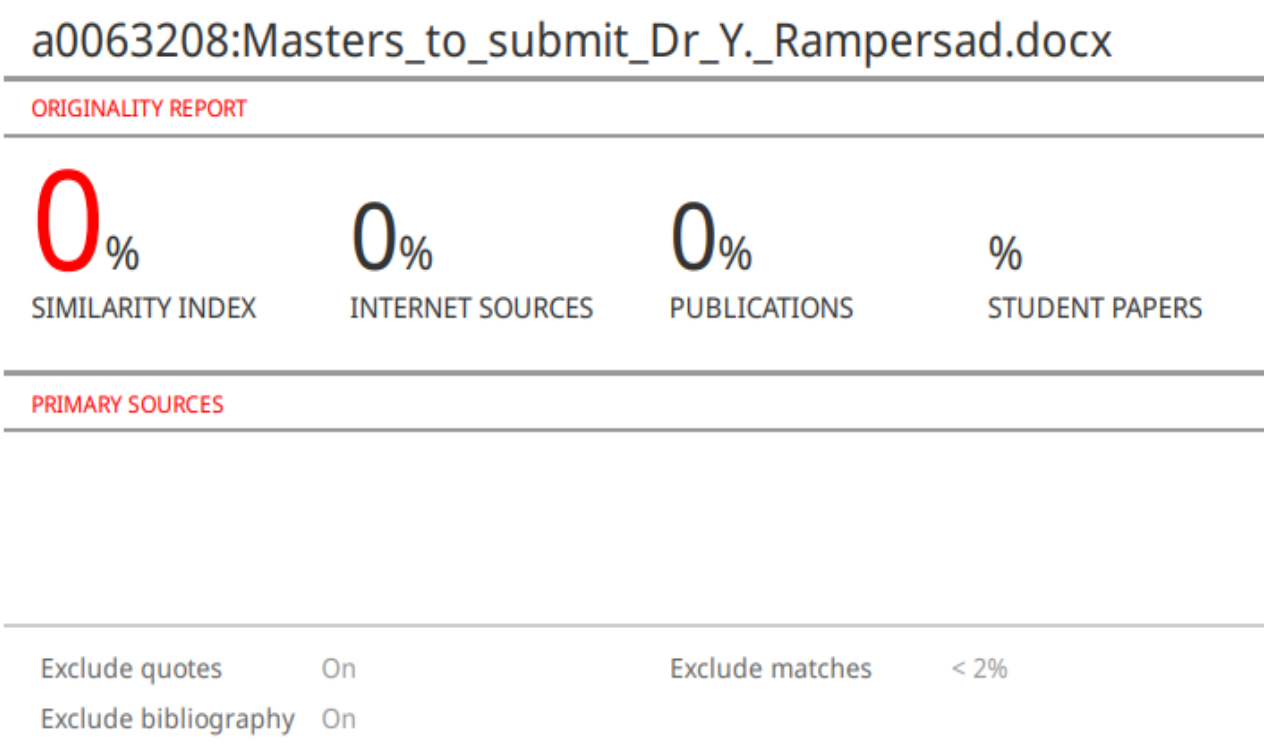
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Appendix E: Turnitin report



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ORIGINALITY REPORT

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