Use of Diagnostic Techniques by Private Practising Optometrists in South Africa

Johanna Antoinette Fraser

Student number: 2016285377

Submitted in fulfilment of the requirements in respect of the Master of Optometry Degree in the Department of Optometry, in the Faculty of Health Sciences at the University of the Free State.

Submission date: 30 September 2020

Supervisors: Mr N. Naicker (M.Optom) and Prof TA Rasengane (PhD)

DECLARATION

"I, Johanna Antoinette Fraser, declare that the dissertation I herewith submit for the Master of Optometry Degree at the University of the Free State, is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education."

ACKNOWLEDGMENTS

It is with immense gratitude that I would like to thank the following people for their support and assistance during the course of this research project:

- My study leaders, Mr Nashua Naicker and Prof Tuwani Rasengane, for guiding me through this project with their wisdom and insights.
- The staff at the Frik Scott Medical Library for their assistance with literature searches. In particular the assistance of Mrs Annamarie du Preez for going the extra mile with sourcing literature.
- Mrs Riette Nel from the Department of Biostatistics at UFS for the processing of questionnaire results.
- School of Postgraduate Studies for offering various support measures and workshops.
- The participants of the study, without them there truly would be no study.
- The SAOA for assisting with the distribution of the questionnaire.
- To my family for their continued support and unwavering belief in my abilities.
- My colleagues, in particular Haseena Majid and Audience Maluleke, for cheering me on.

DEDICATION

For my daughters, Kayla and Riley:

"A woman of vision may lose her eyesight, but she can see afar; because through her mind, she conceives far beyond what eyes can see."

Gift Gugu Mona

ABSTRACT

Introduction: In South Africa, the optometric profession has seen two expansions of the scope of practice within the last two decades. The first of the two allowed optometrists to make use of techniques that required the use of diagnostic pharmaceutical agents.

Aim: The purpose of the study was to establish the extent to which the four specific diagnostic techniques are utilised and if there exist barriers to their utilisation.

Methods: A cross-sectional study was conducted to ascertain the utilisation of diagnostic techniques. The data was collected through a self-administered online questionnaire. The questionnaire contained questions on demographics, practice trends, utilisation of diagnostic techniques, as well as the registration status of the optometrists.

Results: A total of 141 responses were received, and 118 were included for data analysis. There were 46 (39.0%) male participants and 72 (61.0%) were female. Ninety-eight (83.1%) of the participants had a diagnostic qualification, of which 49 (50.0%) were correctly registered with the HPCSA for diagnostic practice. Only 13.4% participants indicated that they performed contact tonometry at every visit, while slit-lamp fundus examinations was performed at every visit by 18.6% of the participants. BIO was only performed on indication by 20.8% of participants and gonioscopy was similarly only performed on indication by 34.7% of participants. Diagnostic techniques and procedures were mostly underutilised as many did not perform applanation tonometry (67.0%), binocular indirect ophthalmoscopy (79.2%), slit-lamp fundus examination (41.2%) and gonioscopy (64.3%). While optometrists were more confident in performing applanation tonometry (52.0%) and slit-lamp fundus examination (64.3%), confidence was considered a barrier for binocular indirect ophthalmoscopy (62.3%) and gonioscopy (54.1%). The lack of reimbursement was regarded as a significant barrier for 63.3% of participants, and 82.5% of respondents indicated the cost of acquiring the specific equipment was prohibitive.

Most participants (92.8%) agreed that diagnostic privileges were appropriate for optometrists as well as the therapeutic scope of practice expansion (96.9%). Of those participants who were not correctly registered for diagnostic practice with the HPCSA, the majority (69.4%) were aware of the process to amend their registration status. The administrative process being too cumbersome and time-consuming was the most commonly

stated barrier to amending the registration status of participants who were incorrectly registered.

Conclusion: The study indicates that diagnostic techniques are mostly underutilised and optometrists prefer non-invasive alternative techniques over methods that are considered to be the gold standard. Another finding of the study is that there exists a discrepancy between the number of optometrists who are registered for diagnostic practice and the number of optometrists who have acquired a diagnostic qualification.

It is recommended that an audit be done on the registration status of optometrists as to ascertain the correctness of the register and to have it amended if needed. It is further recommended that further studies should be done to ascertain the compliance of optometrists concerning their registrations and scope of practice. The reimbursement models need to be revisited, as well as the training of optometrists to ensure appropriate levels of confidence in diagnostic techniques amongst practitioners. These models should be geared towards professional services, emphasising the diagnosis and management of ocular diseases to motivate optometrists to practice more extensively within their full scope of practice

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

BIO	Binocular Indirect Ophthalmoscopy
CAS	Certificate of Advanced Studies
CBD	Central Business District
DPA	Diagnostic Pharmaceutical Agents
ECOO	European Council of Optometry and Optics
GAT	Goldmann Applanation Tonometry
GDP	Gross Domestic Product
GIO	Graduate Institute of Optometry
GOC	General Optometry Council
GOS	General Ophthalmic Services
HPCSA	Health Professions Council of South Africa
HSREC	Health Sciences Research Ethics Committee
IAPB	International Agency for the Prevention of Blindness
IOP	Intraocular Pressure
MCC	Medicines Control Council (now known as SAHPRA)
NCT	Non-Contact Tonometry
NEWENCO	New England College of Optometry
OCT	Optical Coherence Tomography
OD	Doctor of Optometry
ODC	Ocular Diagnostic Certificate

OTC	Ocular Therapeutic Certificate
PBODO	Professional Board for Optometry and Dispensing Opticians
PEP	Practitioner Enhancement Program
PHC	Primary Health Care
POAG	Primary Open Angle Glaucoma
RAU	Rand Afrikaans University
RSA	Republic of South Africa
SAHPRA	South African Health Products Regulatory Authority (Formerly known as MCC)
SAOA	South African Optometric Association
TWR	Technikon Witwatersrand
UDW	University of Durban-Westville
UFS	University of the Free State
UJ	University of Johannesburg
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UL	University of Limpopo
URE	Uncorrected Refractive Error
USA	United States of America
WCO	World Council of Optometry
WHO	World Health Organisation

LIST OF TABLES

LIST OF FIGURES

SELECTED DEFINITIONS AND TERMS

Anaesthetic:	An anaesthetic is a pharmaceutical agent that eliminates or blocks nerve endings from experiencing sensations of pain (Duvall, 2006).
Binocular indirect ophthalmoscopy:	Binocular Indirect Ophthalmoscopy (BIO) is a technique used to evaluate the entire ocular fundus through a dilated pupil with a head-mounted binocular indirect ophthalmoscope (James & Benjamin, 2007).
Cycloplegic:	Cycloplegic agents are parasympatholytic drugs that act to block the iris sphincter and ciliary muscle, causing dilation of the pupil and paralysis of accommodative function or cycloplegia (Duvall, 2006).
Diagnostic pharmaceutical agents (DPA):	Pharmaceutical drugs used for performing diagnostic techniques, such as mydriatics, cycloplegics and local anaesthetics to facilitate the examination and diagnosis of a patient's ocular health (Bartlett & Jaanus, 2008).
Diagnostic Privileges:	The ability and authorisation for an optometrist to use a scheduled substance in his or her practice exclusively during optometric procedures and not the dispensing or sale thereof (RSA DOH, 2001).
Diagnostic Techniques:	The specific procedures or techniques performed with the use of diagnostic, pharmaceutical agents such as binocular indirect ophthalmoscopy, dilated fundus examination, applanation tonometry, and gonioscopy (Barnard, 2008).
Goldmann Applanation	Applanation Tonometry is a technique that makes use of a

Tonometry:	probe to applanate the corneal surface in the process of measuring the intra-ocular pressure (Elliot, 2007).
Gonioscopy:	Gonioscopy is a technique that allows a biomicroscopic view of the iridocorneal angle with the use of a contact lens that contains mirrors (James & Benjamin, 2007).
Mydriatic:	A topical pharmaceutical agent that acts on the iris musculature to dilate the eye (Duvall, 2006).
Slit-lamp assisted fundus examination:	A technique to evaluate the posterior pole of the retina through a dilated pupil using a non-contact high powered condensing lens in conjunction with the slit-lamp (Elliot, 2007).
Therapeutic Privileges:	The ability and authorisation for an optometrist to obtain, possess, administer, prescribe or supply specified scheduled medicines, and use those medicines appropriately for the treatment of conditions of the eye (RSA DOH, 2007).

CHAPTER 1: INTRODUCTION

2.1 Introduction

This chapter provides a broad introduction to the study, to explore the utilisation of diagnostic techniques and the possible barriers that prevent optometrists within South Africa from performing these techniques. An overview will be provided on the scope of practice for optometrists in South Africa and how it has expanded to incorporate the different diagnostic techniques as well as why it is needed to advance a more comprehensive delivery of primary eye health services. The problem statement, aims and objectives of the study are also detailed in this chapter, together with the significance of the study.

2.2 Background

The burden of visual impairment and preventable blindness has huge socio-economic implications and reduces the quality of life for those affected by it (Yan *et al.*, 2019) Globally, approximately 2.2 billion people are affected by either visual impairment or blindness (WHO, 2019b). Optometrists are central to the provision of primary eye care and can assist in decreasing this burden of visual impairment and blindness. A comprehensive eye examination by an optometrist can provide early diagnosis and facilitate the management of visual conditions and eye diseases to prevent the loss of vision (RSA DOH, 2015). The leading cause of visual impairment is uncorrected refractive error, which affects 123.7 million people globally, followed by cataract and glaucoma, which affects 65.2 million and 6.9 million people, respectively (WHO, 2019).

2.2.1 Scope of practice

The scope of practice for optometrists varies in different countries around the world. The World Council of Optometry (WCO) compiled a competency-based model for the scope of optometry in 2005, which detailed the four categories of practice (WCO, 2005). In 2001, the scope of practice for South African optometrists was expanded to include the utilisation of diagnostic techniques, which requires the application of diagnostic pharmaceutical agents

after accredited training has been completed. Optometrists would then be registered with the HPCSA as having diagnostic privileges. According to the HPCSA's IT Statistics & Data Analysis department, as of 2018, of the 3767 optometrists registered with the HPCSA, only 636 were registered to practice with diagnostic privileges (Daffue, Y. 2018, personal communication, January 22).

2.2.2 Diagnostic techniques

The diagnostic techniques include applanation tonometry and gonioscopy and dilated fundus examinations (RSA DOH, 2001). The utilisation of diagnostic techniques assists in the prompt and accurate diagnosis of ocular disease at primary care level, which in turn leads to improved clinical findings and diagnosis (Yoshioka *et al.*, 2015). This would subsequently facilitate more appropriate management and interventions, which then would reduce the rate of over-referrals and bottlenecking, which burdens the secondary and tertiary care pathways. An accurate diagnosis also reduces the risks of visual impairment and preventable blindness that may occur from incomplete clinical investigations and delayed management interventions (Ratnarajan *et al.*, 2013). The use of diagnostic techniques has become crucial in investigating the ocular structures for sight-threatening eye diseases such as glaucoma and diabetic retinopathy, to name a few.

Tonometry, which is the measurement of intraocular pressure (IOP), is an essential investigation for the diagnosis and management of glaucoma. Intraocular pressure determination is especially useful for diagnosing patients in the early stages of POAG as well as when closed-angle glaucoma is suspected (Kurtz and Carlson, 2004). Goldmann Applanation Tonometry (GAT), which is considered highly accurate as a diagnostic procedure, is currently regarded as the gold standard in measuring IOP (Myint *et al.*, 2011). The use of a topical anaesthetic is required for this procedure as the prism probe of the tonometer makes contact with the corneal surface. The prism probe flattens the surface of the cornea, and the IOP is then determined from the force required to flatten the cornea, which is based on the Imbert-Fick principle (Grosvenor, 2007).

Gonioscopy is a technique used to assess the anterior chamber angle in the diagnosis and differentiation of both open and closed-angle glaucoma as well as aid in determining the

cause of primary open-angle glaucoma (Tandon and Alward, 2015). Gonioscopy is also useful in the detection of other diseases such as Pigment Dispersion Syndrome, Rubeosis Iridis and Pseudoexfoliation Syndrome (Kanski, 2007). A topical anaesthetic is instilled into the patient's eyes, as the required gonioscopy lens touches the corneal surface. Once the gonioscopy lens is placed on the cornea, the optometrist can inspect the anterior chamber angle and the related structures to determine whether the angle is closed or open (Unterlauft, 2016).

There are a variety of gonioscopy lenses available, each with different features and applications. The most commonly known gonioscopy lens, the Goldmann Three Mirror lens, can be used to view the various internal structures of the eye. One of the three mirrors, the thumbnail mirror, is used to view the anterior chamber angle; the other two mirrors are used to view the peripheral and mid-peripheral areas of the retina respectively (James and Benjamin, 2007). The Four Mirror gonioscopy lens is designed to reduce examination time, and patient discomfort as all four mirrors are used to view the anterior chamber angle simultaneously and requires little or no rotation of the lens to change the view from the inferior angle to the superior, nasal or temporal angles of the anterior chamber (Kanski, 2007).

Binocular Indirect Ophthalmoscopy (BIO) is used when an overview of the retina, its peripheral structures and overlying vitreous is required. The BIO provides a stereoscopic wide angled view of the retina through a pupil that is dilated with a pharmaceutical mydriatic agent. As the optics of the BIO are less influenced by media opacities and high degrees of uncorrected refractive errors, a clearer view of the fundus is obtained (Rosser, 2010). BIO is indicated when an optometrist needs to view the retinal areas beyond the posterior pole, such as the mid-peripheral and the peripheral areas up to the ora serrata. Eye conditions that would require investigation with the use of this technique would be diabetic retinopathy, retinal tears and detachments as well as other retinal pathologies, which affect the peripheral retinal areas. The investigation of retinal tumours and retinal oedema also require the use of the indirect ophthalmoscopy technique (Barnard and Field, 1995).

Another indirect ophthalmoscopy technique providing a stereoscopic view of the posterior pole of the eye, is a technique which makes use of a handheld condensing lens such as a 78 Dioptre, 90 Dioptre or a Superfield lens in combination with a slit-lamp biomicroscope. This technique requires the pupil to be dilated with a topical mydriatic agent as well. The retinal structures can be seen in greater detail allowing the optometrist to appreciate small differences in depth of any lesions, which proves to be essential in the diagnosis of macular oedema and glaucoma (Jamous *et al.*, 2014). This technique allows for closer inspection of the retinal tissue and associated structures for the investigation of suspected disease due to the magnification and greater detail provided (Meszaros, 2012).

Both BIO and the slit-lamp fundus examinations require a dilated pupil to achieve better views of the retina and to perform a thorough inspection of the retinal structures. These techniques also provide a stereoscopic view of the retina, enabling the optometrist to appreciate any differences in depth of the structures, which can facilitate better diagnosis (Kanski, 2007).

The four diagnostic techniques play an important role in the diagnosis of ocular diseases for optometrists, and have optometrists in South Africa have received the necessary training to use these techniques for well over 20 years (RSA DOH, 2001). The expansion of the scope of practice may be seen as an important step towards providing better patient eye care and addressing the needs of the community.

2.2.3 South African optometrists' scope of practice

Today, more than 18 years after the scope of practice for optometrists has been expanded in South Africa to include diagnostic skills training at undergraduate and postgraduate levels. It is uncertain whether the introduction of these privileges has evolved optometric practice trends to be inclusive of the application of these techniques to provide an improved level clinical care to patients in relation to ocular disease investigation and management.

There are an estimated 1788 optometrists who have graduated with diagnostic privileges from the four academic institutions providing optometric training and education since the scope of practice was expanded in 2001 (RSA DOH, 2017). Another 839 have completed the

Certificate of Advanced Studies (CAS) in diagnostic procedures through the Graduate Institute of Optometry (GIO) as a post-graduate qualification (Kriel, SJ. 2017, personal communication, August 16). This translates into an estimated 2627 optometrists who possess the necessary training and skills to perform the diagnostic techniques. However, the HPCSA diagnostic practice register has only 636 optometrists registered to practice with diagnostic privileges (Daffue, Y. 2018, personal communication, January 22).

The HPCSA database only indicates that optometrists have qualified with diagnostic privileges if they have completed the correct registration forms. Not all optometrists have amended their registration to correctly reflect that they have acquired a diagnostic privileges qualification. There may be optometrists, who have qualified with diagnostic privileges, who could be performing these techniques and are unaware that their registration does not reflect their eligibility to do so. Other optometrists might willingly choose to not amend their registration for reasons currently unknown. It is, thus, apparent that there is a discrepancy between the number of optometrists who have qualified with diagnostic privileges and the number of optometrists who are registered with diagnostic privileges. The differences in optometrists' training and registration statuses give rise to different pockets of data within the population.

This study, therefore, has merit, as it investigates the utilisation of the diagnostic techniques among optometrists who are qualified to do so, as well as the reasons for the underutilisation of these techniques in those instances where it is underutilised. In addition, the study also determines whether optometrists are aware of the need to be registered correctly.

No dedicated study has been done among South African optometrists to investigate the utilisation of diagnostic techniques, much less the barriers that exist to perform the diagnostic procedures since the scope has been expanded to include diagnostic privileges in 2001. This gap in awareness needs to be explored, especially in the light that the scope of practice of optometry in South Africa has once again been expanded to incorporate therapeutic privileges. The utilisation of diagnostic skills becomes especially important when considering that optometrists need to be able to accurately diagnose ocular diseases before

they can treat such diseases.

Monitoring and evaluation play a crucial role in determining the uptake and impact of such changes in the scope of practice. However, since the inception of diagnostic privileges for optometrists, no monitoring or evaluation has been done in this regard. No investigation has been done as to how these techniques have been incorporated into clinical practice or the impact it has had on patient care in the South African health care system since its inception. It is unclear whether or not the expansion of the scope of practice has benefited the profession or even facilitated better ocular disease management.

The scope of practice for optometrists has now been expanded to not just diagnose ocular disease but to also treat various ocular diseases with the prescription of pharmaceutical agents. Yet no reflection has been done on how the previous scope expansion has affected practice trends or even if it has made an impact on the ability of optometry to provide better eye care to the population of South Africa.

Patients would be at a disadvantage if they are not receiving the full comprehensive care that they are entitled to receive from the optometrist if these diagnostic techniques are indicated and are not being performed. Apart from this, a sub-standard level of health care infringes on the principles of quality and comprehensive health care that the public are entitled to under the constitution of our country (Constitution of the Republic of South Africa, 1996).

With the expansion of the scope of practice to now include the prescription of therapeutic pharmaceutical agents, the correct diagnosis of ocular disease has become paramount. The knowledge gained by this study can assist stakeholders within the regulatory and educational authorities to address the barriers optometrists perceive to exist and enable them to practice their profession to the fullest extent of their scope of practice.

2.3 Problem statement

Due to the lack of monitoring and evaluation since the inception of diagnostic privileges for optometrists, it is unknown how successfully these techniques have been incorporated into clinical practice and whether or not practitioners experience any barriers to utilise these

techniques in their practices.

The number of optometrists registered for independent practice with diagnostic privileges (636), is considered an underestimation. Many more optometrists currently possess the necessary skills and qualification but have not been correctly registered with the HPCSA as having diagnostic privileges (RSA DOH, 2017). It is not known why these optometrists are not registered correctly or even whether they are aware of their registration status or not. A great majority of optometrists (69.3%) who have qualified with diagnostic privileges are either not utilising their skills or are possibly doing so without the correct licensure. As a result, it is unknown how many optometrists who have qualified with diagnostic privileges in South Africa are currently utilising these diagnostic procedures and pharmaceutical agents on a regular basis or even how regularly these techniques are utilised.

2.4 Research question

How has the utilisation of diagnostic techniques been incorporated into routine practice by private practising optometrists in South Africa nearly two decades after the expansion of the scope of practice was legislated?

2.5 Aim

The study aimed to investigate the utilisation of diagnostic techniques among South African optometrists who are qualified with diagnostic privileges in their private practice settings.

2.6 Objectives

There are five research objectives for this study:

- Objective 1: To determine the frequency in the usage of the different diagnostic techniques by each of the subpopulations of South African optometrists in private practice.
- Objective 2: To determine the barriers that exist, if there are any, which affect their usage of the diagnostic skills in their private practice per subpopulation.

- Objective 3: To determine the HPCSA registration status of optometrists who have qualified with diagnostic privileges.
- Objective 4: To determine the awareness of optometrists of the requirement to be correctly registered with the HPCSA
- Objective 5: To determine whether optometrists are aware of the implications of performing diagnostic techniques without being correctly registered.

2.7 Significance of the study

The knowledge gained from this study will provide a snapshot of the clinical uptake of diagnostic techniques within the South African optometry industry in light of the two expansions of the scope of practice, one of which is part of the undergraduate degree for the last 18 years. The study will contribute to the understanding of practice trends with regards to the utilisation of diagnostic techniques and the confidence of optometrists to perform these techniques within the expanded scope of practice to include diagnostic privileges. The barriers to performing these techniques will reveal gaps in monitoring and evaluation of practitioners as well as the type and quality of services offered, while attempting to tackle the burden of visual impairment and preventable blindness. The results will also reveal the optometrists' reasons for not amending their registration with the HPCSA as well as the lack of acquiring the MCC Section 22A(15) permit which was initially necessary for optometrists to legally acquire, possess and use the pharmaceutical agents to perform diagnostic techniques (RSA DOH, 2020a).

Optometrists play an important role in preventing visual impairment and irreversible vision loss and to do so effectively; they need to provide comprehensive eye examinations, which include the use of diagnostic techniques. Understanding the way in which these techniques are incorporated into daily practice, and the factors that hinder them from doing so will create opportunities for the optical industry to address and remedy these challenges. In doing so, optometrists may be empowered and more equipped to embrace the scope expansion, which will include the prescription of therapeutic drugs.

2.8 Arrangement of the dissertation

Chapter 1, introduced the background of the study, supported by a rationale followed by the aim, and the objectives to conclude with the significance of this research study.

In Chapter 2, a review of the literature regarding the diagnostic techniques and their uses will be discussed. The utilisation rates of these techniques according to previous studies, as well as the possible barriers to their utilisation, will be outlined.

Chapter 3 is focused on the study design, sampling criteria, selection criteria, data collection and data management.

The results of the online questionnaire are described in Chapter 4, and the analysis of the results is also given.

Chapter 5 provides a summary of the study; interpretation and discussion of results, as well as a comparison with the previous studies, are provided.

In Chapter 6, the strengths and weaknesses of the study are discussed, as well as looking at the limitation of the study and a proposal for further research.

In Chapter 7 recommendations are made, motivating for further research based on the findings of the study.

In Chapter 8, the conclusion of the study is summarised.

2.9 Conclusion

The optometric profession plays a vital role in the provision of primary eye care services to reduce the incidence of visual impairment and blindness. Diagnostic procedures are indispensable to the diagnosis, management and treatment of sight-threatening ocular diseases, which are now part of the standard of care for optometry in South Africa. Furthermore, the effectiveness of optometrists' diagnostic capabilities forms the foundation for the next scope of practice expansion, i.e. therapeutics privileges, as without accurate and timely diagnosis, treatment will be inadequate. The focus of this study is to provide insight into the extent to which optometrists are practising within their scope of practice.

CHAPTER 2: LITERATURE REVIEW

3.1 Introduction

This chapter will define the profession of optometry and explore the role and functions of optometrists as primary health care professionals, with a focus on the usage of diagnostic techniques in practice. Primary Health Care (PHC) is considered the first entry-level contact the community has with the health care system. It plays an essential role in preventing, identifying and treating diseases as well as health promotion to the community. PHC assists in providing rehabilitation services where a cure is not possible. Universal health according to the Alma-Ata Declaration, states that all individuals in the community should have access to health care at an affordable rate for active participation and promotion of the country's social and economic development (WHO, 1978).

The World Council of Optometry (WCO) defines the profession of optometry and optometrists as:

"Optometry is a health care profession that is autonomous, educated, and regulated (licensed/registered), and optometrists are the primary health care practitioners of the eye and visual system who provide comprehensive eye and vision care, which includes refraction and dispensing, detection/diagnosis and management of disease in the eye, and the rehabilitation of conditions of the visual system." (WCO, 2005)

From this definition, it is clear that the main purpose of optometry is to be the primary health care provider when it comes to eye and visual health. Thus, an optometrist is considered the first point of contact an individual has with the health care system when it relates to eye-health problems. Apart from providing visual aids and therapies to correct for any visual system anomalies, optometrists can detect, diagnose, monitor and manage certain diseases of the eye. If a patient should present with any systemic health condition that could impact the visual system, optometrists are then able to refer such patients to ophthalmology for further assessment and the appropriate medical and/or surgical intervention (Hopkins, 2006).

According to Agarwal (2003), optometry, however, was not always integrated into the public health care system as optometrists started as non-professional artisans in the early 19th

century and were known for being spectacle makers with no background in health care. From there, the need to assess and diagnose ocular health abnormalities necessitated the evolution of optometry into a health care profession.

The integration of optometry within the South African health public health care system has been slow due to multiple factors. Firstly, the South African health care system currently experiences many challenges, some which originated within the apartheid government era, where racial segregation led to inequality in health care services split along racial and economic lines. This system of inequality also resulted in two separate health care systems in present-day South Africa; a public health care system which caters for the poor who make up the majority of the population and a private sector which provides health care services to the wealthy and affluent minority (RSA DOH, 2017).

Within the South African public health care system, optometry is poorly integrated, and very few employment opportunities exist for optometrists. Only 262 positions are available within the public sector to address the needs of 80% of the population who cannot afford medical aid and private health care (RSA DOH, 2017). The poorer and more rural communities of South Africa have limited access to eye care and specifically optometric services. This is mainly due to a lack of infrastructure, human resources, as well as financial support. The burden of disease is far too significant for ophthalmology to handle on its own, as it is currently struggling to meet its target on cataract surgery rates. Lecuona and Cook (2014) found that due to a lack of eye care personnel for ocular health management, ophthalmologists are dedicating time to non-surgical tasks, which may delay surgical services. Furthermore, they also found where the support staff, such as optometrists and ophthalmic nurses, performed the pre- and post-surgical workup of patients, it generated a greater degree of efficiency within the clinic, and the surgeon was able to assist a far greater number of patients who needed sight-restoring cataract surgeries (Lecuona and Cook, 2014).

A large portion of the visually impaired needlessly suffers, as visual impairment due to cataracts are highly preventable and treatable. If optometrists, however, are better utilised and perform a significant number of diagnostic procedures, ophthalmologists can focus more on the surgical and medical treatment of eye diseases and patients would then

benefit. The majority of South African optometrists work within the private sector, many of whom are situated in retail or commercial centres. This mode of practice caters for the wealthy and more affluent in the community, who can afford and easily access the services of optometrists in the private sector (Moodley, 1995). This commercial portrayal of the profession has long been seen as a barrier to advance the brand image of optometry as a health care profession, where more focus is placed on the commercial aspects of the services provided instead of the health care aspects (Agarwal, 2003).

Promotion of eye care and eye health awareness is another area of concern within both the public and private sectors, which has contributed to the lack of integration of optometry within the health care system at large. In the public sector, eye health promotion policies are lacking leadership and follow-through, where the private sector is more concerned with curative measures instead of a more preventative approach (Sithole, 2017).

For optometry to play a more significant role in primary health care, the services that are provided by the optometrists need to go beyond that of refractive services and vision correction as they have received the necessary education and training (Hopkins, 2006). Optometry needs to be more involved in the diagnosis of potentially sight-threatening conditions at the primary health care level, to ease the burden and backlog experienced by specialist centres (Beebe, 2007).

Visual impairment and blindness are not considered to be fatal, but it does lead to reduced life expectancy over and above the far-reaching socioeconomic implications thereof. The eye care needs of the South African population are far higher than what has been provided by the curative eye care approach of the past. The scope of practice for optometrists has been expanded to take a more preventative approach to eye care and to address the burden of eye disease of the population more effectively (RSA DOH, 2017). Optometrists, therefore play a crucial role within the primary health care system, as they are imperative for the effective prevention of blindness and visual impairment (WHO, 2013).

3.2 Scope of optometry

The scope of practice for optometry differs significantly across the world due to legislative and cultural differences. Optometrists in some countries are allowed to prescribe

pharmaceutical agents for therapeutic purposes, others are only allowed to use them for diagnostic purposes and in some countries, optometrists are only allowed to examine and assess the visual systems of their patients (Padilla and Di Stefano, 2009). While in other countries, optometry struggles to be recognised as a health profession and is under threat of deregulation (WCO, 2017).

3.2.1 World Council of Optometry global competency-based model

In 2005, the World Council of Optometry (WCO) released a global competency-based model for the scope of practice in optometry for the purpose of categorising the different levels of services that optometrists provide across the world.At level 1, which is the lowest, optometry services are limited to the dispensing of ophthalmic lenses and frames. Level 2 is limited to refractive services, where with level 3, the use of Diagnostic Pharmaceutical Agents (DPA) to examine the eye and surrounding structures to detect, diagnose and manage diseases affecting the eye is added. In countries that allow for optometrists to practice at the highest level, level 4, optometrists can diagnose and treat ocular diseases as well as prescribe therapeutic pharmaceutical agents over and above the visual system examination and dispensing of visual aids (WCO, 2005).

3.2.2 The international scope of practice

Optometrists in the United States of America (USA), the United Kingdom (UK) and Australia practice their profession at the highest level of competency, which includes the ability to prescribe therapeutic agents in the management of ocular diseases, in addition to being able to do refractions, dispense visual aids and diagnose diseases of the visual system and adnexa.

In the USA, the scope of practice was expanded to include diagnostic privileges in 1971 with Rhode Island being the first state to grant optometrists the legal rights to use diagnostic, pharmaceutical agents (Bennet, 2016). Soon after that, in 1976 the scope of optometry was expanded in the states of West Virginia and North Carolina to include therapeutic privileges, where optometrists could prescribe therapeutic agents for the treatment of ocular diseases (Payton, 2017). In 1989, Maryland became the 50th state to include diagnostic privileges for

optometrists, and by 1997 the last state, Massachusetts incorporated therapeutic privileges for optometrists (Kekevian, 2018).

Optometrists in the UK have had diagnostic privileges included as part of their undergraduate programme for decades, as a provision in the Medicines Act of 1968 implied the utilisation of drugs by optometrists and other medical professionals as part of their professional practice. The General Optical Council (GOC) who is the regulating body for optometrists in the UK, never formalised the use of diagnostic drugs as a law, as the council never perceived it to be an issue and wasn't charged to investigate any legal cases around the actual utilisation of diagnostic drugs (Barnard, 2008). The Optician Act of 1958 enabled optometrists in the UK to treat ocular disease with drugs in case of an emergency, but the list of pharmaceutical agents optometrists could prescribe was minimal. In 2007 the law was changed to allow optometrists to independently prescribe therapeutic drugs, which expanded their scope of practice to that of level 4, as envisioned by the WCO (Needle *et al.*, 2008).

Australian optometrists have been utilising diagnostic techniques as part of their scope of practice since as early as 1963 (Faul, 1992). Here too, the scope of practice has been expanded to include therapeutic prescribing for the management and treatment of ocular disease. In Australia, since the expansion of the scope of practice took place in 2004, more than 60% of their 5 871 registered optometrists currently have therapeutic endorsement (Optometry Board of Australia, 2019). Countries such as Germany, France, Italy and Japan, in contrast, are still practising at level 1 or 2 where diagnostic privileges are not part of the scope of practice as can be seen in Table 3.1 (ECOO, 2015).

Table 3.1: Different categories of the optometric scope of practice around the world

	Level 1	**Level 2**	**Level 3**	**Level 4**
Scope of profession	Refraction, Prescription, Dispensing	Refraction, Prescription, Dispensing, Screening for ocular diseases	Refraction, Prescription, Dispensing, Diagnostic Privileges	Refraction, Prescription, Dispensing, Diagnostic and Therapeutic Privileges
Country	France Italy Japan Belgium Iceland	Germany Malawi Austria Czech Republic Denmark Spain	Norway Sudan Israel Finland Netherlands Sweden Ireland	Australia New Zeeland Canada USA Nigeria UK Colombia South Africa
Adapted from (Padilla, 2009) & (ECOO, 2015)				

3.2.3 African context

Optometry in Africa, in comparison to Western countries, is a relatively scarce profession. Nigeria, South Africa, Tanzania and Ghana have a long-established optometric training and education programme. Over 90% of the continent's optometrists are currently residing in these countries after completing their education. In other countries such as Ethiopia,

Malawi, and Mozambique, less than 350 optometrists have graduated from their newly established universities since 2006. Optometry training and education are still in its infancy in countries such as Eritrea and Zimbabwe and these countries very few graduates (IAPB, 2016).

Nigeria has almost 4000 optometrists at WCO level 4 privileges since 1979. The educational programme for optometrists is based on the American curriculum and the graduates from these institutions exit with a Doctor of Optometry (OD) degree (Oduntan *et al.*, 2014). Ghana has a similar structure with their optometrists, who also graduate with therapeutic privileges after completing the six-year Doctor of Optometry (OD) programme, which has replaced an older Bachelor of Science programme that was offered in the early 2000s (IAPB, 2016).

In many other African countries, the profession of optometry is still new, and many do not have any regulatory bodies in place to regulate the scope of practice within these countries. Eritrea, Mozambique and Malawi are three of the countries where no regulatory body currently exists for optometrists, although they all practice optometry at level 4, which is with therapeutic privileges (Mashige, 2017). In Sudan, Zimbabwe, Tanzania and Uganda, universities are currently training optometrists to exit with diagnostic privileges which put them at level 3 of the WCO's competency model. The optometric technician diploma and degree offered in countries such as Cameroon, Gambia, Ivory Coast, Mali and Zambia only qualifies their graduates at level 2 of the WCO optometric competencies. Level 2 of the WCO competency of optometric practice model enables them to manage visual system defects as well as dispense visual aids (Mashige, 2017).

3.2.4 South African context

The scope of practice for optometrists, according to the South African Department of Health (2007) is defined as follows:

"2. (1) The following acts are hereby specified as acts which, for the purposes of the Act, are deemed to be acts pertaining to the profession of optometry:

(a) The performance of eye examinations on patients with the purpose of detecting visual errors in order to provide clear, comfortable and effective vision; and

(b) the correction of errors of refraction and related factors by the provision of spectacles, spectacle lenses, spectacle frames and contact lenses, and the maintenance thereof, and the use of scheduled substances as approved by the board and the Medicine Control Council or by any means other than surgical procedures."

The optometric profession had seen significant changes in the last two decades. The first change was in 2001 when the scope of practice expanded to include diagnostic privileges (RSA DOH, 2001). The next expansion occurred in 2007, which ushered in therapeutic privileges for optometrists (RSA DOH, 2007).

3.3 The rationale for the expansion of the scope

The WHO defines moderate to severe visual impairment as a presenting visual acuity worse than 6/18 up to 3/60 with usual correction, and blindness as a presenting visual acuity of less than 3/60. Globally, there are an estimated 2.2 billion people who suffer from blindness or visual impairment, of which at least 1 billion are suffering needlessly. URE (uncorrected refractive error), cataract, glaucoma and diabetic retinopathy are the most common causes of blindness and visual impairment (WHO, 2019b).

Optometrists are the first port of call when it comes to the primary eye care and needs of the community they work in. They are in a position to diagnose certain diseases early, monitor for progression and manage them as required. If optometry did not play its role of primary eye care provider effectively, secondary and tertiary centres would be overloaded with primary care activities. This then creates a delay in surgical or medical intervention and increases adverse outcomes for those patients unnecessarily waiting for management of their ocular diseases (Hopkins, 2006).

In South Africa, there exists a quantifiable rate of visual impairment and blindness. According to the 2011 census data, 11% of the 51.8 million people living in South Africa have a disability due to either visual impairment or blindness (Statistics South Africa, 2011). The consequences of visual impairment and blindness are profound, as it is associated with reduced average life expectancy, lower quality of life and increased poverty levels and

hinder the development of the country as a whole (RSA DOH, 2017). Glaucoma and cataracts are the most prevalent causes of visual impairment or blindness, which could both be avoided by providing quality eye care services at the primary care level (Sithole, 2017).

The health care sector in South Africa experiences a massive inequality of services provided to its population of 52 million, which contributes to the high burden of disease in the case of visual impairment and blindness, with the brunt of the burden of disease carried by the poor, or those with lower socioeconomic standing. Around 8.5% of the South African Gross Domestic Product (GDP) is spent on health care, where 52% of the total health expenditure in South Africa is being spent in the private sector, which provides health care services to the 8 million South Africans covered by medical aids (RSA DOH, 2015). The remaining 48% of health expenditure has to address the requirements of 84% of the population who cannot afford private medical aid and are dependent on the public health care sector (RSA DOH, 2015).

The burden of visual impairment is further perpetuated by the fact that there are currently only 262 optometrists employed in the public sector, who are responsible for the visual needs of 41.6 million South Africans. This translates to 8% of the total number of optometrists in South Africa, looking after the visual needs of more than 80% of the country's population (Ramson *et al.*, 2016). The majority of the population is grossly under-serviced due to insufficient optometric services in specific areas, and in some instances the services that are provided still fall short of being comprehensive enough to address the needs of the communities in those areas.

Due to the lack of human resources, ophthalmologists within the public sector are forced to perform primary eye care services as well as tertiary levels of care as specialists. They are required to spend a significant portion of their time on medical management, which prevents secondary health care centres from focusing on sight-saving surgical intervention and treatments. This inefficient use of human resources together with unnecessary referrals creates a backlog and avoidable long waiting periods for those who require specialist intervention (Lecuona, 2014). Conditions which may start of as minor, may progress to become more serious without quicker management interventions.

A limited scope of practice, one without diagnostic privileges, limits the ability of optometrists to effectively address the eye care needs of the population. The high prevalence of blindness and visual impairment in South Africa, together with the constraints experienced in the public health care system, necessitated the expansion of the scope of practice. Diagnostic privileges for optometrists play a pivotal role in primary care, by providing the optometrists with the opportunity to intervene at an earlier stage, to diagnose and manage those eye diseases that do not require specialised management. Diagnostic techniques can also assist to provide more accurate and efficient referrals, which would reduce the bottleneck of patients at tertiary facilities as well as visual impairment and preventable blindness (Ratnarajan, 2013).

3.4 Diagnostic privileges

For optometrists to effectively treat or manage eye diseases, they first need to diagnose diseases accurately through appropriate investigations. Specific diagnostic techniques, such as contact tonometry, slit-lamp assisted lens fundus examination, binocular indirect ophthalmoscopy (BIO) and gonioscopy, can enable optometrists to make accurate diagnoses of ocular disease. Optometrists who have qualified with diagnostic privileges have received extensive training in the use of these techniques, as well as the use of the Diagnostic Pharmaceutical Agents (DPA), which enable them to perform these techniques. The use of DPAs comes with great responsibility, and the optometrist needs to consider the presenting signs and symptoms as well as general medical conditions together with the potential for causing harm, before administering these drugs (Hansraj *et al.*, 2000). The training of optometrists equips them to be well versed in the pharmacological properties of these agents and they can assume the responsibility that accompanies drug administration.

3.4.1 Diagnostic pharmaceutical agents

DPAs are central in the performance of diagnostic techniques to investigate or rule out the presence of eye infections and disease states. These drugs are, however, not without side effects and optometrists, who are qualified to perform diagnostic techniques, are familiar with the contra-indications and side effects of the different DPAs (Mashige *et al.*, 2015).

The ophthalmic drugs instilled into the eye are absorbed systemically via the capillaries in the conjunctiva and nasal mucosa via the nasolacrimal system after being absorbed in the conjunctival sac. Topical pharmaceutical agents avoid the first pass metabolism and inactivation in the liver and although rare, can cause systemic side effects (Brunton *et al.*, 2011). The main classes of pharmaceutical agents used in these diagnostic techniques are; local anaesthetics, to reversibly block the nerve impulses; and mydriatic agents which dilate the pupil.

3.4.1.1 Anaesthetics

Anaesthetic drugs mainly serve the purpose of numbing the cornea. Specific techniques, such as applanation tonometry and gonioscopy, require an apparatus to make contact with the cornea and require it to be numbed. Without the use of a local or topical anaesthetic, the patient will experience considerable discomfort and in all likelihood, be unable to endure these invasive procedures.

Oxybuprocaine hydrochloride and Proparacaine hydrochloride have been approved by the Medicines Control Council (MCC) of South Africa for anaesthesia of the cornea to perform diagnostic procedures and techniques in optometric practice (RSA DOH, 2016).

Oxybuprocaine hydrochloride

Oxybuprocaine hydrochloride is a schedule 4 drug and is also known as Benoxinate HCl. One drop of 0.4% solution is sufficient for anaesthesia of the cornea in most cases, although up to three drops can be used if a larger degree of anaesthesia is required. On installation, some burning or stinging may occur. The onset of action is within 6-20 seconds and the duration of action is approximately 15 minutes for one drop of oxybuprocaine, and could last up to an hour if three drops are used (O'Connor Davies *et al.*, 1989).

Proparacaine hydrochloride

Proparacaine hydrochloride is also known as proxymethacaine and is available in a 0.5% concentration as a schedule 4 drug. The onset of action is within 6-20 seconds, and the duration of action lasts approximately 15 minutes. Penetration of the drug into the cornea

and conjunctiva is not as deep and is tolerated better as it does not cause as much stinging and burning upon installation (Rosenfield *et al.*, 2009).

Side effects and contra-indications of topical anaesthetics

The side effect profile of local anaesthetics are mild and include a mild stinging and burning sensation, which occurs after instillation of the drops and is of no real concern as it is transient and requires no treatment apart from patient reassurance. More severe side effects are extremely rare and are mainly related to toxicity or hypersensitivity to the anaesthetic or its preservatives, which affect the corneal epithelium and ocular surface. Patients with asthma, cardiovascular disease, liver disease and hyperthyroidism are likely to be more susceptible to adverse reactions (Bartlett and Jaanus, 2008).

The reduction in corneal sensitivity can cause a decrease in blink rate which affects the tear film stability and increases tear evaporation, which can then lead to epithelial defects and desquamation, superficial punctate keratitis and corneal oedema within 5-30 minutes after installation. This reaction is rather mild and is not clinically significant, but on occasion, in less than 1 in every 1 000 patients, visual acuity drops to between 6/24 and 6/60 due to corneal toxicity. This is more common in patients over 50 years of age and can be treated with lubricant as corneal epithelium recovers quickly with no resultant permanent damage (Wilson and Fullard, 1988).

More severe adverse effects are incredibly atypical and are associated with prolonged and excessive use in self-administration. Corneal nerve damage can occur with excessive use, along with a decrease in corneal thickness and necrotising corneal ulcer, it is therefore crucial that topical anaesthetics are only used in-office for diagnostic purposes and not therapeutically prescribed (Tok *et al.*, 2015).

Systemic side effects are infrequent with topical use of anaesthetic. They can be a result of either over-dosing as mentioned previously or rapid absorption of the drug due to the increased blood flow in cases of hyperaemic conjunctiva. Another cause of systemic side effects is when drug detoxification or systemic drug elimination is slow. Systemic side effects are also more likely to occur with the injection for local anaesthetic or nerve block and affect the central nervous system, cardiovascular and respiratory systems. Central nervous system

side effects include nervousness, tremors, convulsions, central nervous depression or loss of consciousness. Cardiovascular and vascular system side effects present as hypertension, tachycardia and cardiac arrhythmia in the earlier stages and later stages result in hypotension and weak perfusion (Brunton, 2011).

Hypersensitivity to the drugs can occur mainly with ester-link drugs, and present as conjunctival hyperaemia, chemosis, lacrimation as well as itching and swelling of eyelids, 5-10 minutes after instillation of drugs. No life-threatening allergic reactions have been reported with the use of topical anaesthetics, and systemic allergic reactions account for less than 1% of all adverse reactions to local anaesthetics, which are characterised by hives, bronchospasm and hypotension. If such a severe hypersensitivity is reported, the examiner should avoid using the same drug on subsequent examinations of the patient as it is a contraindication (Bartlett, 2008).

Other contraindications to local anaesthetics are liver disease, as the amide link drugs used in the injectable form of the drugs are metabolised in the liver and could have a toxic effect. The ester linkage anaesthetic drugs used for instilling topical drops could interact with anticholinesterases such as neostigmine and pyridostigmine and cause a toxic effect if used in large enough quantities (Bartlett, 2008).

3.4.1.2 Mydriatics and cycloplegics

Mydriatic and cycloplegic agents are sympathomimetic and antimuscarinic drugs. Mydriatic pharmaceutical agents are used to dilate the pupil when performing a fundus examination. This assists the optometrist to gain a wider view of the posterior pole of the eye. It is especially necessary to dilate when a patient's pupils are small or when media opacities are present as this hinders the view of the retina. Dilating the pupil is essential to accurately diagnose and manage various ocular diseases involving the posterior segment such as retinal detachment, diabetic retinopathy, glaucoma, and macular degeneration, to name a few (Grosvenor, 2007).

Cycloplegic drugs are anticholinergics and are used to paralyse the ciliary muscle as well as the sphincter muscle of the iris. This process renders the accommodative system temporarily inactive. The inhibition of cholinergic receptors leads to cycloplegia and dilation.

It is mainly used to perform cycloplegic refractions to reveal the full refractive status of young patients (Attar, 2019).

Mydriatic and cycloplegic drugs that have been approved for use in diagnostic procedures in optometric practice by the MCC include atropine, tropicamide, homatropine hydrobromide and cyclopentolate hydrochloride. These drugs are all schedule 3 pharmaceutical agents under the Medicines and Related Substances Act (RSA DOH, 2016).

Atropine

Atropine is more suited for the cycloplegic refraction in children to eliminate accommodation and is considered the most potent antimuscarinic agent (Rosenfield *et al.*, 2009). Atropine is not ideally suited for routine fundus examination in optometric practice. The onset of pupil dilation after one drop is 15-20 minutes and lasts roughly 3-4 days. The cycloplegic effect of atropine after just one drop can last between 3-7 days which would render a patient unable to focus on near objects and visually impaired for the duration of action, which far exceeds what is clinically required for mere fundus examination (O'Connor Davies *et al.*, 1989).

Other uses of atropine include the treatment of severe inflammation that occurs with uveitis to prevent posterior synechiae and pain from the iris when contracting. Newer research has also shown a low dose of atropine to be effective in the treatment of progressive myopia (Lee *et al.*, 2016).

The local side effects of atropine are due to the parasympathetic innervations of the lacrimal gland being affected, resulting in reduced tear production. Temporary increase in IOP can also occur due to reduced uveoscleral outflow and increased blood supply to the iris and ciliary body (Vale and Cox, 1978).

Atropine has the most significant systemic side effect profile of all the cycloplegic drugs as it is the most potent. Systemic side effects include fever, thirst, diffuse cutaneous flush, urinary retention, tachycardia, drowsiness, excitement, hallucinations and seizures (Rosenfield *et al.*, 2009).

Atropine is contraindicated in patients with known hypersensitivity to belladonna alkaloids, pregnant and lactating women and in both open and closed-angle glaucoma patients. Atropine should not be used in children with Down's syndrome as the effects thereof are exceedingly prolonged (Bartlett, 2008).

Tropicamide

Tropicamide is the weakest acting cycloplegic of all the antimuscarinic drugs and ideally suited for fundus examinations in routine eye examinations as the duration of action is the shortest, which is roughly 8-9 hours after instillation. The duration of the cycloplegic action is too short, and the level of cycloplegia produced is not enough for accurate cycloplegic refraction. The inconvenience caused due to reduced accommodative ability subsides typically within 6 hours after instillation (O'Connor Davies *et al.*, 1989).

Tropicamide is available in a 1% solution, and side effects include the usual stinging and temporary increase in IOP, which is considered to be clinically insignificant as the increase in IOP subsides within a few hours. It is, therefore considered the safer drug to use in patients with glaucoma (Booysen, 2016).

Systemic side effects are particularly rare with tropicamide and are considered safest to use in patients with hypertension, angina cardiovascular disease as well as diabetes mellitus. The pupil dilation effect of tropicamide is also least dependant on the level of pigmentation of the iris compared to other antimuscarinic drugs (Golan *et al.*, 2012).

Homatropine hydrobromide

Homatropine hydrobromide is a semi-synthetic alkaloid of atropine, and its action is similar to that of atropine, paralysing the sphincter muscle of the iris as well the ciliary muscle. Homatropine, as with atropine, is too potent for use as a mydriatic in routine fundus examination. The mydriasis can last between 24-48 hours after instilling one drop, which far exceeds what is practical and clinically necessary (Classé, 1992).

Contraindications and side effects for homatropine are similar to that of atropine but have a lower tendency to increase IOP. Homatropine is not considered to be the drug of choice for pupil dilation or cycloplegic refraction as other shorter-acting drugs are more effective at

producing a higher level of cycloplegia. Due to the long-lasting mydriatic effect, homatropine is better suited for the treatment of uveitis and the prevention of complications of the resultant inflammation (Duvall and Kershner, 2006).

Cyclopentolate hydrochloride

Cyclopentolate hydrochloride is available in a 1% solution and has a faster onset of action and shorter duration than homatropine, yet it produces a better cycloplegic response. It is for this reason that cyclopentolate is used most often for cycloplegic refractions. Cyclopentolate is another antimuscarinic drug which brings about pupil dilation as well as paralysis of the ciliary muscle (Rosenfield *et al.*, 2009).

Ocular side effects of cyclopentolate include stinging as the drug is acidic at a pH of 5. Hyperaemia and slight discomfort are likely to occur, together with blurry vision. Intra-ocular pressure increases temporarily within 60 minutes post instillation but returns to normal within 4 hours. Toxicity to the drug is related to higher than recommended doses or the higher concentration of 2%. It presents similarly to that of atropine toxicity affecting predominantly the central nervous system which tends to subside in 2 hours in adults and 4-6 hours in children (Bartlett, 2008).

3.5 Diagnostic techniques

3.5.1 Applanation tonometry

The measurement of intraocular pressure (IOP) is an essential part of the diagnosis and management of POAG as well as closed-angle glaucoma (Kurtz, 2004). The Goldmann Applanation Tonometry (GAT) procedure is considered to be highly accurate and is therefore currently held as the gold standard in measuring IOP (Myint, 2011).

Applanation tonometry is based on Imbert-Fick's law which states that the IOP is equal to the force required to applanate the surface of the central cornea (Kirstein *et al.*, 2011). GAT is performed by applying a controlled level of force onto the cornea with a prism probe, which is why this procedure requires the use of topical anaesthetic drugs.

Although technology has advanced considerably in the last few decades, there has not yet been a device developed and found to be more accurate in the measurement of intraocular pressure than the GAT (Patel *et al.*, 2016). It is, however, to be noted that the IOP measurement on its own is not enough to make a diagnosis of glaucoma. Still, IOP is the only modifiable factor when it comes to current glaucoma treatment. IOP measurement, therefore, remains vital in the management of ocular hypertension and glaucoma suspects (Chan and Hodapp, 2015).

3.5.2 Fundus examinations

Ophthalmoscopy is the ability to view the fundus inside the eye with the aid of a device called an ophthalmoscope. Since ophthalmoscopy was first achieved in the late 1800s many advances have been made. Direct ophthalmoscopy has a limited field of view which necessitated the development of other techniques to view the retina, especially the peripheral areas which are inaccessible by a handheld direct ophthalmoscope (Haynie, 2005).

Binocular ophthalmoscopy can be facilitated by mainly two different techniques; head-mounted indirect ophthalmoscopy method and slit-lamp assisted indirect ophthalmoscopy with an aspheric lens. Both these techniques require the patient to be dilated and utilise high powered positive lenses, providing a stereoscopic view of the fundus, with a larger field of view, allowing for a significantly larger portion of the retina to be viewed in more detail. These techniques are less affected by media opacities and the patient's degree of ametropia, than the relatively quick and easy direct ophthalmoscopy (Probert, 2016).

Both of the indirect ophthalmoscopy techniques require the illumination and observation systems to be practically in line with each other to view the fundus and its structures. The image of the fundus observed by the optometrists is seen as inverted in the horizontal and vertical plane (Sheehan and Goncharov, 2011).

3.5.2.1 Head-mounted binocular indirect ophthalmoscopy

Binocular Indirect Ophthalmoscopy (BIO) is used when the optometrist requires a view of the retina beyond the posterior pole in order to view the peripheral structures and overlying

vitreous. The BIO technique provides a stereoscopic wide-angled view of the retina through a pupil that has been dilated with a pharmaceutical mydriatic, as the optics of the BIO is less influenced by media opacities and high ametropia. BIO is indicated for the investigation of retinal diseases such as suspected diabetic retinopathy, retinal tears and detachments as well as examining the fundus for subtle variations in colour that could be caused by tumours or oedema (Barnard, 1995).

Being able to perform BIO can assist the optometrist in evaluating a large area of the retina very swiftly, as well as providing the stereoscopic view to appreciate slight variations of colour in the fundus. Retinal disease in the far periphery, such as lattice degeneration and retinopathy of prematurity would be nearly impossible to visualise without the assistance of the BIO method and is vital to the diagnosis and management of these conditions (Probert, 2016).

3.5.2.2 Slit-lamp indirect ophthalmoscopy

Another indirect ophthalmoscopy technique that can be utilised to provide a stereoscopic view of the posterior pole of the eye is performed with a 78D or 90D double aspheric condensing lens through the slit-lamp biomicroscope. This technique is not intended to replace the BIO but does provide higher magnification and more detail of the structures viewed, allowing the optometrist to appreciate the small difference in depth of any lesions which proves to be essential in the diagnosis of macular oedema and glaucoma, to name just a few (Jamous *et al.*, 2014).

As with the head-mounted version of indirect ophthalmoscopy, the examiner is allowed a stereoscopic view of the retina, together with a larger field of view than with a traditional handheld ophthalmoscope. Slit-lamp fundus examination has been proven to be specific and sensitive enough to screen for retinal pathologies such as diabetic retinopathy, glaucoma, and macular degeneration, to name a few. It is a cost-effective method to reduce the burden of disease on secondary and even tertiary health care systems too, by ensuring monitoring of subclinical degrees of pathology in primary care optometric practices and appropriate referral to higher levels when needed (Hulme *et al.*, 2002).

This technique enables the examiner to appreciate slight differences in colour as well as the raised edges of lesions. The magnification of the lesions viewed can be altered by either changing the lens used or with the magnification of the observation system of the slit-lamp. The size of the lesions observed can also be measured by adjusting the light beam to match the size of the lesion and allowance made for the magnification factor of the condensing lens used (Elliott, 2007).

3.5.3 Gonioscopy

Gonioscopy utilises gonioscopy lenses, created by Goldmann in 1938, which is placed on an anaesthetised cornea. The Goldmann gonioscopy lens allows for the patient to be seated behind the slit-lamp. It makes use of mirrors to reflect the light rays from the anterior chamber angle to enable the optometrist to view the structures contained in the anterior chamber angle (Bruce *et al.*, 2016). The newer lenses have either 4 or 6 mirrors contained in the housing of the lens, to enable a quicker examination of the anterior angle and thus less patient discomfort (Kalantzis *et al.*, 2015).

Gonioscopy is needed if the angle is deemed narrow or occludable to assess the risk of precipitating an angle-closure attack upon dilating a patient's pupil. The technique is also considered necessary for the visualisation of the anterior chamber angle and its structures in the diagnosis and differentiation of primary open-angle glaucoma (POAG) and angle-closure glaucoma (Elliott, 2007).

The structures that are visible are then recorded and a standardised grading scale is used to classify the openness of the angle. Many different grading scales have been developed over the years to classify the angle, with the most popular grading systems developed by Schaffer, Speath and Scheie (Alward and Longmuir, 2017).

The type of lens used, however can influence the quality of the examiner's view, thus reducing the reproducibility and validity of the findings. The angle at which the lens is held, the test room illumination as well as the patient's point of gaze all influence which structures and how well the structures are seen. Gonioscopy is, therefore, viewed by Friedman and He as a difficult skill to acquire with a high degree of subjectivity and studies had shown it to have high variability between examiners and only a moderate level of

agreement, even when highly experienced examiners were employed to perform the procedure (Friedman and He, 2008).

3.6 Training of diagnostic techniques in South Africa

The training on therapeutics and the prescription of therapeutic drugs has only started in 2016 after the Health Professions Councils of South Africa (HPCSA) approved the ocular therapeutics course. The first cohort of 218 optometrists have completed the required didactic portion of the post-graduate certificate in ocular therapeutics from the University of KwaZulu-Natal and is at present working to complete the required practical clinical hours (Ramkissoon, 2018).

The diagnostic privileges qualification has been incorporated into the undergraduate training of optometrists in South Africa at the four universities providing optometric education and training since the early 2000s, namely University of Johannesburg (UJ), University of Limpopo (UL), University of KwaZulu-Natal (UKZN) and the newest addition, the University of the Free State (UFS) (Oduntan, 2014).

The Graduate Institute of Optometry (GIO), in partnership with the New England College of Optometry (NEWENCO), has provided post-graduate training in diagnostic and therapeutic techniques since 1994. Optometrists who completed the skills training received a Certificate of Advanced Studies (CAS) in ocular diagnostics and therapeutics (Kriel, 2003) and were prepared to provide diagnostic services using pharmaceutical agents as soon as the legislation was passed in 2001 (RSA DOH, 2001).

Information regarding the exact number of optometrists who graduated with diagnostic privileges was requested from each institution. To date, three institutions have confirmed the number of graduates who completed their training in optometry since the diagnostic techniques training was implemented and is set out in Table 3.2.

Table 3.2: Number of confirmed optometrists who qualified with diagnostic privileges

University	Graduates who qualified with diagnostic privileges
University of Free State (2008 – present)	203
University of KwaZulu-Natal (2002 – present)	463
The University of Johannesburg (2002 - present	868
Total	1534

The University of Limpopo has not yet been able to provide data on the number of optometrists who qualified with diagnostic privileges since its implementation at the undergraduate level. However, according to the Department of Health, there has been an average of 35 graduates per year from the University of Limpopo's optometry department, which translates to roughly 280 optometrists who have qualified with diagnostic privileges since the undergraduate programme incorporated diagnostic techniques training in the undergraduate curriculum (RSA DOH, 2017).

The GIO, which has provided the post-graduate certificate of advanced studies qualification, indicated that 839 optometrists completed the post-graduate skills training in diagnostic techniques between 1996 and 2003. This then translates to roughly 2 623 optometrists who have been trained to perform the diagnostic techniques as described previously, since the scope of practice has been expanded to include diagnostic privileges for optometrists in South Africa.

Table 3.3: Number of graduates who qualified with diagnostic privileges for each academic institution

Academic Institution	**Graduates who qualified with diagnostic privileges**
University of Free State	203
University of KwaZulu-Natal	463
University of Johannesburg	868
University of Limpopo	250*
Graduate Institute of Optometry (GIO)	839
Total	**2 623**
*Estimated amount	

3.7 Legislative requirements

3.7.1 HPCSA registration for diagnostic practice

The Health Professions Council of South Africa (HPCSA) is a statutory body for the different health professions it is mandated to regulate within South Africa and is tasked with setting the standards of care (PBODO, 2019). Designated health care professionals, including optometrists, are required to register with the HPCSA to legally practise their profession in South Africa. At present, there exist three main registers on which optometrists can appear to indicate the level of care they can provide to their patients, namely independent practice; independent practice with diagnostic privileges and the newly added register, independent practice with therapeutic rights (Ramkissoon, 2018).

The HPCSA register, however, only indicates that an optometrist has qualified with diagnostic privileges if the required correct registration form has been completed. This had to be done separately, whether the diagnostic qualification was obtained via post-graduate certification or as part of undergraduate studies. The registration procedure was only recently streamlined to automatically register newly qualified optometrists correctly with a single form.

As of 31 December 2017, there are only 636 optometrists in South Africa out of the total number of optometrists (3 767) that have been registered to practice with diagnostic privileges. This, however, is believed to be a gross underestimation of the exact number of optometrists who possess diagnostic privileges qualification (Daffue, Y.2018, personal communication, 22 January).

As indicated in Table 3.3, it is estimated that 2 623 optometrists have received training in diagnostic techniques and are qualified to perform the procedures. It thus appears that there is a discrepancy between the number of optometrists registered with the HPCSA for diagnostic practice and those that have undergone the training for diagnostic privileges.

3.7.2 MCC Section 22(A) 15 permit

Pharmaceutical agents, such as those used in the diagnostic procedures, are classified into different schedules by the Medicines Control Council (MCC) according to their risk-benefit profile. The MCC was the national regulatory authority, tasked with the monitoring, evaluation as well as the regulation of medicines and other scheduled substances. The Medicines and Related Substances Act 1965 (Act 101 of 1965) was amended in 2017 to also include medical devices and complementary medicines among others. This change in legislation gave rise to the establishment of the South African Health Products Regulatory Authority (SAHPRA) in February 2018 and now incorporates the former MCC (Keyter *et al.*, 2018). For the purpose of the study, the term MCC was used as the incorporation of the MCC into SAHPRA was phased in during the course of the study.

The diagnostic, pharmaceutical agents utilised by optometrists are classified as schedule 3 and 4 substances. Mydriatic and cycloplegic drugs are considered schedule 3 drugs, where topical anaesthetics are classified under schedule 4 substances (RSA DOH, 2016). Current

legislation does not recognise optometrists with diagnostic privileges as prescribers. They are only allowed to acquire, possess and utilise these drugs for diagnostics purposes, provided they are issued with a Section 22A (15) permit. Without this permit, the optometrist would not be able to source and keep the required mydriatic or anaesthetic agents to perform the specific diagnostic techniques (RSA DOH, 2001).

As of October 2018 according to the MCC, now known as SAHPRA, there is a total of 391 permits issued to optometric practices in South Africa (M Bembe, 2018, Personal communication, 12 October) 2018).

It is also of significance to note that if an optometrist should make use of pharmaceutical agents to perform diagnostic procedures on a patient while registered incorrectly with the HPCSA, the optometrist is in contravention of the law and can be held legally accountable.

3.8 The utilisation of diagnostic techniques

3.8.1 International rate of utilisation of diagnostic techniques

Diagnostic procedures are performed fairly regularly by optometrists in the USA as dilated fundus examinations were performed on 75% of all patients as part of routine comprehensive eye examinations (Soroka *et al.*, 2006; Hepp, 2016)

In the UK, it was found that non-contact tonometry was preferred to contact tonometry (73% vs 16%) despite 53% of optometrists confirming that they own a GAT (Myint, 2011). In the USA, Coleman et al. found that of those patients who were followed for glaucoma, less than half of them have had gonioscopy performed by ophthalmologists (Coleman *et al.*, 2006). Patients consulting optometrists for general routine eye examinations may have gonioscopy performed far less than that, as Campbell et al. found that gonioscopy was performed by only 15% of UK based optometrists (Campbell *et al.*, 2015). Varma et al. found in their retrospective study that many patients in Canada presented with undetected angle-closure glaucoma when referred by either optometrists or ophthalmologists for cataract surgery at speciality surgical centres (Varma *et al.*, 2017).

It is to be noted that countries such as UK, USA, Canada and Australia have been practising at a diagnostic level for several decades, and their scope of practice has progressed past this

level to that of managing diseases therapeutically. From a recent study in Australia and New Zealand included, it shows that the expansion in the scope of practice to include prescribing therapeutic drugs has impacted the use of diagnostic drugs and techniques. The study shows that there is a broader adherence to the guideline for the diagnosis of glaucoma which includes the performance of gonioscopy, dilated fundus examinations and applanation tonometry since optometrists have received their therapeutic endorsement in Australia and New Zealand (Zangerl *et al.*, 2015).

In Norway, where optometrists practice at level 3 of the WCO competency model, it was found that only 2% of optometrists performed dilated fundus examination. In contrast, applanation tonometry was performed by 87% of optometrists (Sundling *et al.*, 2007). The study highlighted the low diagnostic specificity when referring patients to ophthalmology, which could be indicative of the low levels of diagnostic investigation (Sundling, 2007).

In India, the scope of practice for optometrists varies considerably, although attempts are underway to regulate and standardise the profession in the country. When the services provided by optometrists in India was assessed in 2015, it was found that indirect ophthalmoscopy was performed by 2.8% of optometrists as part of routine examination and while 29% of the optometrists responded that they only perform indirect ophthalmoscopy when it is indicated (Thite *et al.*, 2015). Applanation tonometry was found to be performed by 41% of the optometrists, where 31% performed alternative tonometry techniques such as non-contact tonometry or Schiotz tonometry. Lack of equipment was named as the main reason for not utilising applanation tonometry by Indian optometrists (Thite, 2015).

3.8.2 The utilisation of techniques in Africa

In Africa, there has not been any study that specifically investigates the use of diagnostic techniques. Still, in some countries, the use of diagnostic drugs or specific diagnostic techniques has been included in studies to evaluate optometric services provided within a particular country or area.

In Ghana, a study by Mashige *et al*. (2015), was done to assess and profile optometrists and optometric practice in the country. The study found that 97% of the participating optometrists utilised diagnostic drugs daily. Contact tonometry was only utilised by 55% of

the participants in the study but the use of gonioscopy and dilated indirect ophthalmoscopy was not included in the study. It was hypothesised that these techniques were not performed very often, with the lack of the required specialised lenses being sighted as the main reason for not performing gonioscopy and indirect ophthalmoscopy (Mashige, 2015).

The optometry programme at Lúrio University in Mozambique started in 2009 and only has 36 graduates up to 2016. The curriculum is based on that provided by the Brien Holden Vision Institute in Australia and optometrists graduate with therapeutic privileges. According to the study that was done to assess the services provided within the newly developed industry, it was found that only 4% of the respondents perform gonioscopy, 29 (82%) of the optometrists perform contact tonometry. Nearly all of them (96%) make use of diagnostic drugs daily. In this study, the participants sighted the lack of equipment as the main barrier to utilising diagnostic techniques more often (Manuel *et al.*, 2016).

3.8.3 The utilisation of techniques in South Africa

In South Africa, there has been one study on optometric practices, which included a small subsection on the use of diagnostic procedures. This study, however, was limited to the KwaZulu-Natal province, and only to private sector optometrists. The study showed a small portion of the respondents performed these procedures regularly, as indicated in Table 3.4(Mashige and Naidoo, 2009).

Table 3.4: Percentage of optometrists who perform diagnostic techniques

Diagnostic technique	Percentage of optometrists performing technique (n=117)
BIO	7.7%
90D	22.2%
Tonometry	23.9%
Gonioscopy	9.4%

(Mashige, 2009)

3.8.4 Reasons for under-utilisation of diagnostic techniques

Previous studies across the world have shown that diagnostic techniques were not utilised regularly, especially techniques such as gonioscopy and indirect ophthalmoscopy. Below is the review of studies that had investigated the underutilisation of different diagnostic techniques.

In South Africa, Mashige and Naidoo (2009) did a descriptive cross-sectional survey among optometrists who owned their practices. A self-administered questionnaire was completed by 117 optometrists within the KwaZulu-Natal province and collected data on specific aspects of diagnostic procedures and the frequency of which the techniques were performed. Of the 117 participants, 62 participants (53%) indicated that they had a qualification that enabled them to utilise diagnostic procedures. However, 60% of the participants did not perform contact tonometry and slit-lamp assisted ophthalmoscopy. Furthermore, 84% of respondents did not perform BIO, and 78% did not perform gonioscopy, and for the most part, when these techniques were indeed performed, only when indicated (Mashige, 2009).

The reasons provided for not performing these techniques were lack of confidence and proficiency (60%); the lack of available clinical time (58%) as well as the lack of financial

incentive (61%). Mashige and Naidoo also attributed the underutilisation of these procedures to the presence of alternative techniques that were less invasive or did not require the use of pharmaceutical drugs. They also theorised that the lack of confidence in performing these techniques was due to the infrequent use the techniques which caused the loss of skill. The authors suggested that there was little to no emphasis put on clinical and practical activities when these techniques were taught at post-graduate level and that, going forward, the clinical training platforms should be expanded to hospital settings to better equip the optometrists for the greater responsibilities that accompany diagnostic qualifications (Mashige, 2009).

In Ireland, a survey was done in 2018 among optometrists to assess their specific challenges in glaucoma case findings. Diagnostic techniques such as GAT, gonioscopy and BIO were evaluated as they were deemed vital in the diagnosis of glaucoma. A questionnaire was developed and distributed to optometrists within Ireland and had 199 participants. Multivariate ordinal regression analysis was done on the Likert scale ratings to analyse effects of multiple factors. The most frequently mentioned barriers to glaucoma case findings were: 61% indicated that a lack of remuneration for diagnostic testing played a role and 71% stated that they needed more training (Barrett, O'Brien, *et al.*, 2018).

Furthermore, Barrett and colleagues found that some of the perceived barriers were linked to clinical experience in practice after graduating. Those with less than ten years of clinical experience were 2.5 times more likely to agree that appointment times were not sufficient to perform the required diagnostic tests, and 2.2 times more likely to agree that the equipment in their practice was inadequate as compared to those with experience of more than ten years (Barrett, 2018).

The level of training was also indicated as a significant barrier to glaucoma case seeking, which involved the diagnostic techniques, as 71% of participants indicated that more training was needed. What was also of interest was that in the open questions, two participants indicated they would be more likely to take up specific training if it meant that the expansion of the scope of practice was implemented. They would be able to treat the patients for glaucoma in their practices instead of referring them. Furthermore, those participants without post-graduate qualifications were 3.2 times more likely to indicate that

they needed more training. It was noted that the nature of the post-graduate courses completed did not impact on the confidence levels or the need for further training, and those who had post-graduate qualifications had higher levels of confidence in detecting glaucoma (Barrett, 2018).

The reasons for the underutilisation included:

- Lack of financial incentives.
- Low confidence levels in performing techniques.
- Insufficient or ineffective training and education.
- Risk of adverse reactions with the use of diagnostic pharmaceutical agents.
- Lack of equipment to perform the techniques.
- Allocated time for eye examination and special investigative procedures.
- Mode of practice and employment.
- Experience of optometrists.

3.8.4.1 Financial constraints

The most common reason for underutilisation of diagnostic techniques was found to be the lack of financial incentive for performing these investigative procedures.

Mashige and Naidoo (2009) found that 61% of practitioners were less than eager to perform diagnostic techniques due to the lack of remuneration for specific procedures by the medical schemes. Even though the tariff codes for these diagnostic procedures have been created by the South African Optometric Association (SAOA), very few medical aids benefit structures remunerate optometrists for specific diagnostic procedures (Mashige, 2009).

Overall, Mashige and Naidoo (2009) found that 61% of participants were discouraged from performing diagnostic tests due to the lack of remuneration and patient unwillingness to pay for procedures if health care funders would not cover it. The ordinal regression analysis showed that participants who had shorter appointment times (less than 30 minutes), had an

increased agreement to perceived barriers as compared to those participants who have appointments slots of longer than 30 minutes. For the optometrist who had appointment slots of less than 30 minutes, 57% perceived the allocated consultation slots as a barrier as compared to 31% of the participants who had longer appointment times allocated (p=0.006). Those who have shorter appointment times allocated also had a 4.2 times likelihood of reporting inadequate equipment as a barrier. Furthermore, they were three times more likely see the lack of remuneration as an impediment (Mashige, 2009).

The utilisation of applanation tonometry had increased from 11.8% to 50% in 2006 when the General Ophthalmic Services (GOS) contract made way for optometrists to charge a nominal fee for the procedure as part of glaucoma screenings (Myint, 2011). A recent study in Ireland likewise showed that the lack of remuneration for specific diagnostic procedures and follow-up appointments were a significant barrier to performing specific procedures (Barrett, 2018).

Coleman et al. found that patients were more likely to refuse to have the procedure done if medical aid schemes do not cover a specific procedure, which further contributes to the underutilisation of specific diagnostic techniques (Coleman *et al.*, 2006).

3.8.4.2 Confidence levels

The optometrists' level of confidence to perform specific procedures impacted their keenness to perform these techniques. If a practitioner had little practical experience performing a particular technique, their confidence was negatively affected. Moreover, if a skill is not used often enough for an extended period, the practitioner's ability to perform the procedure effectively and confidently was further affected. It thus also reduced their eagerness to perform the techniques (Campbell, 2015).

3.8.4.3 Training and education

Training and education of optometrists plays an important role in whether or not practitioners are confident in performing specific diagnostic techniques. Jamous and others found that older optometrists were less confident in slit-lamp ophthalmoscopy, as their core training did not emphasise the importance of the procedure (Jamous, *et al.*, 2014). Mashige

(2009) also stated that the lack of confidence in the techniques found was due to the training these optometrists received. He speculated that the lack of community service and limited practical experience that South African optometrists received when these techniques were initially taught, negatively impacted the use of the techniques. Their limited exposure to the techniques in a hospital or clinic settings impeded their ability to achieve high levels of competency as well as confidence (Mashige, 2009).

Post-graduate diagnostic qualifications of optometrists have been shown to influence the utilisation of diagnostic techniques. The recent study by Barrett *et al.* (2018) showed that optometrists who have completed post-graduate qualifications are more likely to perform diagnostic procedures. They also have higher confidence in performing these procedures and disease detection, regardless of the field of interest or specialisation of the post-graduate studies (Barrett, 2018).

3.8.4.4 Risk of adverse reactions to diagnostic pharmaceutical agents

With the use of Diagnostic Pharmaceutical Agents (DPA), the possibility of side effects and adverse reactions occurring exists. These adverse reactions and the optometrists' ability, or lack thereof, to deal with these reactions can be another possible deterrent to utilise the diagnostic drugs and the techniques associated with the use of the drugs as shown in an earlier study (Krueger and Trevino, 1990).

3.8.4.5 Equipment

Many of the diagnostic techniques require specialised equipment to perform these techniques such as a gonioscopy lens for the performance of gonioscopy, the Goldmann tonometer for applanation tonometer as well as the head-mounted binocular indirect ophthalmoscope used for dilated fundus examinations. Acquiring the equipment could come at a great expense and are not always available in every practice. If the optometrist does not own or have access to the specialised equipment needed, it stands to reason that they cannot perform that specific technique (Manuel, 2016).

In the technological era of today, some practices have access to modern equipment that may conceivably be used in the place of the recognised gold standard. The use of technology

in eye care is fast becoming part of mainstream practice as optometrists are looking for quicker and non-invasive ways to get results. One such example is the use of fundus cameras, which provides a photographic record of a patient's retina without the use of a mydriatic agent to dilate the patient's pupil. This method of evaluating the health of a patient's retina causes the patient less discomfort as there are no side effects from the mydriatic agents. It takes less time and skill to perform than the indirect ophthalmoscopy methods. It can also serve as a valuable tool for monitoring of diseases over time as there is a photographic record of the retina and has opened the doors to telemedicine and the collaboration between optometry and ophthalmology across borders (Muñoz-Negrete *et al.*, 2015). Though it does not replace a three-dimensional view that one would get by using a diagnostic procedure, a camera is still used more frequently due to the swiftness and non-invasive nature of the tool.

In the case of measuring IOP, there are a multitude of different equipment available and provide results in a manner that are quicker and less invasive when compared to applanation tonometry. These alternative methods to measure IOP also provide good agreement with GAT. This equipment can be effective screenings tools in routine eye examinations as they too require no pharmaceutical agents and in some cases are more portable than the use of Goldmann tonometry, which requires a slit-lamp (Patel, 2016).

3.8.4.6 Available examination time

Time allocation for routine eye examinations has a significant impact on whether diagnostic procedures are performed. Procedures that require pupil dilation, such as BIO or slit-lamp fundus exam, take up more time, as the mydriatic drops on average take 20-30 minutes to fully dilate the average patient's pupil. This requires longer chair time to be allocated to a patient, or the patient would be required to return for a follow-up appointment to complete the procedure. It has been found that optometrists who allocate less than 20 minutes time slots to perform a routine eye examination, perceive time constraints or available chair time as a barrier to perform diagnostic techniques or follow-up procedures (Barrett, 2018).

3.8.4.7 Mode of practice and employment status

The business model and employment status of the optometrists have been found to impact on whether or not specific diagnostic techniques are performed. Large group practices or franchise practices are more likely to allocate shorter time slots per appointment, which then leads to a lesser likelihood of diagnostic procedures being performed, compared to optometrists who work within a private independent practice where it is easier to dictate the length of time slots available for routine eye examinations (Barrett, 2018).

Optometrists employed within a practice tend to perceive the same barriers, which can be explained by pressure from management structures to perform shorter eye examinations (Barrett, 2018). Clinical development tends to be side-lined by corporate employers if it does not increase the sale of optical appliances, where independent optometrists are more care focused and have a higher regard for clinical development (Kokkinakis, 2011).

Another revelation from the study conducted in Ireland, was that employee optometrists showed a positive correlation with shorter time slots for routine eye examinations, lower confidence levels with diagnostic procedures and less experience in terms of years in practice when compared to those optometrists who are self-employed (Barrett, 2018). Optometrists within these modes of practice perceived time constraints as well as confidence levels as some of the barriers to performing certain techniques and procedures. Years in practice were also shown as a negative correlation to perform diagnostic techniques, this due to younger optometrists being more likely to be in an employed position and possibly more susceptible to pressure from management to perform shorter eye tests (Barrett, 2018).

3.8.4.8 Practitioner experience

In Canada, a study in the 1990s, after the scope of practice was expanded to include the use of Diagnostic Pharmaceutical Agents (DPA) in optometry practice, showed that the utilisation of DPAs was influenced by the age of the optometrists, mode of practice as well as which optometry school the optometrist attended. Older optometrists, contrary to findings by Barret *et al*. (2018), were less likely to change their routine. They were inadequately prepared for the use of DPAs, therefore less likely to embrace the use of

diagnostic drugs. The survey also highlighted the importance of optometric training institutions and how DPAs were introduced and taught to undergraduates. The use of DPAs was significantly higher among optometrists who qualified after legislative changes took effect and the importance of these techniques were emphasised to a greater extent (Krueger, 1990).

The same study also noted that the practice modality, i.e. practitioners working within a single optometrist practice versus those working within a group practice bare some significance in the use of DPAs. The authors noticed that solo practitioners were less likely to make use of diagnostic techniques; however, they did also note that at the time of the study, older optometrists were more likely to practice as solo practitioners as opposed to being in a group (Krueger, 1990).

3.8.4.9 Barriers related to specific techniques

Ting *et al.* (2011) found that dilated fundus examinations were only performed on patients by 23% of optometrists as part of their routine exam in Australia. As previously mentioned, light sensitivity and blurry vision are some of the temporary side effects of instilling mydriatic drops and as such patients are advised not to drive until the effects of the mydriatic drops have worn off. A total of 51% of the optometrists who participated in the study, sighted the inconvenience caused to patients as a barrier to dilation. Optometrists stated that their patients were either not prepared to drive after the examination or they would need to return on a day when they can arrange for someone to drive them home (Ting *et al.*, 2011).

The headband binocular indirect method comes with its own unique set of barriers to regular utilisation. It is a difficult skill to master especially when the patient cannot be supine for the procedure and if the technique is not used often, mastering the skill will not be achieved (Probert, 2016). Most optometric practices are not equipped to enable the patient to be examined supine, resulting in patients having to be seated for the procedure. Rosser also stated that patient discomfort and inconvenience is considered a deterrent in performing dilated indirect ophthalmoscopy along with the increased chair time, as it can

take 20-30 minutes for the mydriatic drops to take effect and dilate the pupils to the required level (Rosser, 2010).

Applanation tonometry, although considered the gold standard for measuring IOP, requires the use of a slit-lamp and is not portable. This can be regarded as a barrier to utilising the technique (Abraham *et al.*, 2008). Not all patients can reach the slit-lamp for this technique to be performed, such as young children and patients who are wheelchair-bound (Patel, 2016). Newer equipment had been developed to measure IOP and together with portability can provide measurements with acceptable reliability which can serve as practical screening tools for glaucoma (Abraham, 2008).

Gonioscopy is a technique that seems to be the least utilised by eye care practitioners, as only half of the patients who present with POAG have gonioscopy performed at their initial work-up. Poor patient co-operation, low examiner confidence, lack of practice by the practitioner, inadequate view from poor technique and reliance on other techniques such the Van Herick method have all been cited as reasons for not performing gonioscopy (Bruce, 2016). It has also been reported that ultrasound and OCT are used to evaluate the anterior chamber angle for occludability with acceptable levels of reliability (Castaneda-Diez *et al.*, 2011; Tun *et al.*, 2017).

3.9 Conclusion

From the literature reviewed, it is apparent that the utilisation of diagnostic techniques and their perceived barriers have not been extensively explored in South Africa since the initial expansion of the scope of practice took place in 2001. It is also evident that optometrists experience similar barriers to perform diagnostic techniques in other regions of the world. The next chapter will deal with the methodology followed in the study.

CHAPTER 3: METHODOLOGY

4.1 Introduction: This chapter gives an overview of the methodology employed to address the aim of the study. An outline of the research design, study area and sampling is provided. Thereafter, an explanation of the data collection process will follow. The chapter concludes with a discussion on data management, which explains how data was stored, as well as the statistical analysis of the data.

4.2 Research design

The study was a quantitative descriptive cross-sectional study. This study design was adopted to best investigate and answer the research inquiry, which provided insight into the pattern of practice regarding diagnostic techniques in private optometric practices. Cross-sectional studies have the advantage of results being achieved quicker and at a lower cost as well as the ability to expose associations between variables (Hulley *et al.*, 2007).

A quantitative research design was utilised as it has the advantage of identifying the factors that influence an outcome, such as the utilisation of diagnostic techniques (Creswell, 2014). It also served to understand the predictors of the underutilisation of diagnostic procedures within the optometric industry in South Africa (Neuman, 2014).

4.3 Study population

The study was aimed at optometrists who were registered with the HPCSA to practice optometry within South Africa at the time of the study. The study population was divided into three groups, according to the diagnostic qualification and registration status.

4.3.1 Group 1

The first group (Group 1) consisted of optometrists who qualified with diagnostic privileges and were correctly registered with the HPCSA for diagnostic practice.

4.3.2 Group 2

The second group (Group 2) consisted of optometrists who had qualified with diagnostic privileges but were not registered with the HPCSA for diagnostic privileges. These optometrists failed to amend their registration with the HPCSA to update their registration for diagnostic licensure

4.3.3 Group 3

The third group (Group 3) consisted of the optometrists who did not qualify with diagnostic privileges. These optometrists have not undergone any further training in diagnostic techniques and to permit the use of DPAs.

4.3.4 Summary of group descriptions

The last two groups of the study population, Group 2 and Group 3, consisted of optometrists that were not registered with the HPCSA for diagnostic practice. Both Group 2 and Group 3 were registered for "independent practice" only. Of these 2 groups, Group 2 did qualify with with diagnostic privileges while Group 3 did not qualify with diagnostic privileges .

4.4 Study sample and size

For the purpose of this study, it was not feasible to do an accurate and representative sampling of the population of optometrists who have qualified with diagnostic privileges. Firstly, as indicated, the HPCSA register recorded an underestimation of optometrists who qualified with diagnostic qualifications, and some did not appear on the HPCSA diagnostic register. Secondly, gaining access to the HPCSA database came at a premium, as one has to pay a fee per entry. Thus optometrists in a private practice setting were recruited for this study, and convenience sampling was chosen for greater access to practising optometrists.

In order to recruit participants for the study, the researcher contacted the SAOA and requested assistance with the distribution of the questionnaire as the SAOA's database contains email addresses of optometrists to whom they provide industry related news on a regular basis. The SAOA assisted by electronically distributing the questionnaire to the 2721

email addresses on their mailing list at no cost to the researcher. However, for reasons of confidentiality and to protect SAOA members, the SAOA does not disclose email address contact information. The optometrists were placed into the different groups during data analysis.

4.4.1 Inclusion criteria

Optometrists who were registered with the HPCSA as an optometrist, that had a valid email address and currently practising in private practice on a full-time basis in South Africa, were included in the study.

4.5 Exclusion criteria

The optometrists excluded from the study were those who were retired, working overseas, employed as locums, academic personnel, public sector optometrists, or sales representatives. Optometrists from these groups were excluded as the nature of the services they provide were considered to have the capacity to be fundamentally different from those who were employed full time within the private sector. The practice habits and potential barriers experienced were thought to be dissimilar, specifically for public sector optometrists, where ophthalmologists performed the bulk of diagnostic tests. Additionally, the level of input and control on practice protocols and the access to equipment within public hospitals were considered to vary from private sector optometrists and were therefore excluded.

4.6 Data collection tool

A structured online questionnaire, consisting of closed-ended and open-ended questions, was employed for the study (Appendix A). Open-ended questions were included to provide participants with the opportunity to elaborate on certain aspects or clarify issues they perceived to be essential.

The online questionnaire had the advantage of being able to access a large sample size over a large geographic area, as well as being a cost-effective data collection method at a

relatively low cost. Another perceived advantage of a survey study was that this method of data collection offered its participants anonymity and allowed for more truthful answers (Kumar, 2011).

The extensive literature review provided the background to formulate the questions contained in the questionnaire, as no single instrument existed to answer the research question. Questions about the use of diagnostic techniques and perceived barriers to their use had been taken from a previous study (Mashige, 2009) and revised to suit the three different groups of participants.

The questionnaire was only available in English, as the training of optometrists in all of the South African departments of optometry was done in English. The questionnaire was set up via the Evasys system and was a self-administered electronic questionnaire which enabled the participants to complete it at a time and place that was convenient for them.

The questionnaire consisted of a total of 99 questions, of which 91 questions were closed-ended, and the remaining eight questions were open-ended. The questionnaire was prepared in such a way as to differentiate the participants into different groups according to their answers, as shown in Figure 3.1. There were 73 questions for group 1, 82 for group 2 and 49 for group 3. Thus, this single electronic questionnaire was structured to accommodate all three groups of optometrists and was able to filter and redirect the participants to the different sections of the survey according to their group.

The questionnaire consisted of the following ten sections:

- Section 1: Demographic and practice information.
- Section 2: Diagnostic qualification details.
- Section 3: Equipment and techniques used.
- Section 4: Perceived barriers.
- Section 5: Diagnostic pharmaceutical agents used.
- Section 6: Techniques and equipment used in lieu of diagnostic qualification.
- Section 7: Perceived barriers to obtaining a diagnostic qualification.
- Section 8: Registration with the HPCSA.

- Section 9: Perceived barriers to registration with the HPCSA.
- Section 10: Medicine Control Council Permit.

All the participants completed section 1, while Group 1 and Group 2 participants completed Sections 2 to 5 and 8. Sections 6 and 7 were completed by Group 3; Section 9 was completed by Group 2 and Section 10 by Group 1.

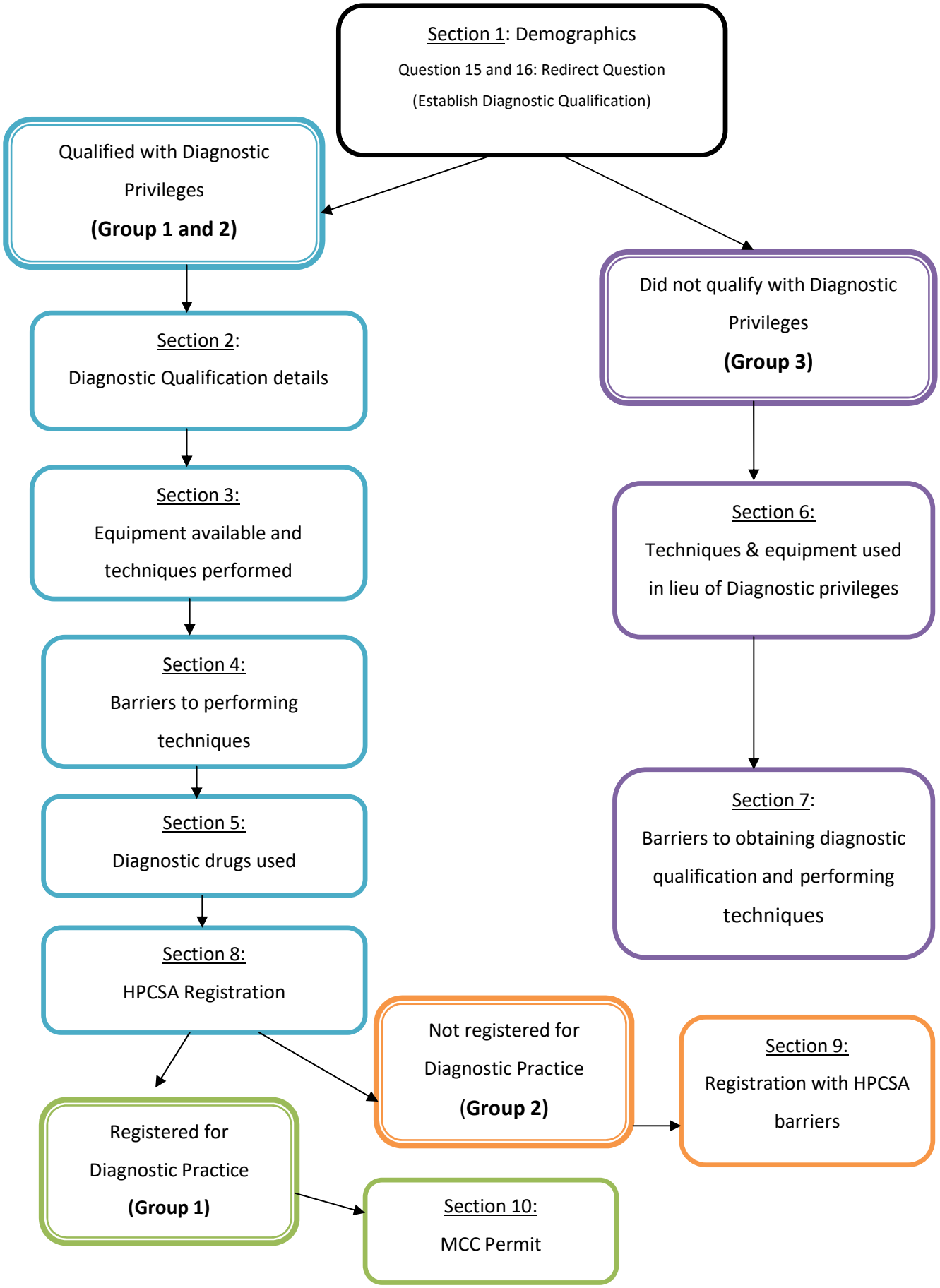

Figure 4.1: Flow of survey questions

4.6.1 Section 1: Demographic and practice information

This section consisted of 16 questions and aimed to collect personal information and biographic details of the participants. This category was completed by all participants as it dealt with information on the modality of the practice as well as the location thereof. The second half of this section collected information on the participant's optometric qualifications. This section concluded with questions that redirected the participants to appropriate sections, according to their specific responses.

4.6.2 Section 2: Diagnostic qualifications

The four questions in this section aimed to collect information about the diagnostic qualifications of those participants who have obtained a qualification in the use of Diagnostic Pharmaceutical Agents (DPA) and the techniques that are associated with it (Group 1 and 2).

4.6.3 Section 3: Equipment and techniques performed

In this section, the different types of equipment and techniques available to the optometrists that enabled them to perform diagnostic procedures and the possible alternative techniques that may be utilised were investigated together with the frequency with which they were performed. This section contained 15 questions that were directed to Group 1 and Group 2 participants. The availability of equipment and the frequency of diagnostic techniques performed addressed the first research objective of determining the utilisation rate of the different diagnostic techniques.

4.6.4 Section 4: Perceived barriers

This section consisted of 21 questions, which aimed to determine the existence of barriers perceived by optometrists who made use of diagnostic techniques, which may restrict or reduce their capacity to perform the diagnostic procedures if any. These 21 questions addressed the second research objective, which dealt with the perceived factors that affect the usage of the techniques by optometrists who received training in diagnostic techniques.

4.6.5 Section 5: Diagnostic pharmaceutical agents used

The type of DPAs used in practice, together with the usage, was evaluated by the two questions in this section. After completion of this section, the participants were directed to Section 8, which questioned their registration status at the HPCSA. This section addressed the research question of the frequency of use of techniques as the drugs are needed to perform them.

4.6.6 Section 6: Techniques and equipment used in lieu of diagnostic qualification

This section was to be completed by those participants who do not hold a diagnostic qualification (Group 3). These eight questions aimed to collect information on what techniques the optometrists make use of, in lieu of the other specific diagnostic techniques optometrists are qualified to perform. This section aimed to answer the research question of utilisation of techniques by optometrists who were not trained in diagnostic techniques.

4.6.7 Section 7: Perceived barriers to obtaining a diagnostic qualification

The 17 questions in this section gauged the attitudes of non-diagnostic qualified optometrists toward the diagnostic qualification and the barriers they perceived in obtaining the diagnostic qualification. This section was the last section to be completed for those optometrists who do not hold a diagnostic qualification, as they were prompted to submit their answers once this section was completed. This section addressed the research question of possible barriers to the utilisation of diagnostic techniques from the perspective of those who have not received training in diagnostic techniques.

4.6.8 Section 8: Registration with the HPCSA

This section contained one question, which established whether the participating optometrists in Group 1 and 2 were correctly registered with the HPCSA to reflect their diagnostic qualification. This question also served to filter and redirect the participants to the different sections that dealt with specific questions pertaining to their registration barriers when not correctly registered, which addressed the research objective of registration requirement awareness among optometrists.

4.6.9 Section 9: Perceived barriers to registration with the HPCSA

This section was for participants who were not correctly registered with the HPCSA to reflect their diagnostic qualification (Group 2). The 12 questions in this section addressed participants' awareness of the registration process as well as their reasons for not amending their registration. This section was the last section completed by Group 2, as these participants were then directed to submit their answers at the end of this section.

This section addressed the third research objective, which was the awareness of the need to be correctly registration by those optometrists who were not registered for diagnostic practice as well as the implications of practising diagnostic techniques without the correct HPCSA registration.

4.6.10 Section 10: Medicine Control Council Permit

This section was the last section of the questionnaire completed by the optometrists who were correctly registered with the HPCSA (Group 1) and only contained three questions. The purpose of this section was to determine the awareness of the need to obtain the Section 22(A) 15 permit from the Medicines Control Council to acquire, possess and store the pharmaceutical agents for the use of diagnostic techniques. This section addressed the research objective of establishing the awareness of the correct registrations and permits required for diagnostic practice by those optometrists who appeared on the correct register with HPCSA.

4.7 Questionnaire piloting

A pilot study was conducted electronically among five optometrists, who practised in private practice and had been pre-identified by the researcher after the approval (Appendix B) was obtained from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State. The researcher invited the pilot study participants via email to complete the questionnaire online, which was hosted on the same electronic system as the main study.

The pilot study assisted with determining whether the wording of the questions was understandable; whether the interpretation of the questions was consistent, and also aimed

to eliminate ambiguity. The pilot study further assisted in determining if there were questions that were perceived to cause discomfort among participants, in addition to learning the time it took to complete the questionnaire (Andrews, *et al*., 2003). The pilot study was conducted over two weeks. The comments and remarks received from the pilot study group were taken into account to make the necessary changes to the questionnaires before distribution.

The pilot study revealed that the wording of some questions could be misunderstood. As a result, changes were made to the questionnaire. The data collected from the pilot study was not included in the final data analysis.

4.8 Procedure

An invitation email contained an information document (Appendix C) to introduce the prospective participants to the researcher and study. It described the purpose of the survey and was sent to those optometrists who were registered with the HPCSA and had valid email addresses. The information document explained the ethical information such as the risks and benefits of the study. The email contained the URL link to the questionnaire together with a cover letter. (http://surveys.ufs.ac.za/evasys/online.php?p=WUG6N)

Participation in the research study was voluntary and informed consent to participate in the study was obtained by an "opt-in" option contained in the email. By clicking on the link contained in the invitation email and again by clicking on the submit button, the participants provided consent.

The online questionnaire was available to participants for two months from commencement. Reminders to complete the survey were sent out to prospective participants at two weekly intervals to facilitate an increased response rate (Neuman, 2014). All data collection occurred online via the Evasys Survey Automation Suite software (Version 6.1), which enabled the survey responses to be automatically verified and stored.

4.9 Ethical Considerations

Ethical approval for the study was obtained from the HSREC, Faculty of Health Sciences, University of the Free State. Prior to participation in the study, participants had to consent to voluntary participation in the study. An Excel spreadsheet containing the participants' answers was kept on a secure password-protected computer at all times. The information collected from the participants was handled with strict confidence, and no names or personal identifying information was collected, ensuring the anonymity of the participants. No identifying characteristics were collected and no participant was identified individually, protecting their anonymity at all times.

4.10 Data management and analysis

The data collected in the study were analysed by the Department of Biostatistics (University of Free State). Descriptive statistics, namely frequencies and percentages, were used for categorical data, and means and interquartile ranges or medians and percentiles were used for numerical data and were calculated per group. Responses from open-ended questions were summarised. The groups were compared by means of Chi-square or Fisher's exact test for categorical data and Kruskal Wallis test for numerical data.

4.11 Conclusion

A questionnaire was designed to establish the utilisation of diagnostic techniques by a private practising optometrist in South Africa. The aim of the questionnaire was to determine the frequency of use of the techniques as well as to establish if there were any barriers that hindered the optometrists from performing diagnostic procedures. The questionnaire was made available online to reach optometrists from across the country. A total of 141 responses were received, and the analysis of the results is presented in Chapter 4.

CHAPTER 4: RESULTS

5.1 Introduction

In this chapter, the results of the study, which aimed to determine the utilisation of diagnostic techniques by optometrists practising in South Africa, are presented. Firstly, the demographic profile of the participants is described, followed by the description outlining the subpopulation breakdown. This progresses to the frequency in the utilisation of diagnostic techniques, the possible perceived barriers to practising diagnostic procedures encountered by optometrists, as well as the HPCSA registration status of the participants.

A total of 141 participants completed the questionnaire, which gives a response rate of 5.2%. Twenty-two participants met the exclusion criteria and were excluded from the data analysis. These participants were excluded due to the fact that their practice habits and the barriers they experience may differ from that of full-time private-sector optometrists and would potentially skew the data of the study. One questionnaire was incomplete and thus discarded; this resulted in a total of 118 questionnaires that were included in the analysis of the results.

The responses received from the participants determined the separation of participants into three groups. Group 1 consisted of 49 participants who had obtained a diagnostic qualification and who were correctly registered with the HPCSA for diagnostic practice; Group 2 consisted of 49 participants who were not registered for diagnostic practice with the HPCSA despite having completed the diagnostic training and Group 3 consisted of 20 participants who had not undergone training to utilise diagnostic drugs and techniques.

Table 5.1: The breakdown of participants for the three groups

PARTICIPANTS		
Group 1: Qualified & registered correctly	49 (41.5%)	n = 118
Group 2: Qualified but not registered correctly	49 (41.5%)	
Group 3: Not Qualified	20 (17.0%)	
Excluded	23	
Total responses received	141	

5.2 Demographic information of participants

5.2.1 Age and gender of participants

Among the 118 participants, 46 (39.0%) were male, 72 (61.0%) were female, and one participant did not indicate their gender. Of the 101 participants who indicated their age, the median age of the participants was 39 years (IQR: 33;45). The median age for Group 1 and Group 2 was found to be 37 years (IQR: 33;40) and 39 years (IQR: 33;48) respectively, where Group 3 was found to be significantly older (p=0.0083) with a median age of 45.5 years old (IQR: 39;50)(Table 4.2).

Table 5.2: The breakdown of age and gender characteristics for each of the three groups

	Group 1: Participants with diagnostic qualification, correctly registered with HPCSA	**Group 2: Participants with diagnostic qualification, not correctly registered with HPCSA**	**Group 3: Participants without diagnostic qualifications**
Gender (n=117)			
Male	16 (33.3%)	20 (40.8%)	10 (50%)
Female	32 (66.7%)	29 (59.2%)	10 (50%)
Age (n=101)			
Median age	37 years	39 years	45.5 years
Range	22-56 years	24-66 years	27-61 years
Lower Quartile	33 years	33 years	39 years
Upper Quartile	40 years	48 years	50 years

5.2.2 The geographic location of the participants

The majority of the participants, 44 (37.6%) were found in Gauteng followed by KwaZulu-Natal with 23 (19.7%) and Western Cape with 18 (15.4%), Mpumalanga 10 (8.5%), Free State 8 (6.8%), Eastern Cape 8 (6.8%), Limpopo Province 4 (3.4%) and the Northern Cape province had the least participants with 2 (1.7%). The distribution of the geographic location for the

different groups were presented in Table 4.3. One participant did not indicate in which province they practised.

Table 5.3: The breakdown of the geographic location for the three groups

Province	**Group 1 (n=49)**	**Group 2 (n=49)**	**Group 3 (n=20)**
Gauteng	21 (43.8%)	18 (36.7%)	5 (25.0%)
Free State	2 (4.2%)	4 (8.2%)	2 (10.0%)
Limpopo	3 (6.23%)	0 (0.0%)	1 (5.0%)
Northern Cape	0 (0.0%)	1 (2.0%)	1 (5.0%)
Eastern Cape	3 (14.6%)	3 (6.1%)	2 (10.0%)
Western Cape	7 (14.6%)	8 (16.3%)	3 (15.0%)
Mpumalanga	5 (10.4%)	2 (4.1%)	3 (15.0%)
KwaZulu-Natal	7 (14.6%)	13 (26.5%)	3 (15.0%)
Did not indicate	1	0	0

Table 5.4 reflects the area where the participants' practices are situated for the different groups. Overall, an urban location was the most common area (55 of 117 (46.7%)) where respondents' practices were found followed by Central Business Districts (CBD) at 31 (26.5%), shopping mall practices at 21 (17.9%) and rural practices at 10 (8.5%). One participant did not indicate their area of practice.

Optometric practices in urban settings referred to those found in areas of residential as well as commercial districts. CBDs were understood to be practices found in areas of economic hubs and business districts only (Park and Allaby, 2017). Mall practice locations referred to those optometric practices found in designated large shopping centres within the urban or suburban areas.

Table 5.4: The breakdown of the areas of practices for the three groups

Area of Practice	**Group 1 (n=49)**	**Group 2 (n=49)**	**Group 3 (n=20)**
Rural	2 (4.2%)	4 (8.2%)	4 (20.0%)
Urban (residential & semi-business districts)	24 (50.0%)	21 (42.9%)	10 (50.0%)
CBD(Economic hub/business district only)	14 (29.2%)	13 (26.5%)	4 (20.0%)
Shopping mall (designated shopping centres within urban setting)	8 (16.7%)	11 (22.5%)	2 (10.0%)
Did not indicate	1	0	0

5.2.3 Mode of practice and employment status of participants

The mode of practice is defined as the specific type of practice the practitioner practices in. Independent private practice refers to those practices where the optometrist is not governed by the external rules and policies other than those set by the regulator. Group or

franchise practices, in contrast, are those practices that have policies in place to ensure uniform business practices among multiple practitioners.

The majority of the participants; 86 out of 116 (74.1%) found themselves in independent private practice, whereas 26 (22.4%) worked in a group or franchise practice. The remaining participants, one (0.9%) worked in a private hospital setting, and three (2.6%) practised in an ophthalmology practice. Two participants did not indicate their mode of practice. There was no significant difference between the groups with regards to the mode of practice they indicated, as seen in Table 5.5.

Table 5.5: The mode of practice of the participants for the different groups

	Group 1	**Group 2**	**Group 3**	**Total**
Independent private practice	37 (75.5%)	35 (72.9%)	14 (73.7%)	86 (74.1%)
Group or franchise practice	9 (18.8%)	12 (25.0%)	5 (26.3%)	26 (22.4%)
Hospital (private)	1 (2.0%)	0 (0.0%)	0 (0.0%)	1 (0.9%)
Ophthalmology practice	2 (4.1%)	1 (2.1%)	0 (0.0%)	3 (2.6%)
Total	**49**	**48**	**19**	**116**
Did not indicate	0	1	1	2

The majority of optometrists, 85 (71.2%) were self-employed practitioners, and 34 (28.8%) were employed as full-time optometrists. The employment status was similar across the different groups ($p>0.05$), as shown in Table 5.6. Self-employed optometrists accounted for 69.4% of both Group 1 and Group 2 as well as 80% of Group 3.

Table 5.6: Employment status of participants

	Group 1	Group 2	Group 3	Total
Employed	15 (30.6%)	15 (30.6%)	4 (20.0%)	34 (28.8%)
Self-employed	34 (69.4%)	34 (69.4%)	16 (80.0%)	85 (71.2%)

5.2.4 Experience of participants

A total of 99 participants indicated the number of years they have been in practice; the median years in practice were found to be 15 years (IQR:10;21.5). The *p*=0.0085 indicated an association between the groups and years in practice. Table 5.7 showed the interquartile range of the years in practice for Group 1 was found to be nine years in practice for the lower quartile and 18 years for the upper quartile (median, 13 years). Group 2 participants had slightly more experience and the median experience was 15 years (IQR:9;24). Whereas, Group 3 were found to be more experienced with the median years in practice found to be 21 years (IQR: 16.5;24.5).

Table 5.7: Years of experience of participants by groups (*p*-value=0.0085)

	Group 1	Group 2	Group 3
Median	13 years	15 years	21 years
Lower Quartile	9 years	9 years	16.5 years
Upper Quartile	18 years	24 years	24.5 years

5.2.5 Duration of patient examination

There were 48 (40.7%) participants that indicated they allow for less than 30 minutes for a routine optometric consultation and 51 (44.6%) participants allocated between 30 and 45 minutes for a routine visual examination. Eighteen (15.3%) indicated that they allocated

more than 45 minutes for a routine eye examination, and one participant did not indicate the time allocated.

Most participants with diagnostic qualifications (93 out of 97, 95.9%) indicated that there was flexibility within their practice schedule to incorporate diagnostic techniques. Only four (4.1%) participants with diagnostic training indicated that they did not have flexibility in their time schedules to incorporate diagnostic techniques. Only answers from Group 1 and 2 participants were analysed and one participant from these two groups did not indicate whether or not they have flexibility in their schedule. There was no significant difference (p>0.05) in flexibility of time between Group 1 and Group 2, as 49 (100%) participants from Group 1 and 44 (91.7%) of Group 2, indicated similar flexibility in the time schedule.

5.2.6 Qualifications of participants

5.2.6.1 Primary optometry qualification

The majority of the participants – 96 (81.4%) – held a B.Optom degree. Seven (5.9%) of the participants held a B. Tech qualification; eight (6.8%) held a Diploma in Optometry, and three (2.5%) underwent conversion to a Doctor of Optometry degree (OD). Four (3.4%) participants indicated that they held a qualification not mentioned in the options provided. Figure 5.1 shows the primary optometric qualifications of the participants for the different groups.

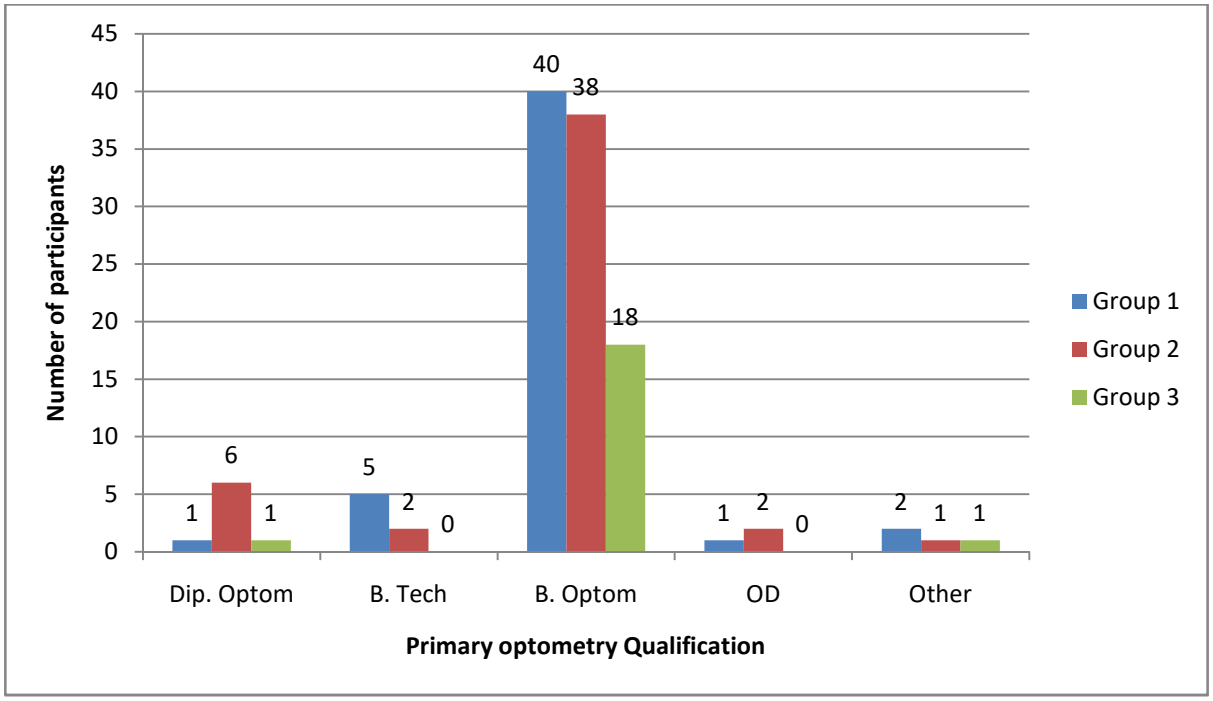

Figure 5.1 The primary optometric qualifications of the participants

5.2.6.2 The institution where optometry qualification was received

The participants predominantly obtained their qualification from the Gauteng-based institutions, ie. University of Johannesburg (UJ) and the two former higher education institutions that amalgamated in January 2005 to become UJ. Twenty-three (19.5%) participants obtained their optometric qualification from UJ. The Rand Afrikaans University (RAU) and Technikon of Witwatersrand (TWR), which amalgamated to become UJ, accounted for 24 (20.3%) and 14 (11.9%) of the participants, respectively. Nineteen (16.1%) of the participants graduated from The University of KwaZulu-Natal (UKZN) and 9 (7.6%) from the former University of Durban Westville (UDW), which merged with the University of Natal to become UKZN in 2005 (Oduntan *et al.,* 2014). Five (4.2%) graduated from the former University of the North, which was later renamed the University of Limpopo (UL), which had 13 (11.0%) graduated participants. Only 10 (8.5%) of the participants are alma maters of the University of Free State, which started offering an optometric qualification in 2002. One (0.8%) participant indicated that they obtained their qualification from an

institution not mentioned in the questionnaire as they obtained their qualification from a foreign institution.

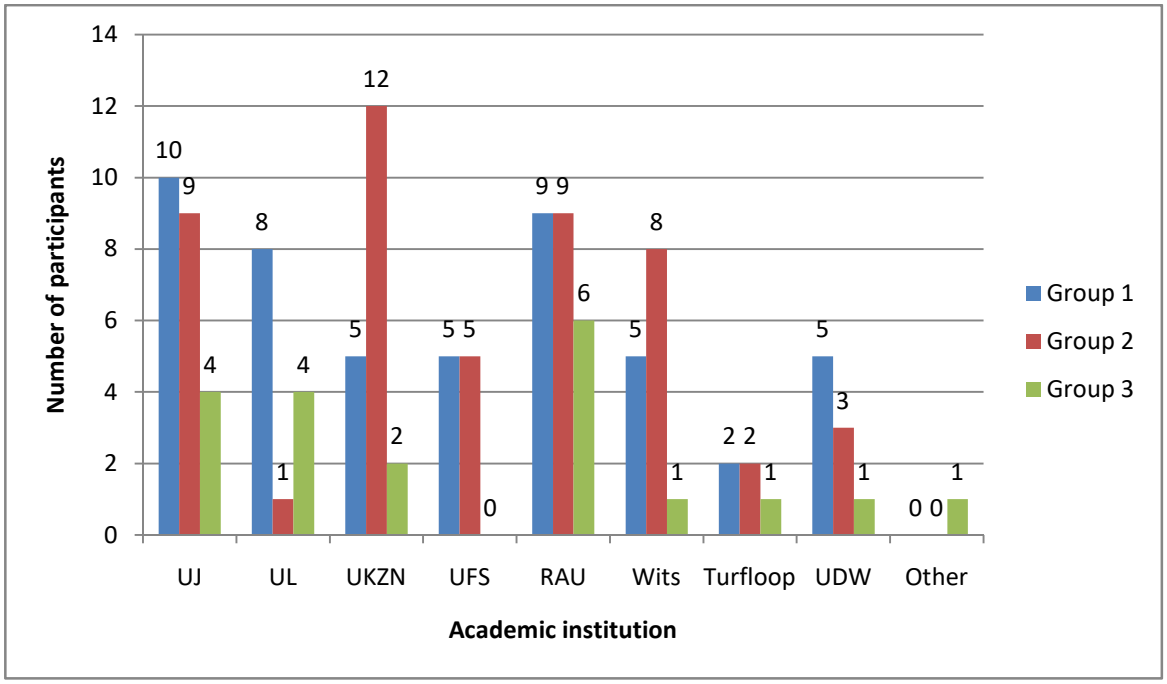

Figure 5.2: The institutions where participants obtained their primary optometry degree

5.2.6.3 Year in which primary optometry qualification was received

The median year in which participants across all three groups obtained their primary optometry qualification were 2002 (IQR: 1995;2007). Participants from Group 3, which are those who have not undergone diagnostic training, had a median year of qualification of 1996 (IQR: 1993.5;1999.5) and were found to have qualified significantly earlier than the two other groups (*p*=0.0051), who graduated at the median year of 2005 (IQR: 2000;2008) for Group 1 and 2002 (IQR: 1994; 2009) for Group 2 as seen in Table 5.8.

Table 5.8: The median year when primary optometric qualification was obtained

	Group 1	Group 2	Group 3
The median year of primary optometry qualification	2005	2002	1996
Lower quartile	2000	1994	1993.5
Upper quartile	2008	2009	1999.5

5.2.6.4 Postgraduate education and training

Fifty-seven (48.7%) participants indicated that they had obtained a post-graduate qualification as opposed to 61 (51.3%) participants who did not have post-graduate qualifications. Some participants had multiple post-graduate qualifications, while others did not specify theirs. Table 5.9 indicates the post-graduate qualifications that were specified.

Table 5.9: The post-graduate qualifications indicated by participants

Qualification	Group 1 (n=28)	Group 2 (n=21)	Group 3 (n=9)
CAS (Certificate of Advanced Study)	12	9	4
Sports Vision	4	4	3
Masters	6	3	1
PhD	2	0	0
ODC (Ocular diagnostic certificate)	5	3	0
OTC (Ocular Therapeutics Course)	5	4	0
Other post-graduate courses:			
TMOD (Treatment and Management of Ocular Disease – USA Board Exam)	1	0	0
Wet labs (NEWENCO)	0	1	0
Dyslexia	3	0	0
D Optom (Aston – UK)	0	1	0
MSc Optom (UK)	0	2	0
FCOVD (USA)	0	1	0
FCSO (USA)	0	1	0
Finance for Health	0	0	1
OD (Doctor of Optometry)	1	1	0

5.2.6.5 Diagnostic privileges qualification

The majority of the participants; 93 (78.8%) indicated that they held a diagnostic privileges qualification while 18 (15.3%) did not have a qualification that enabled them to practice diagnostic techniques. Seven (5.9%) respondents indicated that they were unsure whether or not they held a diagnostic privileges qualification.

Of the seven participants who were unsure as to whether or not their qualification equipped them for diagnostic privileges, five indicated that they underwent training to perform diagnostic techniques such as gonioscopy, binocular indirect ophthalmoscopy (BIO) and applanation tonometry and two participants indicated that they did not receive training in these specific techniques.

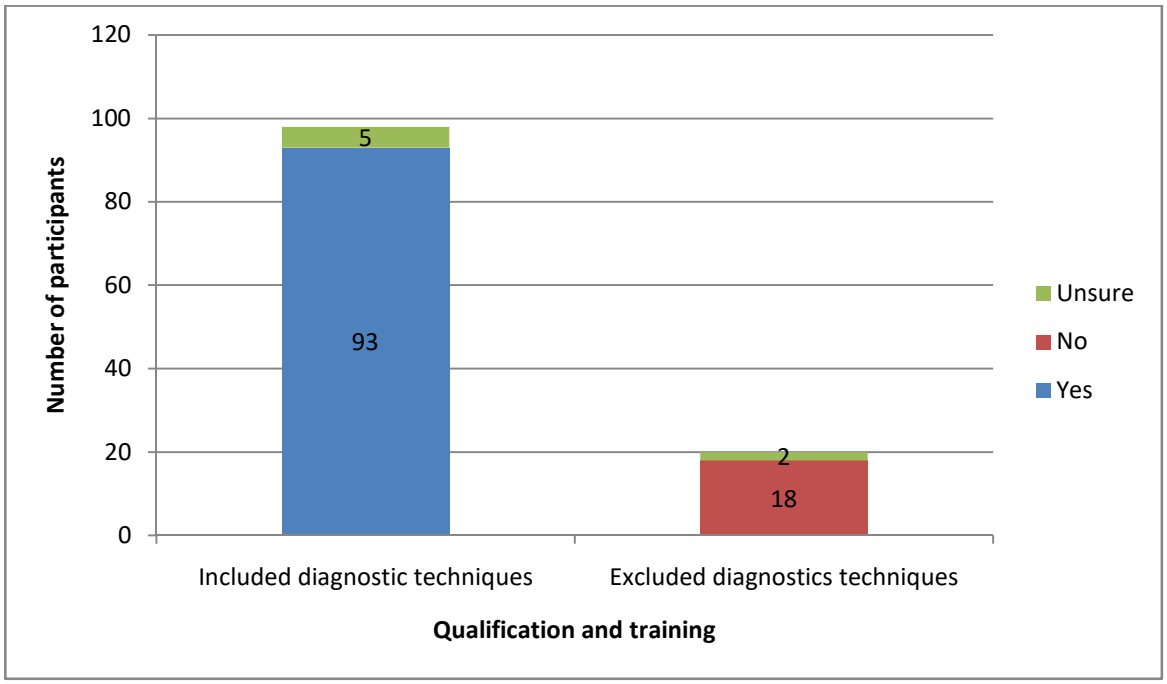

Figure 5.3: Diagnostic privileges qualifications of participants

5.3 Participants without diagnostic qualifications and privileges [Group 3]

Group 3 consisted of the 20 participants, who had no training or qualifications that enabled them to perform diagnostic techniques, with 10 (50.0%) being female and 10 (50.0%) male.

The interquartile range of Group 3's ages were from 39 to 50 years with the median age of 45.5 years. The median years of being in private practice were 21 years (IQR: 16.5;24.5).

5.3.1 Techniques and equipment used in practice

The participants in Group 3 indicated the most available items of equipment for ocular health assessment in their practices were the NCT tonometer, slit-lamp, hand-held ophthalmoscope and fundus camera Table 5.10. The least available equipment was the BIO, Goldman tonometer and OCT.

Table 5.10: Equipment available to participants from Group 3 (n=20)

Equipment	No	Yes
NCT Tonometer	3 (15.0%)	17 (85.0%)
Goldman Tonometer	18 (90.0%)	2 (10.0%)
BIO	19 (95.0%)	1 (5.0%)
Handheld Ophthalmoscope	5 (25.0%)	15 (75.0%)
20D/25D lens	20 (100.0%)	0 (0.0%)
Slit-lamp	3 (15.0%)	17 (85.0%)
90D/78D lens	11 (55.0%)	9 (45.0%)
Gonioscopy lens	14 (70.0%)	6 (30.0%)
Fundus Camera	6 (30.0%)	14 (70.0%)
OCT	18 (90.0%)	2 (10.0%)

5.3.2 Measurement of IOP [Group3]

The majority of participants, 17 (85.0%), indicated that IOP was measured at every patient visit while three (15.0%) participants indicated that the IOP was measured or evaluated only when indicated.

Twelve (60.0%) participants used non-contact air-puff tonometers to measure IOP, and seven (35.0%) participants used a rebound tonometer.

5.3.3 Assessment of the fundus [Group3]

Most (17 out of 20, 85.0%) of the participants indicated that they used undilated direct ophthalmoscopy to evaluate their patients' fundus at every visit, while three (15.0%) participants did not perform direct ophthalmoscopy at all.

Fundus photography was done at every visit with five (25.0%) participants and nine (45.0%) used this technique only when indicated, while six (30.0%) of the participants had no access to a fundus camera. OCT of the posterior pole was used at every visit by one (5.3%) participant, one respondent used it only when indicated (5.3%), 17 (89.5%) did not perform this assessment as they did not have access to an OCT scanner and one participant did not indicate an answer to this question (Table 5.11).

Table 5.11: The frequency of fundus evaluation techniques used as alternative to dilated fundus examination (n=20)

	First Visit	Every Visit	Only when indicated	Do not perform
Direct ophthalmoscopy	0 (0%)	17 (85.0%)	3 (15.0%)	0 (0%)
Fundus Photography	0 (0%)	5 (25.0%)	9 (45.0%)	6 (30.0%)
OCT of posterior pole (n=19)	0 (0%)	1 (5.3%)	1 (5.3%)	17 (89.5%)

5.3.4 Assessment of anterior chamber angle [Group3]

The number of participants who assessed the anterior chamber angle and depth at every patient visit, was 8 (42.1%), where 7 (36.4%), indicated that they only evaluated the anterior chamber angle when indicated and three (15.8%) respondents indicated they never evaluate the anterior chamber angle. One participant did not indicate how often they assessed the anterior chamber angle.

The preferred method to evaluate the anterior chamber angle by participants from Group 3 was found to be the Van Herrick angle estimation technique as 12 (60.0%) participants indicated that they made use of this method, followed by the shadow test at nine (45.0%) and the OCT scan was utilised for anterior chamber angle assessment by two (10.0%) respondents.

Table 4.12: Techniques used to evaluate the anterior chamber angle by Group 3 participants (n=20)

	No	**Yes**
Van Herick	8 (40.0%)	12 (60.0%)
Shadow test	11 (55.0%)	9 (45.0%)
OCT	18 (90.0%)	2 (10.0%)

5.3.5 Co-management with ophthalmologists

A large portion of the participants, 17 (85.0%), indicated that they co-managed patients with an ophthalmologist and three (15.0%) did not.

5.3.6 Group 3 participants' attitudes towards the expansion of the scope of practice and perceived barriers to obtaining a diagnostic privileges qualification

Nineteen (95.0%) participants from Group 3 agreed that diagnostic techniques were needed by optometrists, while one (5.0%) participant disagreed.

Seventeen (85.0%) participants indicated that they would be keen to acquire the qualification that would enable them to utilise diagnostic techniques and three (15.0%) participants were not keen.

Most participants either agreed, eight (40.0%) or strongly agreed, seven (35.0%) that the prospect of therapeutic privileges encouraged them to pursue a diagnostic qualification, whereas only five (25.0%) participants disagreed. The majority of participants, 17 (85.0%), agreed that a therapeutic qualification was appropriate for optometrists to acquire, while three (15.0%) participants disagreed.

A summary of motivations to acquire a diagnostic qualification in South Africa for Group 3 participants can be found in Table 5.13.

Table 5.13: Summary of motivating reasons for acquiring diagnostic qualifications by Group 3 participants.

Courses and training aspects o Access to courses in rural areas. o International courses/qualifications not recognised. o Improved knowledge of diseases
Financial constraints o Remuneration for procedures. o Cost of course. o Access to equipment.

Improved inter-professional relationship between ophthalmologists and optometrists
Primary eye care role o Essential for patient care. o The high cost of specialist eye care for patients. o Better quality primary eye care service. o Lack of ophthalmology services in the local area. o Improve patient health outcomes.
Scope of practice related motivations o Expansion of scope of practice. o Treatment of the most common conditions.
Not interested in diagnostic procedures themselves, only need a qualification to use diagnostic drops for cycloplegic refractions.

Nine (47.4%) participants from Group 3 agreed that the alternatives to diagnostic techniques available to them were sufficient for effective patient care, while eight (42.1%) participants disagreed, and two (10.5%) strongly disagreed. One participant did not indicate whether they agreed or disagreed.

5.3.7 Attitudes towards diagnostic techniques

The majority of participants from Group 3 indicated that diagnostic techniques should not be left to ophthalmologists to perform as eight (40.0%) disagreed and a further eight (40.0%) strongly disagreed with the statement, while one (5.0%) participant strongly agreed, and three (15.0%) participants agreed with the statement “diagnostic techniques should be left to ophthalmologists to perform”.

Six (30.0%) participants from Group 3 strongly agreed, and seven (35.0%) agreed that the lack of monetary remuneration for specific diagnostic techniques discouraged them from

obtaining a diagnostic privileges qualification, whereas four (20.0%) participants disagreed and three (15.0%) participants strongly disagreed.

The extended time required to perform the diagnostic techniques as part of a routine patient examination was not considered to be a major discouragement to obtain diagnostic accreditation as seven (35.0%) participants disagreed and three (15.0%) participants strongly disagreed with the statement. However, nine (45.0%) respondents agreed, and one (5.0%) strongly agreed that they were discouraged from undergoing the training due to the extended chair time involved.

The possible inconvenience and discomfort caused to patients were not considered a discouragement as 10 (50.0%) participants disagreed, and two (10.0%) strongly disagreed with the statement that it would discourage them. Seven (35.0%) participants agreed, and one (5.0%) participant strongly agreed that they would be discouraged to perform the technique due to patient discomfort and inconvenience.

The implied risks and obligations was not a deterrent to obtaining the diagnostic privileges qualification as more than half of the participants, i.e. 11 (55.0%) indicated that they disagreed and two (10.0%) participants strongly disagreed. Four (20.0%) participants agreed that the associated risks and obligations deterred them from obtaining diagnostics qualifications, while three (15.0%) participants strongly agreed.

Many participants indicated that the process of obtaining a diagnostic qualification would be excessively time-consuming to pursue: two (10.0%) strongly agreed and 10 (50.0%) agreed, while seven (35.0%) disagreed and one (5.0%) strongly disagreed.

For those who qualified before the expansion of the scope of practice, the cost of obtaining a diagnostic qualification as a postgraduate qualification was indicated to be a barrier, as four (20.0%) respondents strongly agreed and eight (40.0%) agreed, while seven (35.0%) disagreed and one (5.0%) strongly disagreed.

The possibility of retirement was a deterrent to some participants as two (10.0%) agreed and one (5.0%) strongly agreed that they would not pursue the qualification due to their approaching retirement, while 11 (55.0%) disagreed and six (30.0%) strongly disagreed.

Table 4.14 indicates the summary of the level of agreement with the indicated barriers by non-diagnostic optometrists.

Table 5.14: Level of the agreement to perceived barriers by non-diagnostic qualified participants

	Strongly Agree	Agree	Disagree	Strongly Disagree
Diagnostic techniques should be left to ophthalmology (n=20)	1 (5.0%)	3 (15.0%)	8 (40.0%)	8 (40.0%)
Alternative techniques, without the use of pharmaceutical agents, used for disease detection is deemed sufficient for effective patient care (n=19)	0 (0.0%)	9 (47.4%)	8 (42.1%)	2 (10.5%)
The lack of monetary remuneration for specific diagnostic techniques discourages the respondent from obtaining a diagnostic qualification (n=20)	6 (30.0%)	7 (35.0%)	4 (20.0%)	3 (15.0%)
The extended chair time involved in performing diagnostic techniques is an important factor in deciding whether to obtain and perform diagnostic accreditation (n=20)	1 (5.0%)	9 (45.0%)	7 (35.0%)	3 (15.0%)
Patient inconvenience and discomfort that accompanies diagnostic techniques can be a deterrent to perform diagnostic techniques (n=20)	1 (5.0%)	7 (35.0%)	10 (50.0%)	2 (10.0%)
The risks and obligations that accompany diagnostics techniques are a deterrent to obtaining diagnostic privileges (n=20)	3 (15.0%)	4 (20.0%)	11 (55.0%)	2 (10.0%)

Obtaining a diagnostic privileges qualification would be too time consuming to pursue (n=20)	2 (10.0%)	10 (50.0%)	7 (35.0%)	1 (5.0%)
Obtaining a diagnostic privileges qualification would be too expensive to pursue (n=20)	4 (20.0%)	8 (40.0%)	7 (35.0%)	1 (5.0%)
The participant is too close to retirement to pursue a diagnostic privileges qualification (n=20)	1 (5.0%)	2 (10.0%)	11 (55.0%)	6 (30.0%)

Other perceived barriers mentioned by the participants were as follows:

- Barriers to completing a therapeutics qualification, or not being able to treat, hamper the pursuit of a diagnostic qualification.
- Cost of courses.
- Shortage of courses.
- International qualification not recognised for diagnostic privileges.

5.4 Participants with diagnostic privileges: [Group 1 and Group 2]

Participants from both Group 1 and Group 2 indicated that they qualified with diagnostic privileges; however, not all participants were correctly registered for diagnostic practice with the HPCSA. The results from these two groups are presented in order to show their level of homogeneity.

5.4.1 Demographics of optometrists with diagnostic qualifications

The gender distribution of Group 1 and Group 2 was similar to that of the overall study participants, as seen in Figure 4.4, 16 (33.3%) of Group 1's participants were male, and 32

(66.7%) were female. Similarly, 20 (40.8%) of Group 2's participants were male, and 29 (59.2%) were female.

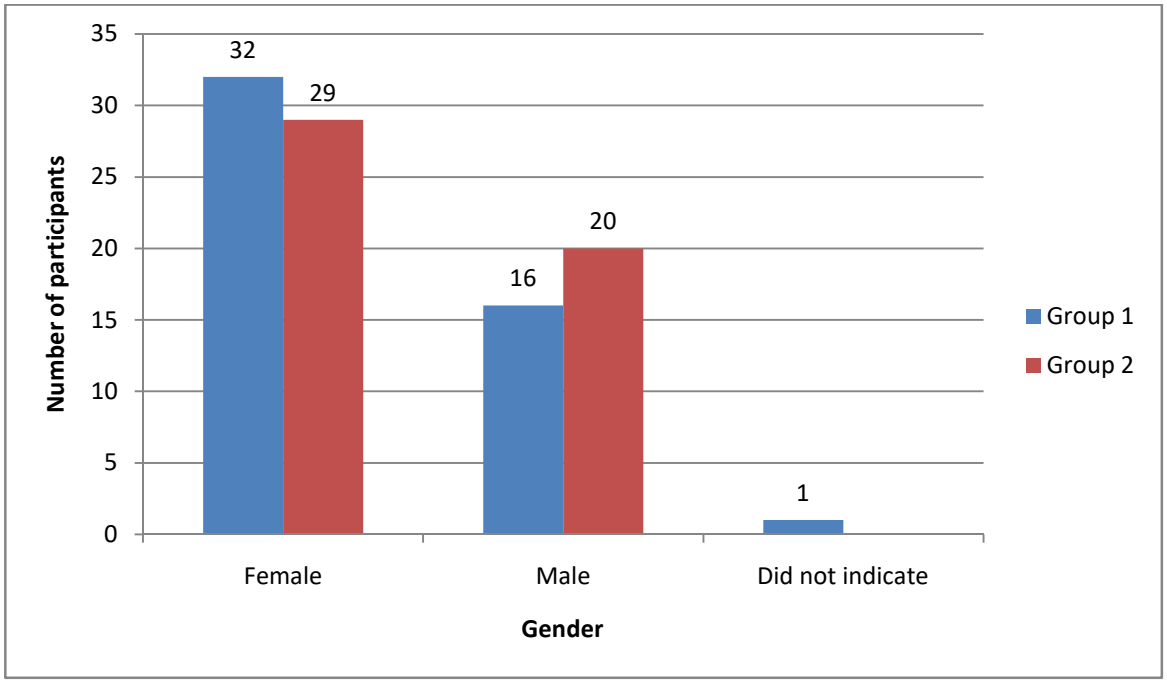

Figure 4.4: Gender of participants from Group 1 and Group 2

There was no significant difference in the median ages of the two groups of participants with diagnostic qualifications. Group 1 had a median age of 37 years (IQR: 33;40), and the median age for Group 2 was 39 years (IQR: 33;48).

Figure 4.5 shows the geographical distribution of the participants in Group 1 and Group 2, where there was little difference between the two groups.

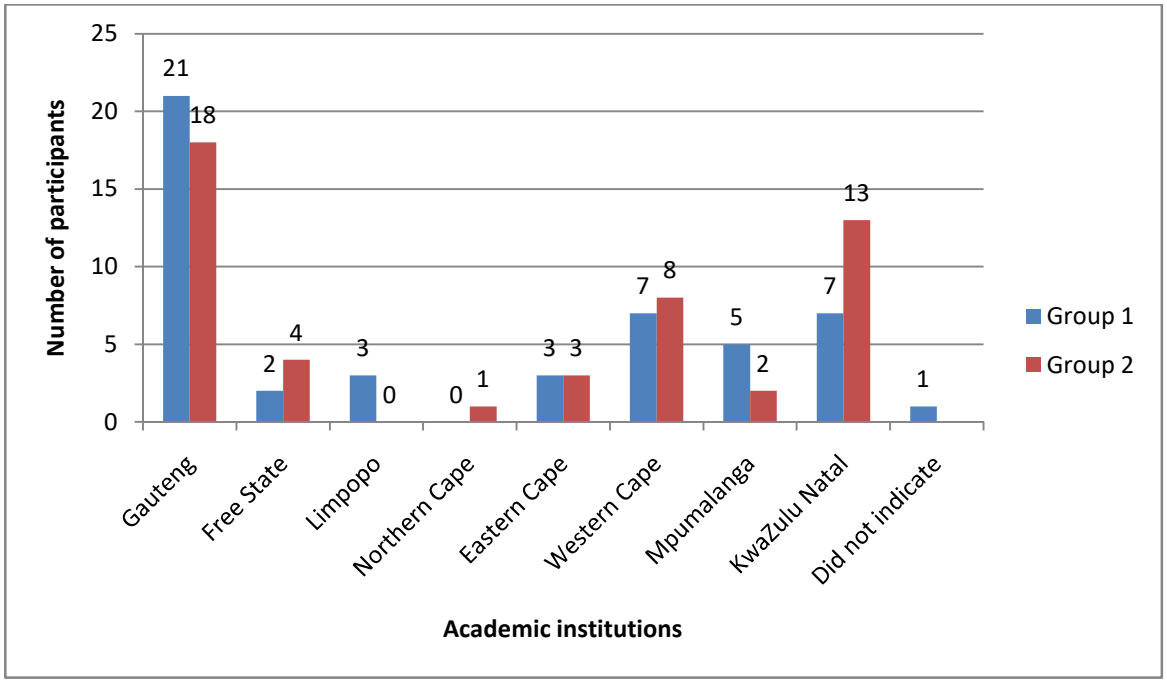

Figure 4.5: Geographical distribution of participants from Group 1 and Group 2

A total of 98 participants indicated that they had received the necessary training to make use of pharmaceutical agents and to perform the diagnostic techniques. A large portion of these participants practises optometry in urban areas set within the residential and semi-business districts, with Group 1, who had 24 (50.0%) participants and Group 2 with 21 (42.9%) participants.

The majority of participants worked in independent private practice: 37 (75.5%) from Group 1 and 35 (72.9%) from Group 2. A large number of participants were self-employed, and there was no statistical difference between Group 1 and Group 2 (*p*-value=0.6338).

Forty-seven (50.5%) participants obtained the diagnostics qualification as part of the undergraduate optometry degree, and 46 (49.5%) participants obtained the diagnostic privileges as a postgraduate qualification. Five participants did not indicate at what stage of their education they obtained their diagnostic qualifications, as shown in Figure 4.6.

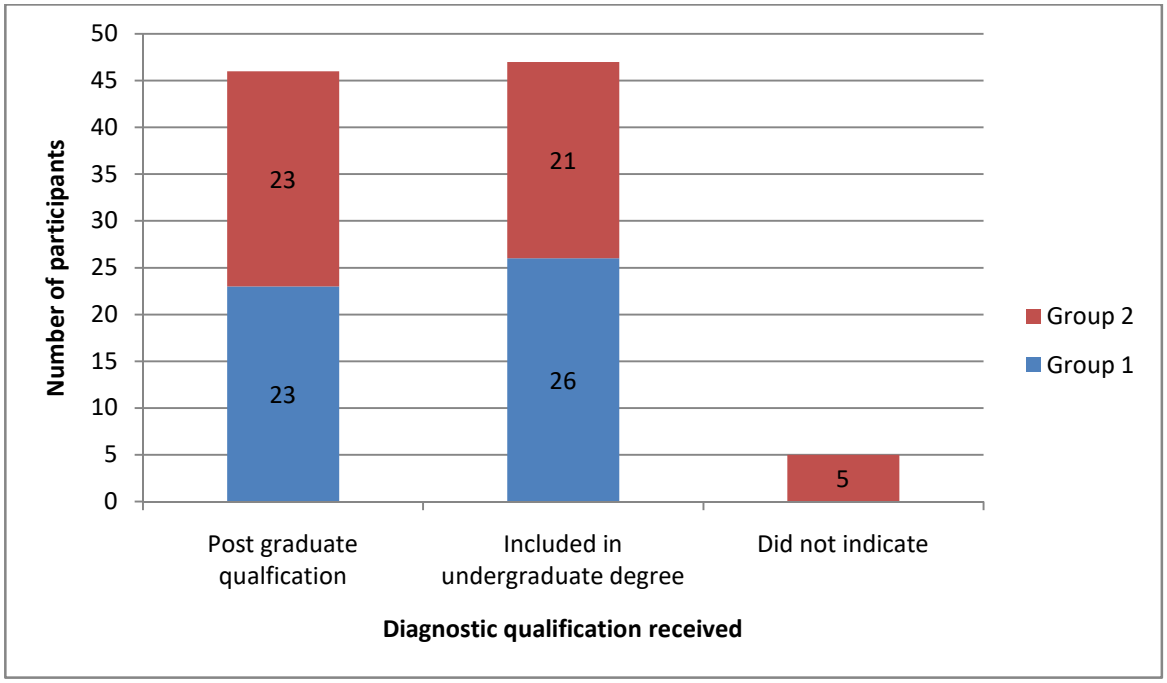

Figure 4.6: Diagnostic qualification obtained as part of undergraduate studies vs postgraduate studies for Group 1 and Group 2

The median year of obtaining a postgraduate diagnostic qualification was 2007 (IQR: 2000;2015); however, there was a significant difference between Group 1 and Group 2 (p=0.005). Participants from Group 1 received their postgraduate diagnostic qualification at the median year of 2014 for Group 1 (IQR: 2006;2016), whereas Group 2 participants received their postgraduate diagnostic qualification at the median year of 2002 (IQR: 1999;2008).

Table 5.15: Year in which post-graduate diagnostic qualification was obtained

	Group 1	**Group 2**
Median	2014	2002
Lower Quartile	2006	1999
Upper Quartile	2016	2008

Figure 4.7 indicates the institutions where the participants obtained their postgraduate diagnostic qualification. The GIO accounted for the largest number of postgraduate diagnostic qualifications with 21 (45.7%), followed by UKZN with 17 (37.0%) then UJ with seven (15.2%) and UL with one (2.2%).

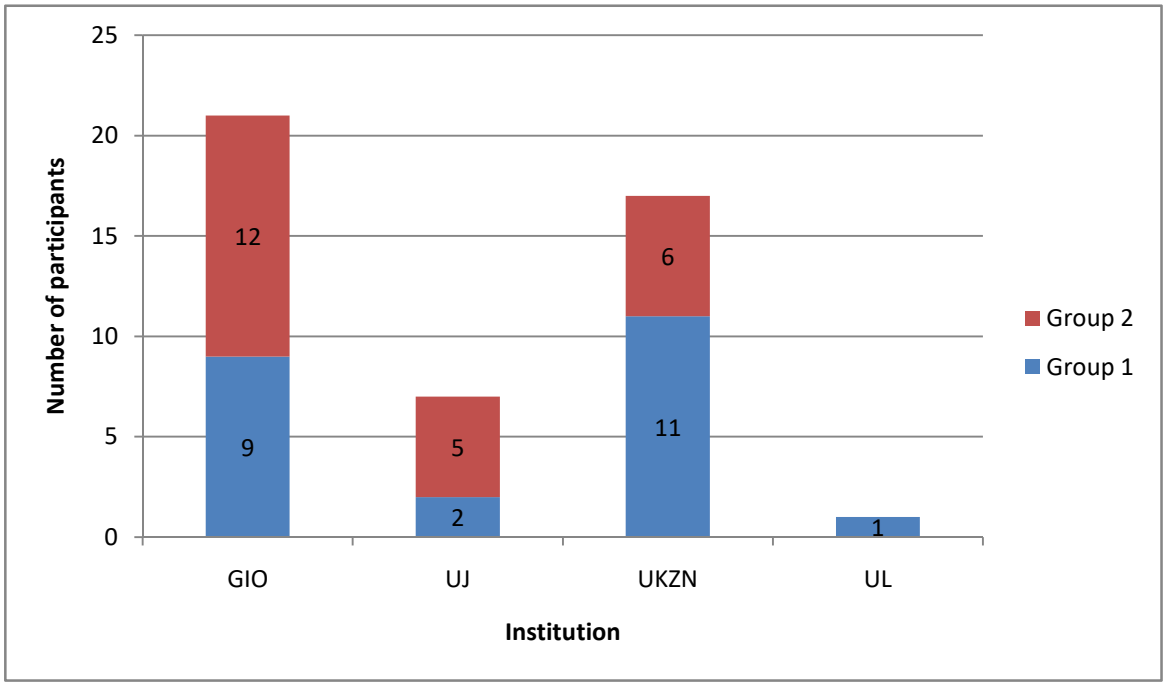

Figure 4.7: Institutions where postgraduate diagnostic qualifications were obtained

Forty-seven (51.1%) participants who have a diagnostic privilege qualification indicated they had started the newly implemented therapeutic privileges training as well, while 45 (48.9%) participants had not. Six participants did not indicate whether they had studied towards a therapeutic privileges qualification.

5.4.2 Techniques and equipment

5.4.2.1 The equipment found in practice

The most commonly available equipment was found to be the slit-lamp biomicroscope, rebound tonometer, handheld direct ophthalmoscope and fundus cameras while BIOs,

20D/25D lenses, applanation tonometers and OCT scanners were found to be the least available equipment as shown in Table 5.16.**Error! Reference source not found.**

Table 5.16: Equipment available in practice for participants (n=98)

Equipment	Group 1	Group 2
Non-Contact or Rebound Tonometer	44 (89.8%)	43 (87.8%)
Contact tonometer	15 (30.6%)	18 (36.7%)
BIO	12 (24.5%)	13 (26.5%)
Ophthalmoscope	39 (79.6%)	36 (73.5%)
20D/25D Volk Lens	15 (30.6%)	15 (30.6%)
Slit-lamp	48 (98.0%)	47 (95.9%)
78D/90D Volk Lens	35 (71.4%)	27 (55.1%)
Gonioscopy Lens	21 (42.9%)	20 (40.8%)
Fundus Camera	34 (69.4%)	38 (77.6%)
OCT	11 (22.5%)	16 (32.7%)

5.4.2.2 Measurement of intraocular pressure

Table 5.17: The frequency of utilising applanation tonometry vs non-contact tonometry illustrates the frequency at which participants indicated they utilise the different techniques for intraocular pressure measurement. Sixty-five (67.0%) participants indicated that they did not perform applanation tonometry, while 18 (18.6%) participants only performed applanation tonometry when indicated and 13 (13.4%) performed the technique at every

visit. One (1.0%) participant performed applanation tonometry on their patients' first visit and one participant did not indicate how frequently they perform applanation tonometry.

The majority of participants, 79 (82.3%) made use of non-contact tonometer at every visit to measure the IOP of their patients. Five (5.2%) only performed IOP measurement via non-contact method when indicated while 12 (12.5%) never performed the measurement. Two participants did not indicate how frequently they perform non-contact tonometry.

Group 1 and Group 2 utilised the two IOP measurement techniques at a similar frequency with the majority favouring non-contact tonometry at every visit with 40 (85.1%) and 39 (79.6%) respondents for Group 1 and Group 2 respectively. Thirty-three (68.8%) of Group 1's respondents and 32 (65.3%) of Group 2's participants did not perform applanation tonometry, as seen in Table 5.17.

Table 5.17: The frequency of utilising applanation tonometry vs non-contact tonometry

	First visit	**Every visit**	**Only when indicated**	**Do not perform**
Applanation tonometry				
Group 1 (n=48)	1 (2.1%)	5 (10.4%)	9 (18.8%)	33 (68.8%)
Group 2 (n=49)	0 (0.0%)	8 (16.3%)	9 (18.4%)	32 (65.3%)
Total for applanation tonometry	1 (1.0%)	13 (13.4%)	18 (18.6%)	65 (67.0%)
Non-contact tonometry				
Group 1 (n=47)	0 (0.0%)	40 (85.1%)	3 (6.4%)	4 (8.5%)
Group 2 (n=49)	0 (0.0%)	39 (79.6%)	2 (4.1%)	8 (16.3%)
Total for NCT	0 (0.0%)	79 (82.3%)	5 (5.2%)	12 (12.5%)

5.4.2.3 Assessment of the fundus

The most popular technique to evaluate the fundus was found to be direct ophthalmoscopy through an undilated pupil as 73 (74.5%) participants indicated they made use of this technique. Fundus photography was the second most popular technique to assess the fundus at 68 (69.4%). The high powered aspheric fundus lens technique (78D/90D) was the third most utilised technique of fundus examination with 39 (39.8%) participants. BIO is used less frequently than OCT assessment of fundus at 14 (14.3%) and 24 (24.5%) respectively. Table 5.18 indicates how frequently participants utilised the different fundus examination techniques.

Sixty-four (86.5%) participants performed direct ophthalmoscopy through an undilated pupil at every visit. Eight participants (10.8%) responded that they only performed this technique when indicated and two (2.7%) participants indicated that they never performed this technique. Twenty-four participants did not indicate the frequency at which they performed direct ophthalmoscopy. Group 1 participants were more likely to utilise undilated direct ophthalmoscopy than Group 2 (p=0.0082).

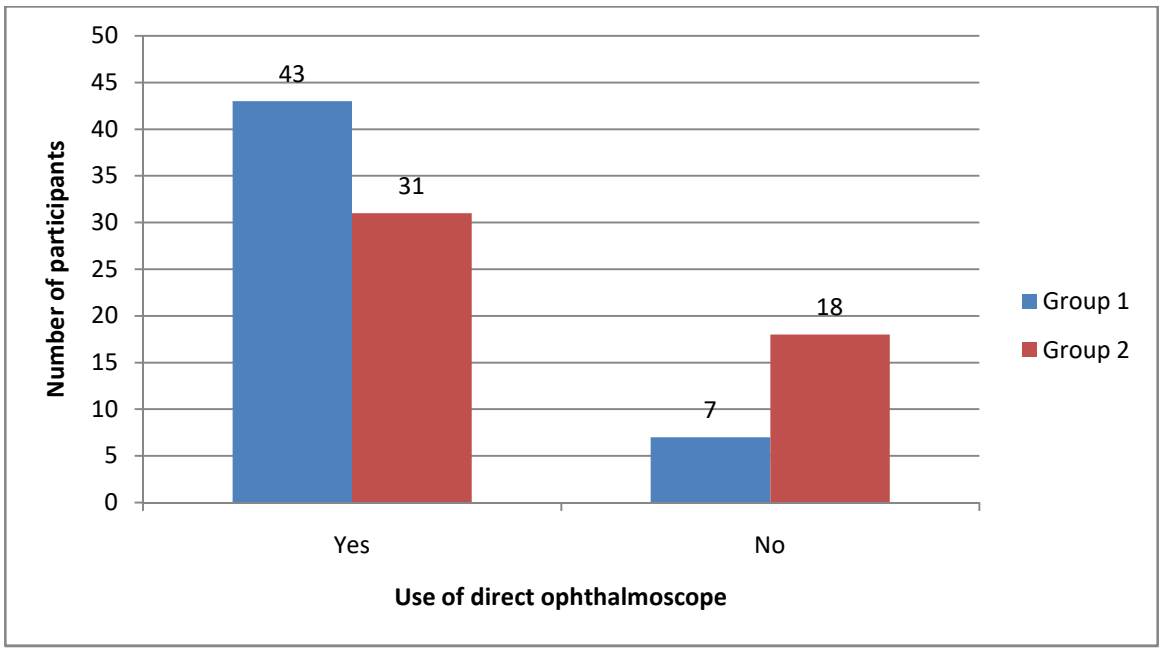

Figure 4.8: Direct ophthalmoscopy used as a method for fundus examination

Seventy-six (79.2%) diagnostically qualified optometrists who participated in the study indicated that they did not perform BIO at all, while 20 (20.8%) participants indicated that they only perform BIO when indicated. Two participants did not indicate the frequency at which they make use of the headset BIO technique to perform a fundus evaluation.

Forty (41.2%) participants indicated that they did not perform slit-lamp-assisted fundus examination, while 39 (40.2%) participants indicated that they only perform the technique when indicated. A further 18 (18.6%) participants indicated that they perform the technique at every visit, while no participant indicated they only performed the technique at the first visit. One participant did not indicate the frequency at which they used this technique.

Of the 72 participants who have access to fundus cameras, 47 (66.2%) indicated that they utilised fundus photography at every visit to examine the posterior pole, while 19 (26.8%) participants indicated that they only utilise this method when indicated. Only four (5.6%) participants indicated that they never made use of this method for fundus examination and one (1.4%) participant indicated that they utilise this method on their patient's first visit. One participant with access to a fundus camera did not indicate how frequently they made use of this equipment for fundus evaluation.

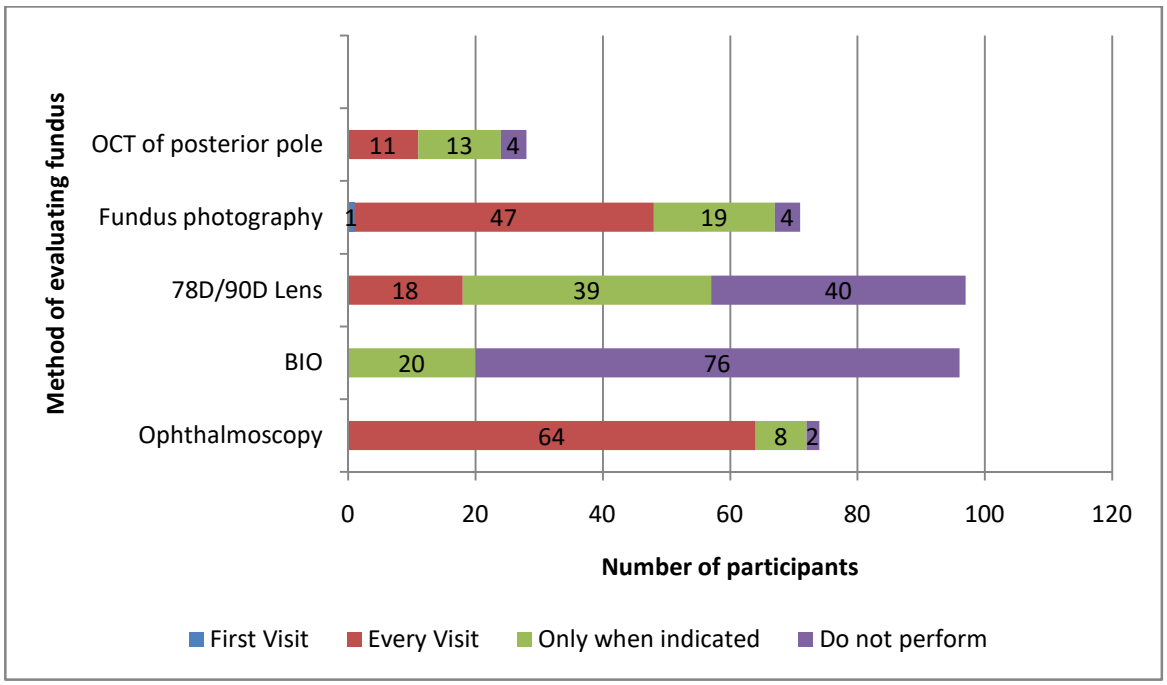

Figure 4.9: The frequency of utilisation of different fundus examination techniques

Of the 27 participants who indicated that they had access to an OCT scanner and who made use thereof for fundus examination, 13 (48.1%) participants performed it only when indicated, while 11 (40.7%) participants utilised this technique at every visit their patients presented.

Table 5.18: Techniques of performing fundus evaluations and their frequency

	The technique used for fundus examination	First visit	Every Visit	Only when indicated	Never perform
Undilated Direct Ophthalmoscopy (n=74)	73 (74.5%)	0 (0.0%)	64 (86.5%)	8 (10.8%)	2 (2.7%)
BIO (n=96)	14 (14.3%)	0 (0.0%)	0 (0.0%)	20 (20.8%)	76 (79.2%)
78D/90D (n=97)	39 (39.8%)	0 (0.0%)	18 (18.6%)	39 (40.2%)	40 (41.2%)
Fundus Photography (n=71)	68 (69.4%)	1 (1.4%)	47 (66.2%)	19 (26.8%)	4 (5.6%)
OCT of the posterior pole (n=27)	24 (24.5%)	0 (0.0%)	11 (40.7%)	13 (48.1%)	3 (11.1%)

5.4.2.4 Anterior Chamber Angle Assessment

Of the 98 participants who have diagnostic privileges, 14 (14.4%) did not evaluate the anterior chamber angle. The majority of participants, 55 (56.7%), included this evaluation in their examination routine only when indicated and 26 (26.8%) included this evaluation at every visit as seen in Table 5.19. One participant did not indicate how often they assessed the anterior chamber angle.

Sixty-four (64.3%) participants indicated that they do not perform gonioscopy for the evaluation of the anterior chamber angle, while 34 (34.7%) respondents indicated that they

only performed the technique when indicated. One (1.0%) participant indicated that they performed gonioscopy on patients at every visit as part of a routine examination.

Table 5.19: Frequency of assessing the anterior chamber angle and the specific gonioscopy technique

	First Visit	Every Visit	Only when indicated	Never perform
Assess AAC (n=97)	2 (2.1%)	26 (26.8%)	55 (56.7%)	14 (14.4%)
Gonioscopy (n=98)	1 (1.0%)	0 (0.0%)	34 (34.7%)	63 (64.3%)

The preferred alternative method to evaluate the anterior chamber angle is the Van Herick method which was used by 81 (82.7%) participants, followed by the shadow angle estimation test (also known as eclipse test) used by 32 (32.7%) participants and the technique used the least was an OCT as only 23 (23.5%) respondents indicated they made use of this technique. Table 5.20 indicates that participants mostly only performed these techniques when indicated.

Of the 81 participants who indicated they made use of the Van Herick technique, 52 (64.2%) indicated that they performed this technique only when indicated, while 25 (30.9%) performed the technique at every visit and three (3.7%) performed it at the first visit their patient presented. One (1.2%) indicated that they do not perform Van Herrick. Group 1 and Group 2 had similar responses, and there was no significant statistical difference in their frequency ($p>0.05$).

Thirty-two participants indicated that they used the shadow test to assess the anterior chamber depth. Twenty (62.5%) of those 32 participants indicated that they only performed the shadow test when indicated, 11 (34.4%) performed the technique at every visit and none performed the technique at the first visit, while one (3.1%) respondent did not perform the technique.

OCT scanning of the anterior chamber angle was not a widely popular method to assess this structure with only 23 participants who made use of it. Twenty-two (95.7%) respondents used this technique when indicated, while one (4.3%) participant used this technique at every visit.

Table 5.20: Different techniques for evaluation of the anterior chamber angle and their frequency of use (n=98)

Techniques used			**Frequency of use**			
	No	Yes	First Visit	Every Visit	Only when indicated	Do not perform
Van Herick	17 (17.3%)	81 (82.7%)	3 (3.7%)	25 (30.9%)	52 (64.2%)	1 (1.2%)
Shadow test	66 (67.3%)	32 (32.7%)	0 (0.0%)	11 (34.6%)	20 (62.5%)	1 (3.1%)
OCT of anterior structures	75 (76.5%)	23 (23.5%)	0 (0.0%)	1 (4.2%)	22 (95.7%)	0 (0.0%)

5.4.3 Diagnostic pharmaceutical agents

5.4.3.1 Topical anaesthetic agents

As seen in Table 5.21, oxybuprocaine was the most frequently used topical anaesthetic by the participants of the study (73 out 98 (74.5%)), followed by tetracaine (12 of 98 (12.2%)) and proparacaine being the least used (3 out of 98 (3.1%)). Twenty-one (21.4%) respondents indicated that they did not make use of any topical anaesthetic drops.

Table 5.21: The topical anaesthetic drugs used as indicated by participants (n=98)

	Group 1	Group 2	Total diagnostic qualified optometrists
Oxybuprocaine	38 (77.6%)	35 (71.4%)	73 (74.5%)
Proparacaine	2 (4.1%)	1 (2.0%)	3 (3.03%)
Tetracaine	9 (18.4%)	3 (6.1%)	12 (12.2%)
None	8 (16.3%)	12 (24.5%)	21 (21.4%)

5.4.3.2 Mydriatic/cycloplegic agents

The most common pharmaceutical agents used for the dilation process was tropicamide with 53 (54.1%) users; cyclopentolate with 55 (56.1%) respondents followed by atropine with 17 (17.3%) participants and homatropine was the least common agent used with four (4.1%) participants for dilation. There was no significant difference between Group 1 and Group 2 in their preferred dilating agents, as seen in Table 5.22.

Table 5.22: Mydriatic and cycloplegic agents used in practice by diagnostically qualified optometrists (n=98)

	Group 1	Group 2	Total diagnostic qualified optometrists
Tropicamide	26 (53.1%)	27 (55.1%)	53 (54.1%)
Cyclopentolate	32 (65.3%)	23 (46.9%)	55 (56.1%)
Atropine	10 (20.4%)	7 (14.3%)	17 (17.3%)
Homatropine	2 (4.1%)	2 (4.1%)	4 (4.1%)
None	11 (22.4%)	11 (22.4%)	22 (22.4%)

5.4.4 Factors affecting the usage of diagnostic techniques

5.4.4.1 Confidence in performing the diagnostic techniques

Participants were asked to rate their confidence in performing the different diagnostic techniques and participants from both Group 1 and Group 2 indicated that they were confident with slit-lamp assisted fundus examination (78D/90D lens) and applanation tonometry. Participants were less confident with gonioscopy and few were confident with performing BIO as seen in Table 5.23. There was no statistical association found between these two groups and their confidence levels for each of the techniques as the $p > 0.05$ in all cases.

Table 5.23: The level of confidence with diagnostic certification (n=98)

	Very confident	Confident	Slightly confident	Not confident at all
Applanation Tonometry	30 (30.6%)	21 (21.4%)	29 (29.6%)	18 (18.4%)
90D/78D	31 (31.6%)	32 (32.7%)	23 (23.5%)	12 (12.2%)
Gonioscopy	15 (15.3%)	30 (30.6%)	27 (27.6%)	26 (26.5%)
BIO	14 (14.3%)	23 (23.5%)	32 (32.7%)	29 (29.6%)

5.4.4.2 Co-management of patients with ophthalmologists

At 72 (73.5%), the majority of the 98 participants with a diagnostic qualification indicated that they co-manage patients with ophthalmologists. Twenty-six (26.5%) participants indicated that they do not co-manage patients with an ophthalmologist. Participants from both Group 1 and 2 indicated similar levels of co-management with ophthalmologists at 37 (75.5%) and 35 (71.4%) respondents, respectively.

5.4.4.3 Attitudes towards diagnostic techniques

An overwhelming majority of optometrists at 90 (92.8%) respondents deemed it appropriate for optometrists to possess the diagnostic privileges qualification, whereas only seven (7.2%) optometrists believed the opposite. One participant did not indicate whether or not they deemed diagnostic techniques appropriate for optometrists. The responses were similar across both groups as 46 (95.8%) of Group 1 participants and 44 (89.8%) participants from Group 2 believed that optometrists needed diagnostic techniques.

The majority of participants either disagreed, 37 (38.1%) or strongly disagreed, 51 (52.8%), that diagnostic techniques were infringing on the scope of ophthalmologists, where only five (5.2%) strongly agreed and four (4.1%) agreed with the statement. One participant did not indicate an answer to the question. There was no significant difference between Group 1 and Group 2 as both groups disagreed that diagnostic techniques should be left to ophthalmologists.

5.4.4.4 Financial implications of diagnostic techniques

The lack of monetary remuneration for specific procedures was a deterrent from performing diagnostic techniques as 34 (34.7%) participants agreed and 28 (28.6%) participants strongly agreed that they considered it a barrier, while 29 (29.6%) participants disagreed and seven (7.1%) strongly disagreed and both groups of participants had similar responses with no significant differences in their responses.

The cost of acquiring the equipment to perform the diagnostic technique was considered a barrier as 34 (35.1%) participants strongly agreed, and 46 (47.4%) participants agreed that it deterred them from performing the techniques. Only four (4.1%) participants strongly disagreed, and 13 (13.4%) participants disagreed that the cost of the equipment was a barrier to performing the techniques. One participant did not indicate an answer. Both Group1 and Group 2 agreed that the cost of equipment was a deterrent to performing diagnostic techniques, and there was no significant difference between the levels of agreement of the two groups of participants.

Chair time was a less critical factor in deciding whether to perform diagnostic techniques as 39 (40.2%) participants disagreed, and 13 (13.4%) participants strongly disagreed that it impacted on their decision to perform the techniques, while 16 (16.5%) participants strongly agreed and 29 (29.9%) participants agreed. One participant did not indicate their level of agreement or disagreement with chair time being a deterrent to diagnostic techniques. The responses were found to be similar across both groups ($p > 0.05$).

The cost of diagnostic drugs was not considered a barrier as 57 (58.2%) participants disagreed, and 13 (13.3%) participants strongly disagreed with the statement that it discouraged them from keeping the drugs. Some participants, nine (9.2%); however,

strongly agreed, and 19 (19.4%) participants agreed that the cost of the drugs discouraged them from keeping the drugs. The responses from Group 1 and Group 2 were similar, and there was no statistically significant difference between their responses (*p*-value=0.4133).

The wastage of unused diagnostic drugs was not considered as a significant deterrent to keep the drugs as 39 (40.6%) participants disagreed, and 12 (12.5%) participants strongly disagreed that they were deterred by it. The wastage of the drugs discouraged 45 participants from keeping the drugs, as 33 (34.4%) participants agreed and 12 (12.5%) participants strongly agreed with the statement. Two participants did not indicate their answer to this question, and there was no significant difference in responses between Group 1 and Group 2.

The possibility of adverse reactions to DPAs was not considered a barrier to using the technique as 55 (56.1%) participants disagreed, and 15 (15.3%) participants strongly disagreed with the statement, where 10 (10.2%) participants strongly agreed, and 18 (18.4%) participants agreed that the possibility of adverse reactions occurring discouraged them from utilising the drugs. Group 1 participants were more likely to strongly disagree that adverse reactions would discourage them from using them *(p*= 0.0214).

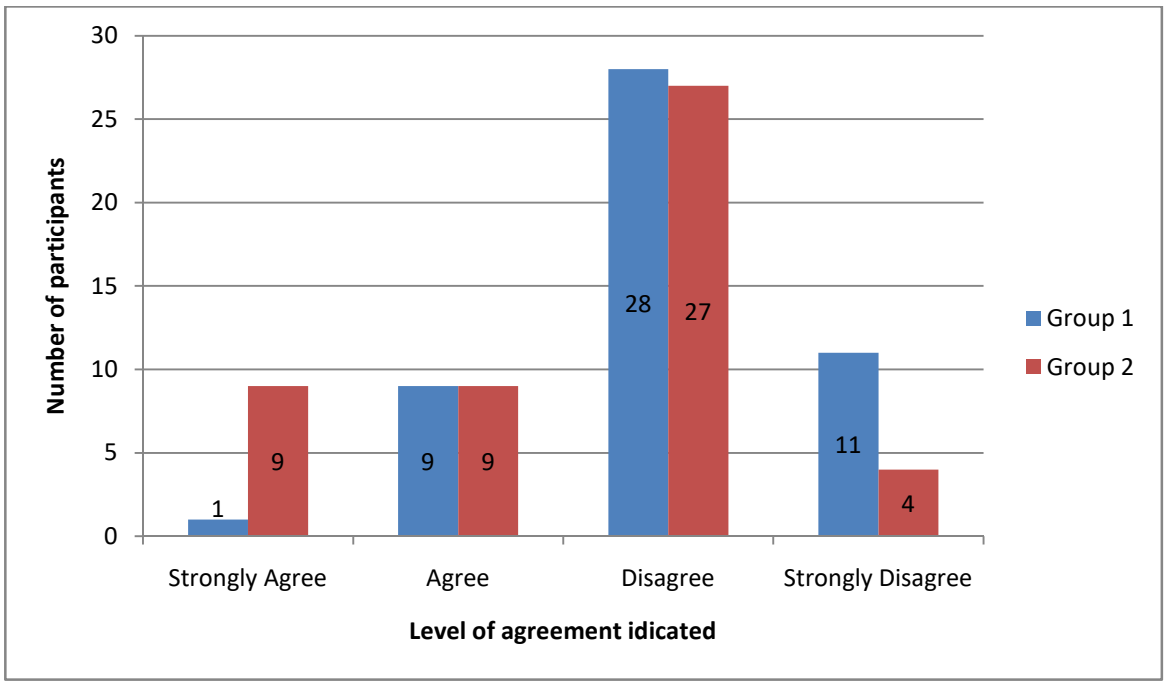

Figure 4.10: The possibility of adverse reactions to DPAs discourage usage for Group 1 and Group 2

5.4.4.5 Patient experiences

The prospect of enhanced patient satisfaction was a key motivator for performing diagnostic techniques as 39 (40.2%) participants strongly agreed, and 49 (50.5%) participants agreed that enhanced patient satisfaction motivated them, while eight (8.2%) participants disagreed, and one (1.0%) participant strongly disagreed. One participant did not indicate whether patient satisfaction was a motivator or not. There was no significant difference in the responses given by Group 1 and Group 2.

Thirty-three (33.7%) participants disagreed, and 12 (12.2%) participants strongly disagreed with the statement that patient inconvenience deterred them from administering mydriatic agents for fundus examination. Whereas 41 (41.8%) participants agreed, and 12 (12.2%) strongly agreed that they were discouraged from dilating their patients' eyes for fundus examinations. Group 2 was found to be more likely to agree that patient inconvenience was a factor when considering whether to perform a dilated fundus evaluation (p=0.0282), as seen in Figure 4.11.

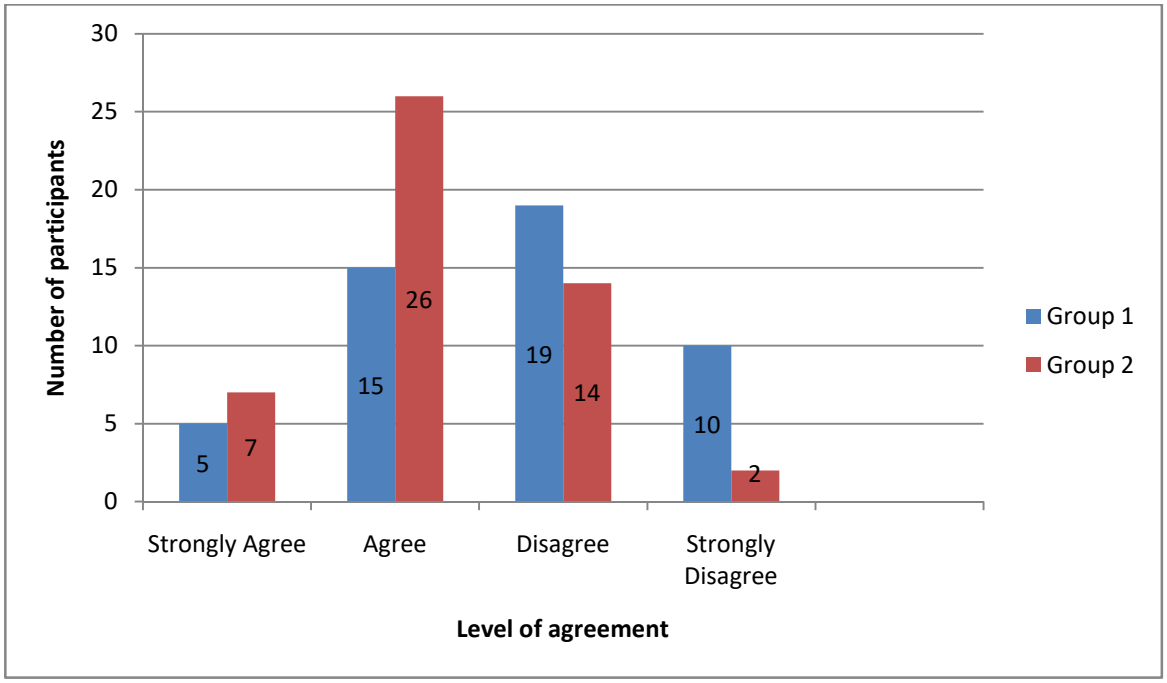

Figure 4.11: The level of agreement that patient inconvenience deters administering mydriatic agents for Group 1 and Group 2

The discomfort caused to patients during the gonioscopy technique discouraged half of the participants from performing this technique, as 38 (38.8%) participants agreed and 12 (12.2%) participants strongly agreed that patient discomfort during gonioscopic evaluation discouraged them from performing the technique, while 35 (35.7%) participants disagreed and 13 (13.3%) participants strongly disagreed. There was no significant difference or association between the responses of the two groups.

5.4.4.6 Therapeutic privileges

The majority of participants indicated that they were encouraged to perform diagnostic techniques by the prospect of optometrists practising with therapeutic privileges as 43 (43.9%) participants strongly agreed and a further 44 (44.9%) agreed with the statement. A small number of participants, eight (8.2%) disagreed and three (3.1%) strongly disagreed. There was no difference in the responses received from Group 1 and Group 2.

Almost all the participants, 95 out of 98 (96.9%), who have a diagnostic qualification believe it is appropriate for optometrists to possess the ability to prescribe therapeutic agents in the management of ocular disease, where only three (3.1%) believed it was not. There was no difference between the responses of the two groups.

Most of the participants also indicated that they were keen to obtain the therapeutic privileges qualification at 94 (96.9%) respondents while only three (3.1%) participants showed no interest in it, and one participant did not indicate whether they would be keen or not. This sentiment was found to be similar among Group 1 and 2.

5.4.4.7 Barriers to performing diagnostic techniques listed by participants

Eleven participants from Group 1 indicated that they experienced barriers to performing diagnostic techniques and the barriers named were grouped together according to themes as follows:

- The process to acquire the DPAs was either unclear or cumbersome.
- Patients waiting longer periods.
- A concern with the quality of the training received.
- Refresher courses were needed.
- Practical hours to complete the training for a diagnostic qualification.

The barriers indicated by 14 participants from Group 2 were as follows:

- Alternative techniques were considered to be sufficient to decide as to whether to refer to an ophthalmologist or not.
- Cost of consumables.
- Distrust of the level of service and care of colleagues.
- The process to correctly register with the HPCSA for diagnostic practice was either unclear or cumbersome.
- The knowledge of ocular pathology was deemed insufficient.

- The perception that the standard of care, in terms of eye examinations, was dictated by medical aid schemes.
- Lack of experience and exposure to practice within public hospital settings.
- Insufficient training.
- Patient education and expectations with regards to eye examinations as well as diagnostic techniques.
- Challenges with acquiring the appropriate permits.
- Insufficient practice liability cover.
- Inability to deal with side effects or adverse reactions that may potentially occur.

Barriers that were mentioned by participants from both Group 1 and Group 2 were as follows:

- The inability to treat diagnosed diseases renders the process mute.
- Lack of equipment.
- Cost of equipment.
- Lack of patient co-operation.
- Lack of remuneration for specific procedures.
- The prospect of ophthalmology repeating the same procedures or techniques on patients.
- Small workspaces.

5.5 Registration status of participants

Figure 4.12 shows that 31 (31.6%) of the participants who had undergone diagnostic training were not registered for diagnostic practice, 45 (45.9%) respondents were indeed registered correctly to reflect their diagnostic qualification, four (4.1%) participants have recently

qualified and registered as such for therapeutic practice and 18 (18.4%) participants were unsure of their registration status.

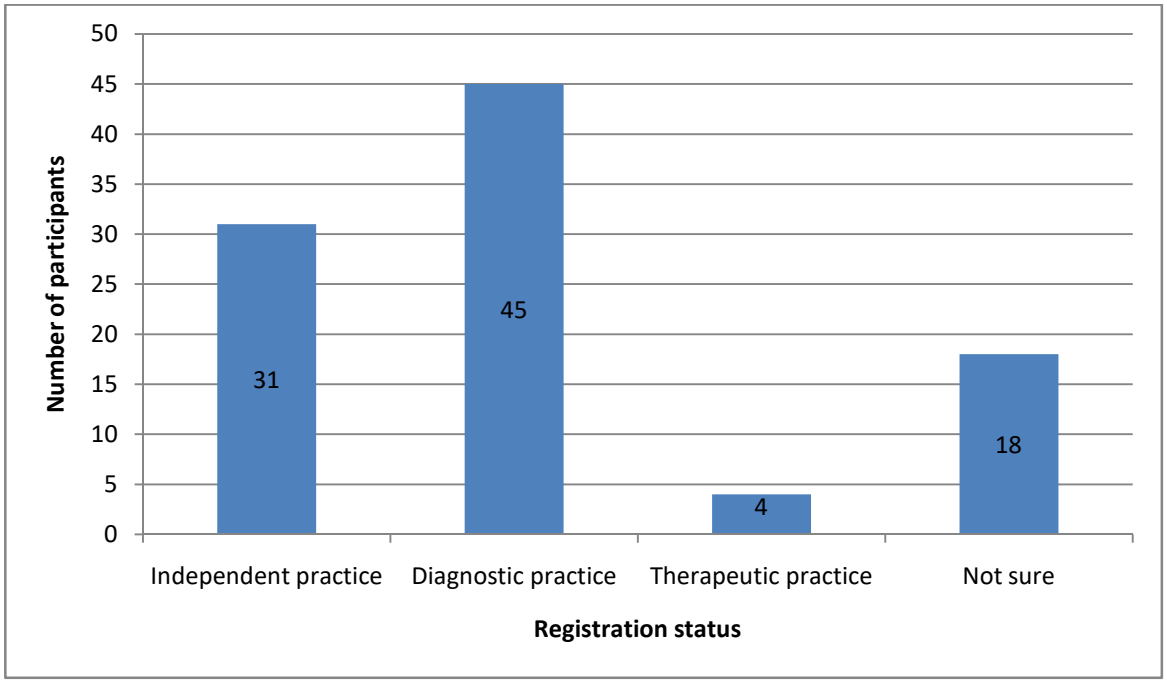

Figure 4.12: Registration status of diagnostically qualified participants

5.5.1 Participants NOT on the HPCSA diagnostic practice register [Group 2]

Of the 49 participants that constituted Group 2, 34 (69.4%) participants indicated that they were aware of the process to follow to amend their registration with the HPCSA to correctly reflect their diagnostic training and qualifications.

Twenty (41.7%) participants indicated that the correct registration with the HPCSA would encourage them to perform diagnostic techniques and three (6.3%) participants indicated that it would not, while one participant did not indicate an answer. The remaining 25 (52.1%) participants indicated that their registration status with the HPCSA would make no difference in their motivation to perform diagnostic techniques.

At 47 (97.9%), the vast majority of participants indicated that no one from either the HPCSA, SAOA, any academic institution or even patients enquired about their registration for diagnostic practice, while only one (2.1%) participant indicated that someone did contact

them to confirm that their registration reflected their diagnostic qualification. One participant did not indicate whether anyone enquired about their registration status.

The holding of a diagnostic qualification was considered an enabler of better patient care by 39 (81.3%) participants, where nine (18.8%) participants did not believe it to be. One participant did not indicate whether they felt diagnostic techniques enabled them to provide better care to their patient base.

Not using the diagnostic techniques was believed to limit the ability of examination of ocular health by 34 (70.8%) participants, while 14 (29.2%) participants believed it did not place limitations on their ability. One respondent left this question blank on their submission.

5.5.1.1 Perceived barriers to Section 22A(15) permit

Thirty-one (63.3%) participants indicated that they were aware of the process involved in applying for an MCC section 22A(15) permit, while 18 (36.7%) participants were not aware of the process.

The participants indicated that 23 (47.9%) of them experienced challenges in obtaining the MCC Section 22A (15) permit, while the other 25 (52.1%) indicated that they did not experience challenges to obtain the permit. One participant did not indicate whether or not they experienced challenges with regards to the MCC Section 22A (15) permit to acquire the drugs.

The challenges experienced by the 18 participants who answered this question, were grouped according to specified themes as follows:

- Administrative burden.
- Department of Health building inaccessible due to the building being condemned.
- Lack of contact details.
- No responses received from the HPCSA and MCC.
- The need to renew the permit regularly as well as the inability to do so.
- Documents and forms not readily available.
- Process too time-consuming and tedious.

- Unaware of the process to follow or requirements to do so.

5.5.1.2 Perceived barriers to registration

The perceived deterrents to register for diagnostic practice with the HPCSA, mentioned by the participants, were as follows:

- Previous attempts unsuccessful.
- Not aware of the process, or process is too confusing.
- Not aware of the requirements.
- Process is too time-consuming.
- Administrative burden to cumbersome.
- Assumed already registered.
- Not sure of registration status.
- Undergraduate diagnostics qualification not stated on registration.
- Training received insufficient to effectively provide the care needed.
- International recognition of local qualification lacking.
- Lack of recognition of qualification by ophthalmologists.
- Already co-manage with ophthalmology and do not need to do registration.

The participants indicated their reasons for not amending their registration with the HPCSA as follows:

- Already registered.
- Assumed registration was automatic.
- Delays from the HPCSA.
- Have not applied for diagnostic registration yet.
- Ignorance.

- Lack of communication from the HPCSA.
- Lack of remuneration.
- No need, as the participant works with an ophthalmologist who does diagnostic procedures.
- Not aware of the requirements.
- Paperwork, administrative burden.
- Previous attempts to register were unsuccessful.
- Still studying to complete the diagnostic qualification.
- Too time-consuming.
- Unsure of the process to follow.
- University did not provide proof of diagnostic qualification in order to register correctly.
- Lack of information regarding qualification.

5.5.1.3 Knowledge of implication of not registering

Twenty-five (52.1%) participants from Group 2 indicated that they were aware of the implications of practising diagnostic techniques in the absence of the correct registrations and 23 (47.9%) of these participants were not aware of the implications. One participant chose to not indicate an answer to this question.

5.5.1.4 Preference for the method of registration

Forty-six (93.9%) participants indicated that they preferred an automatic registration amendment after completion of a diagnostic qualification, while only three (6.1%) participants indicated that it would make no difference to them to have their registration automatically amended.

5.5.2 Participants on the HPCSA diagnostic practice [Group 1]

5.5.2.1 Awareness of Section 22(A)15 permit

The process involved in applying for an MCC section 22A(15) permit was known to 39 (79.6%) participants, where 10 (20.4%) participants were unaware of the process.

5.5.2.2 Perceived barriers in obtaining Section 22(A)15 permit

Even though most were aware of the process, some 24 (50.0%) participants experienced challenges in finding information on how to obtain the forms to apply for the section 22A(15) permit. The remaining 24 (50.0%) participants from Group 1 did not experience challenges in obtaining the necessary paperwork to apply for the permit.

The specific challenges the participants experienced and indicated were as follows:

- Alternative methods used to obtain drugs, therefore "no need" to obtain a permit.
- Communication barriers experienced.
- Delay in the processing of the application.
- Lack of information on the procedure to obtain the permit.
- The renewal process was cumbersome.
- Too time-consuming.

5.6 Summary of results

5.6.1 Demographics

The participants of the study were 61.0% female (IQR: 33;45). The participants were mostly self-employed optometrists (71.2%) and were practising in independent practice (74.1%) within urban areas (50.0%) in Gauteng (37.6%), KZN (19.7%) and Western Cape (15.4%).

Most of the participants, 96 (81.4%) had a B. Optom degree from either UJ, 23(19.5%) or its legacy institution, RAU 24(20.3%). Forty-seven (48.7%) participants had a postgraduate qualification, and the Certificate of Advanced Studies from GIO was the most popular postgraduate qualification.

5.6.2 Participants without diagnostic qualifications [Group 3]

Twenty participants did not have diagnostic qualifications and were mostly older with a median age of 45.5 years (IQR: 39; 50) as they mostly qualified before the expansion of the scope of practice and therefore were in practice longer, with a median of 21 years (IQR: 16.5; 24.5).

5.6.3 Participants with diagnostic qualification [Group 1 & Group 2]

Ninety-eight participants had a diagnostic qualification, and 46 (49.5%) obtained this qualification after they had completed their undergraduate studies.

The most commonly available equipment to participants from Group 1 and 2 were slit-lamp biomicroscopes (96.9%), non-contact tonometers (88.8%), handheld ophthalmoscopes (76.5%) and fundus cameras (73.5%), while fewer participants had access to GATs (33.7%), BIOs (25.5%) and OCTs (27.6%)

The most commonly used technique for IOP measurement was non-contact tonometry (82.3%) and was mostly performed at every visit that patients presented. Applanation tonometry was not performed by 65 (67.0%) participants and was only used when indicated by 18 (18.6%) participants. There was no association between the two groups and their habits of IOP measurements as all the calculated *p*-values > 0.05.

The most commonly used technique for fundus examination was direct ophthalmoscopy (74.5%) and was utilised at every visit by 64 (86.5%) of the participants. There was a significant difference between Group 1 and Group 2 regarding how often they utilised direct ophthalmoscopy (*p*-value = 0.00822), as Group 1 was found to be less likely to use this technique than Group 2. The slit-lamp assisted indirect ophthalmoscopy technique was the second most utilised technique, 39 (40.2%) respondents, for fundus examination and used at every visit by 18 (18.6%) participants. Fundus photography (68 (69.4%) participants) and OCT scanning of the posterior pole (24 (24.5%) participants) proved to be more popular than BIO, which in contrast was performed by only 14 (14.3%) participants. There was no significant difference in the utilisation rates of fundus examination techniques between the

two groups of participants with diagnostic qualifications apart from their use of direct ophthalmoscopy.

The anterior chamber angle and depth were measured at every visit by 55 (56.7%) participants and 14 (14.4%) respondents did not perform this technique at all. Sixty-four (64.3%) participants did not perform gonioscopy at all, and 34 (34.7%) respondents only performed the technique when indicated. The most popular alternative technique to assess the anterior chamber angle was Van Herrick with 81 (82.7%) respondents performing this technique when indicated, followed by the shadow test with 32 (32.7%) participants.

5.6.3.1 Factors affecting the usage of diagnostic techniques

Participants indicated overall confidence with performing slit-lamp assisted fundus evaluations (31 participants (31.6%) very confident) and applanation tonometry (30 respondents (30.6%) very confident). Confidence with the gonioscopy technique was less as only 15 (15.3%) participants were very confident and 26 (26.5%) respondents were not confident at all. BIO was the technique where the least number of participants were very confident, 14 (14.3%), and 29 (29.6%) were not confident at all.

The financial impact of performing the diagnostic techniques was a strong determinant in whether the techniques would be performed or not. The lack of remuneration for performing specific procedures discouraged 63.3% of participants (34.7% agreed and 28.6% strongly agreed) from utilising diagnostic techniques. The cost of the equipment was considered a significant factor, as 82.5% of respondents (47.4% agreed and 35.1% strongly agreed) felt that the cost of acquiring the equipment was a deterrent to performing diagnostic techniques.

The prospect of extended chair time was a lesser deterrent in deciding to perform diagnostic techniques as most disagreed (40.2%) that it discouraged them, this is evident from the fact that 51 (44.6%) participants indicated that they allow for 30-45 minutes for a routine examination and 18 (15.3%) respondents allow for more than 45 minutes; moreover, 93 (95.9%) participants indicated that they have flexibility in their schedule to allow for diagnostic techniques.

The cost and wastage of drugs were not vital factors impacting on the decision to perform diagnostic techniques. Fifty-seven (58.2%) participants were not discouraged from performing diagnostic techniques by the cost of the drugs and similarly, 39 (40.6%) participants were not deterred from performing diagnostic techniques by the wastage of the drugs.

The overall patient experience featured high when deciding to perform diagnostic techniques, as 90.7% of participants believed that patient satisfaction drove their motivation to perform these techniques. Some participants (41.8%) were put off from performing a dilated fundus evaluation due to patients' inconvenience. Group 2 participants were more likely to take patient inconvenience into consideration when deciding whether or not to perform a dilated fundus examination. Thirty-eight (38.8%) participants were deterred from performing gonioscopy due to patient discomfort during the procedure.

Most participants were not deterred by the possibility of adverse reactions occurring when administering diagnostic pharmaceutical drugs as 56.1% disagreed that the possibility of adverse reactions discouraged them from performing diagnostic techniques, although Group 1 participants disagreed more strongly (p = 0.0214).

The possibility of further scope expansion to incorporate therapeutic privileges encouraged 88.8% of participants to perform diagnostic techniques. The majority of participants, 96.9% (n=95), considered it appropriate for optometrists to have therapeutic privileges and 96.9% (n=94) of participants were keen to obtain a qualification that would allow for them to treat ocular diseases.

5.6.4 Registration status

Forty-nine participants were correctly registered for diagnostic or therapeutic practice with the HPCSA while 31 were not correctly registered and 18 were unsure of their registration status. Of those who were incorrectly registered for diagnostic practice, 25 (52.1%) participants were not aware of the implications of being incorrectly registered. Some, 34 (69.4%) participants were aware of the process to follow to amend their registration and the vast majority of participants, 20 in total (41.7%), agreed that automatic registration would be preferred once a diagnostic qualification was completed.

Twenty-five (63.3%) participants indicated that their registration status did not influence their motivation to perform diagnostic techniques and 39 (81.3%) participants did not believe the diagnostic qualification affected their ability to provide quality eye care to their patients.

5.6.5 Permit

Thirty-one (63.3%) participants from Group 2 were aware of the process involved to obtain an MCC Section 22(A)15 permit and 23 (47.9%) participants experienced difficulties with obtaining the permit, which was mostly indicated to be administrative in nature.

Similarly, 39 (79.6%) participants from Group 1 were aware of the process involved to obtain an MCC Section 22(A)15 permit and 24 (50.0%) participants experienced challenges with obtaining the permit, which was again mostly indicated to be administrative issues with the Department of Health, which issues the permits.

5.7 Conclusion

Diagnostic privileges have afforded optometrists the ability to provide better care to the communities they serve. The privilege, however, comes with a greater responsibility to practise at a higher level than before the expanded of practice was legislated. The results showed that diagnostic techniques are underutilised; in particular, gonioscopy and BIO are utilised less than GAT and 90D. Participants are further largely hindered to perform these techniques by time constraints and the lack of remuneration. The participants' confidence levels with some techniques are lower than with others and may also contribute to the utilisation of the techniques. The next chapter will contain a discussion on the main results.

CHAPTER 5: DISCUSSION

6.1 Introduction

This chapter provides a discussion and analysis of the results obtained from the electronic survey. The study aimed to determine the rate of utilisation of diagnostic techniques among South African optometrists as well as the barriers to practising these techniques. The objectives were to determine the frequency of diagnostic techniques used, the potential hurdles that impede optometrists from performing the techniques as well the optometrists' awareness of the HPCSA's registration requirements to reflect their qualifications correctly.

6.2 Response rate

The online questionnaire attracts a total of 118 respondents who fulfil the inclusion criteria of the study. Participants are included in the study if they are registered with the HPCSA for optometric practice and have a valid email address due to the convenience sampling applied in the study. Participants who work as locum optometrists as well as those who practice in hospitals are excluded from the study as the nature of their work environments are considered to vary substantially from those who work within the private sector on a full-time basis.

The email containing the link to the questionnaire is distributed by the SAOA, who indicates it has a total of 2721 email addresses on its database. Fincham (2008) suggests a goal of 60% for online surveys, however a response rate of 20% is not uncommon according to Andrews (2003). Furthermore, previous surveys sent to optometrists in South Africa by the HPCSA attracted a response rate of 20%, and as such the goal is set at 544 responses (20%) for the present study (PBODO, 2019). After sending three reminders over the course of the study, a total of 141 responses to the questionnaire are received, which equates to a response rate of 5.2%. It is unknown how many of the 2721 emails sent, were indeed opened and read, which hindered the ability to determine the true response rate.

Nonetheless, with the exclusion criteria applied, 118 valid responses were used for the data analysis. This translates to an effective response rate of 4.3%, and within a confidence level of 95%, the response rate provides a margin of error of 8.83%. The response rate is

considered low and it may impact significantly on the overall statistical significance of many results found in the study.

Schuldt and Totten found email questionnaires and surveys enjoyed response rates of as high as 50% during the 1990s due to their novelty and ease of administration (Schuldt and Totten, 1994). However, in the last decade, online questionnaires have seen a dramatic decline in response rates (Shih and Fan, 2009). One possible reason for the decline in response rates may be attributed to the increase in unsolicited emails that are flagged as spam or junk mail by the email application used and subsequently blocked (Newberry and Israel, 2017).

Personalisation of the survey, by addressing the participant by name, is a known method to increase the response rate (Saleh and Bista, 2017). However, personalisation is not possible in this study as the questionnaire is distributed by the SAOA as a generic email requesting participation. The researcher has no access to the database of email addresses, as the SAOA does not disclose any personal information of its members or those on the database. Furthermore, participation in the study is strictly voluntary and entirely anonymous. To ensure privacy and anonymity, no identifying characteristics are collected in the data collection process, therefore rendering personalisation impossible.

The SAOA has sent follow-up reminders to the database at two weekly intervals in an attempt to increase the response rate. In order to avoid being perceived as spam, a total number of 3 reminders were sent, as more than that may negatively impact the response rate (Neuman, 2014).

A further reason for the low response rate may be the participants' lack of interest in the subject matter or topic of the research study. The interests and practice habits of respondents may be systematically different from those who opt not to respond to the research study (Nulty, 2008). It is for this reason that inferences to the population at large are limited and generalisation of the results may not be possible.

6.3 Summary of demographic information

Just over half of the participants are female (61.0%), which is similar to the gender profile of optometrists registered with the HPCSA (Nirghin *et al.*, 2011).

The median age of the participants who do not have diagnostic privileges (Group 3) is found to be 45.5 years (IQR: 39;50), and their median year of graduating from an undergraduate optometry programme is 1996 (IQR: 1993.5;1999.5). As the scope of practice only expanded in the early 2000's and diagnostic techniques were only incorporated thereafter, it stands to reason that those who graduated before the expansion of the scope of practice would not have diagnostic privileges unless they have completed a post-graduate course in ocular diagnostics (RSA DOH, 2001). Respondents in Group 1 and Group 2 are younger, with a median age in the mid to late thirties, and graduated after the scope of practice expansion at the median year of 2005 and 2002 for the respective groups.

Within the private optometrists, category studied, 74.1% of participants are independent practitioners and 22.4% in a franchise or large group practices. Sustainability of private practice is intrinsically linked to profitability, which is why optometrists would be clustered in areas where their practices would be financially viable (Mashige, 2009).

The majority of the participants are found in the three provinces with the strongest economies namely Gauteng (37.9%), KwaZulu-Natal (19.7%) and the Western Cape (15.4%) (Statistics South Africa, 2018). Therefore, very few participants are found to practice in rural areas as most are either in CBDs (26.5%) or residential and semi-urban areas (46.7%). The inequitable distribution of eye care services was further perpetuated by the lack of infrastructure needed to support rural communities, as well as the perception that these communities were poorer and could not afford the services offered (Oduntan *et al.*, 2007).

Eighty-five participants (71.2%) are self-employed, compared to 66% in Mashige's study in 2009 (Mashige, 2009). Optometrists who are self-employed or have more experience are more likely to be in the position to dictate the time allocated for consultations (Barrett, 2018). The current study then shows that 44.6% of participants indicate they allocate between 30 and 45 minutes for a routine comprehensive consultation and almost all (95.9%) have flexibility in their schedule to adjust the time allocated to incorporate diagnostic techniques as part of their patient examination.

The majority of participants (81.4%) indicate they have a bachelor of optometry degree which is not unexpected as it is the only optometry course on offer in the Republic of South Africa (RSA) since the amalgamation of RAU and TWR in 2004 (Nirghin *et al.,* 2011). More

than half of the participants indicate they obtained their primary optometry degree from UJ or its legacy institutions: 19.5% of the participants graduated from UJ, 20.3% graduated from RAU and 11.9% obtained their optometry qualification from TWR.

6.3.1 Diagnostic qualification

The scope of practice expanded in 2001 to include the use of DPAs and 78.8% of the participants indicate they have undergone training to make use of these DPAs. In 2009, Mashige found that 52.9% of the participants in his study within the KwaZulu-Natal province had diagnostic qualifications. The increase in number of participants with diagnostic qualifications was to be expected as the undergraduate curriculum had included the training in diagnostic techniques since the early 2000s (Oduntan, 2014).

Three participants indicate they had an OD as a primary optometry qualification. This is not a course offered in South Africa and when evaluating the answers more closely, these optometrists indicate their qualifications have been obtained from South African institutions. One indicates that they obtained their primary optometry qualification from UKZN and two indicated TWR as the institution they qualified from. It is thus to be assumed that these optometrists underwent a conversion course overseas in order to convert their primary qualification to that of Doctor of Optometry.

Almost half of the participants (49.5%) with diagnostic privileges (Group 1 and Group 2) obtained their diagnostic qualification through post-graduate studies, and the GIO accounted for 45.7% of the post-graduate diagnostic qualifications among the participants. GIO has offered the diagnostic training for optometrists well before the actual expansion of the scope of practice took effect and the subsequent undergraduate incorporation of the diagnostic techniques training (Kriel, 2003).

6.3.2 Post-graduate qualifications

The study finds 48.7% of the participants have a post-graduate qualification which is significantly higher than the 23.9% Mashige found in a previous study (Mashige, 2009). This correlated with the fact that 51% of participants indicate they have undergone parts of the training required for therapeutic practice, which in itself is a post-graduate course. Also,

49.5% of participants indicate their diagnostic privileges qualification as a post-graduate qualification.

The most common post-graduate qualification indicated by participants in the certificate of advanced studies (CAS) courses ran by the GIO in conjunction with the New England College of Optometry (NEWENCO). The post-graduate courses the participants specify tallied 78, of which 25 (32.1%) are indicated as CAS courses. There has been, however, many different courses offered by this collaboration over the years, and from the answers provided it is difficult to distinguish which specific courses the participants have completed as many did not specify.

6.4 Participants without diagnostic qualifications and privileges [Group 3]

The participants from Group 3 form part of the main objectives of the study, however, their responses with regards to utilisations and perceived barriers are somewhat similar to that of those participants who have undergone diagnostic training and will be briefly discussed.

6.4.1 The utilisation of techniques not requiring diagnostic qualifications

IOP measurement is an important part of the routine examination and is vital to the assessment of risk for glaucoma. For Group 3 participants, the only method available to them to measure IOP is a non-contact method, and 85% of Group 3 participants indicate they measure the IOP at every visit their patients present.

Fundus examination equipment such as handheld ophthalmoscopes and fundus cameras are available to Group 3 participants at a similar frequency to Group 1 and Group 2 respondents. Fundus examination with a handheld direct ophthalmoscope is performed at every visit by 85% of Group 3 participants. Almost three-quarters of the Group 3 participants have access to fundus cameras in their practices and 45% of participants utilise the cameras only when indicated.

It is interesting to note that although participants from Group 3 do not have diagnostic training or the ability to use DPAs to dilate their patients' eyes, nine participants (45%) indicate they have access to 78D or 90D condensing lenses in their practice. Slit-lamp assisted fundus examination with a high powered condensing lens can be performed

through an undilated pupil, although it may be more difficult to master the technique. Even when used undilated, the technique can still provide relatively good stereoscopic views of the fundus with a larger field of view as compared to a direct ophthalmoscope (Elliott, 2007). It is therefore not inconceivable that these participants from Group 3 will be able to utilise the technique even though they do not have the formal qualification and training to utilise diagnostic drugs.

The preferred alternate method to assess the anterior chamber in lieu of gonioscopy is the Van Herick test, as indicated by 60% of Group 3 participants and is performed only when indicated by 42.1% of the optometrists. Elliott (2007) states the Van Herick test is considered to only be a screening test for optometrists to evaluate the anterior chamber angle depth to determine whether or not it would be safe to dilate. Furthermore, Elliott (2007) states that if the angle is deemed too narrow, gonioscopy should be performed to determine whether or not the patient is at risk of acute angle-closure glaucoma. The Van Herick test has been proven to provide acceptable specificity and sensitivity for determining the depth of the anterior chamber. Furthermore, the technique has also shown to have minimal inter-observer variation and although it does not replace the gold standard method of gonioscopy, it does serve as a good screening method (Gispets *et al.*, 2014).

6.4.2 The role of diagnostic and therapeutic privileges within optometry

Participants in the study, who do not possess a diagnostic qualification, indicate the expansion of the scope of practice is appropriate for optometrists, as 95% of Group 3 participants believe diagnostic privileges to be appropriate for optometrists and 85% believe the same for therapeutic privileges.

In 2009, Mashige found that 55.5% of optometrists in KwaZulu-Natal agreed that diagnostic techniques were the territory of ophthalmologists in contrast with 20% of the Group 3 participants in this research study, who believe diagnostic techniques should be left to ophthalmologists. It is possible that this change in mindset among optometrists is due to a change in education and training in the last ten years.

It is also encouraging to see that the Group 3 participants positively receive the expansion of the scope of practice and three-quarters of respondents are encouraged to pursue a

diagnostic qualification since the scope of practice has expanded once again to include therapeutic privileges.

6.4.3 Barriers to obtaining a diagnostic qualification

Respondents indicate 'time' as a common barrier to pursuing a post-graduate qualification such as diagnostic privileges. The ocular diagnostic course offered in 2017 by UJ required a commitment to the course of three days for each of the five modules that were offered over a six month period (van Poser, 2016, Personal communication, October 31). A considerable amount of time also needed to be put in to practice the new skills acquired as well as to prepare for the evaluation of those skills in an examination setting. Among the participants who do not have diagnostic qualifications, 60% of them agree that completing the course will be too time-consuming.

In Canada, after legislation was changed to incorporate the use of DPAs for optometrists, it was found that optometrists older than 50 years were ill-prepared to incorporate the use of diagnostic agents and as a result did not utilise them (Krueger, 1990). However, the median age of Group 3 is 45.5 years and it is reasonable to believe that these participants still have between 15 to 20 years of their careers ahead of them. Retirement is therefore, still a fair number of years away to not present a prominent barrier to obtaining the diagnostic qualification, as 85% of the participants have indicated.

The second barrier featuring prominently is the financial implications of performing diagnostic techniques. According to Kriel (2017), medical schemes do not reimburse for specific diagnostic techniques performed and as a result 65% of Group 3 participants agree this is considered a barrier or a deterrent to obtaining a diagnostic qualification. It is therefore rational for a practitioner to be hesitant to pursue a qualification that would not conceivably increase their income stream (Mashige, 2009).

Other barriers to obtaining a diagnostic qualification, which are mentioned in the open-ended questions by Group 3 participants, are the cost and availability of the courses.

6.5 The utilisation of the different diagnostic techniques

The first objective of this study was to determine the frequency of use for each of the different diagnostic techniques, namely contact tonometry, dilated fundus examination and gonioscopy by optometrists in their private practice settings.

6.5.1 Intraocular pressure measurement

The majority (85%) of the participants (Table 5.16) have access to a non-contact tonometer, while only a third of the participants with diagnostic qualifications have a Goldmann applanation tonometer (GAT) available in the practices they work at. This is similar to what Mashige found in 2009, where only 23.9% of optometrists in KwaZulu-Natal had access to contact tonometers (Mashige, 2009).

It has been shown that non-contact tonometry (NCT) is the preferred method of IOP measurement as it has the advantage of requiring less skill to screen for glaucoma, which does not require the use of an anaesthetic and is more acceptable to patients (Patel, 2016). It is therefore not unexpected to note that 82.3% of optometrists perform NCT at every visit. In contrast, GAT, which is considered the gold standard for IOP measurement, is not performed by 67% of the participants who have diagnostic privileges. Barret and Loughman found that among optometrists in Ireland who had access to both NCT and GAT equipment, 82% of them preferred to use NCT for measuring IOP (Barrett and Loughman, 2018). Although there are different types of non-contact tonometers, they are in most instances more portable than a GAT, which makes it more convenient to use. Specificity and sensitivity of NCT was considered clinically acceptable when compared to GAT (Kouchaki *et al.*, 2017)

6.5.2 Fundus examination

There exists a variety of methods to examine a patient's fundus, each requiring a different piece of equipment. The handheld direct ophthalmoscope is by far the most commonly found piece of equipment among participants and the binocular indirect ophthalmoscope being the least popular (Table 5.16).

Handheld direct ophthalmoscopy is the preferred method of examining the fundus of a patient as 74.5% of participants indicate they make use of this technique. Barret and

Loughman (2018) similarly found that direct ophthalmoscopy was more popular among optometrists in Ireland (64%) despite the disadvantage of being more susceptible to media opacities, high refractive error and not having a stereoscopic view (Barrett, 2018). This technique is performed at every visit by 86.5% of participants, with only a few (2.7%) participants indicating they do not perform the method at all.

For slit-lamp indirect ophthalmoscopy, 71.4% of Group 1 participants indicate they have access to a high powered condensing lens such as the 78D or 90D lens, compared to 55.1% of Group 2 participants. Comparing equipment availability, a higher number of participants from Group 1 have access to the 78D or 90D condensing lenses. The expectation is then that Group 1 participants will prefer the slit-lamp indirect ophthalmoscopy as fundus technique. However, from the responses, Group 1 participants indicate a higher preference for handheld direct ophthalmoscopy than Group 2 participants as a fundus examination method (p=0.0082).

Furthermore, participants from Group 1 indicate higher availability of the high powered aspheric lenses than Group 2 participants, p=0.0937 and as such, statistically, there is no difference between the two groups. There is also no difference in the frequency of utilisation of the aspheric high powered condensing lenses between the two groups as both groups make use of this technique with similar frequency (Table 5.18).

Overall, 40.2% of participants indicate they performed slit-lamp indirect ophthalmoscopy when needed. In comparison, 18.6% of respondents perform the method at every visit the patient presented.

In Mashige's 2009 study of KZN optometrists, the slit-lamp indirect ophthalmoscopy was lesser utilised, compared to this research study as only 33.3% of optometrists had access to the condensing lenses. The majority of those optometrists (77.8%) did not utilise the technique at all, and few (17.9%) performed the method on indication (Mashige, 2009). Barrett and Loughman (2018) found that approximately a third of the optometrists surveyed in Ireland indicated that slit-lamp assisted indirect ophthalmoscopy was their preferred technique to examine the posterior retina of their patient (Barrett, 2018). Mashige and Naidoo (2009) established that although the slit-lamp fundus examination technique was not the primary fundus examination technique for South African optometrists, the current

study finds the utilisation of it is seemingly increasing. The advantages of the technique are that it provides the practitioner with a stereoscopic view of the patient's fundus, while simultaneously providing a larger field of view. Although a dilated pupil is required for the best possible view of the fundus, the technique may be performed with an undilated pupil (Elliott, 2007).

Chu and colleagues (2020) ascertain that BIO as a method of evaluating the fundus is a more difficult skill to master when compared to direct ophthalmoscopy, and slit-lamp fundus evaluation and required extensive exposure to the technique to become proficient in it (Chu *et al.*, 2020). A binocular indirect ophthalmoscope is only available to 25.5% of participants and 79.2% of those who have a diagnostic qualification indicate they do not perform BIO at all. This represents a slight increase in the availability of equipment when compared to Mashige and Naidoo, who found that only 9.4% of optometrists in KZN owned a BIO. However, only a marginal increase in utilisation is noted when considering Mashige and Naidoo found that 84% did not perform BIO at all (Mashige, 2009). When extracting the responses from only those participants who reside in KZN, it becomes apparent that not much has changed since Mashige's study in 2009. Of the 20 participants from this research study who reside KZN, seven (35%) own a BIO, which is an increase from what Mashige found. However, only one participant indicated that they actually utilise a BIO to evaluate their patients' fundus and 17 (85%) participants who practice KZN do not utilise the BIO technique at all.

When questioned how often optometrists utilise BIO, none use it as a routine method to evaluate the vitreoretinal health of their patients and 20.8% perform the technique when there is an indication to do so. Globally, BIO is less likely to be used on a routine basis as Tithe *et al.,* found in their study among optometrists in India. BIO is used by 29.8% of Indian optometrists when indicated and 2.8% on a routine basis (Thite, 2015). While in Ireland, Barrett and Loughman (2018) found that 1% of optometrists surveyed make use of BIO as a method to assess for retinal diseases (Barrett, 2018).

Varner (2014) pointed out that when considering the relatively low yield of clinically significant peripheral retinal disease when incorporating an assessment of the periphery in a

routine examination, the BIO technique would mostly be performed when indicated on presentation of symptoms or risk factors for such (Varner, 2014).

Modern technologies approaches of fundus examinations with fundus photography and OCT scanners have slowly been embraced by optometrists, as Murphy (2012) indicates. This technology has become comparatively cheaper over time, and more optometrists are now incorporating this technology into their practices: Nearly three-quarters (73.5%) of the participants indicate they have fundus cameras available in their practices, and 27.5% of them have access to OCT scanners. This finding deviates from Mashige, who found that only 16% of optometrists owned fundus cameras (Mashige 2009). OCT technology had only become available in the early 2000s and was mostly used in ophthalmic practices as the costs of this technology was prohibitive to ownership within optometric practices, according to research done by Dabasia *et al.* (2014). However, as OCT and fundus photographic technology have since become cheaper, it is conceivable that its availability within optometric practices will increase, especially when coupled with an increase in relevance that such applications may hold in optometric practice settings.

6.5.3 Anterior chamber angle assessment

Anterior chamber angle and depth assessment played a vital role in determining a patient's propensity to develop angle-closure glaucoma, according to Campbell (2016). Patients very rarely had symptoms with a narrowed anterior chamber angle until they experienced an acute angle-closure attack. It was, therefore, important to have the anterior chamber assessed (Radhakrishnan, 2019). In general, 56.7% of participants indicate they only assess the anterior chamber angle or depth when there is an indication to do so, and it isn't a routine investigation.

Gonioscopy assists the optometrist primarily to view the anterior chamber angle structures, when if occluded in 180 degrees or more and may significantly increase the probability to develop angle-closure glaucoma (Foster *et al.*, 2002). Although 41.8% optometrists with diagnostic qualifications indicate they have access to a gonioscopy lens in their practice, 64.3% do not perform gonioscopy at all and 34.7% only perform the technique when indicated.

Gonioscopy, as a technique, is generally perceived to be a difficult technique to perform and require many hours of practice (Kanski, 2007). Mashige found in his 2009 study that 90.6% of participants do not perform gonioscopy at all and of the few that do make use of the technique, the majority (81.8%) only perform the technique when there is an indication for it. It was no surprise then that angle-closure glaucoma is often missed and under-diagnosed (Varma, 2017).

Gonioscopy, additionally may be used to view different retinal zones through a dilated pupil and the other mirrors in the three-mirror gonioscopy lens. Historically, diagnostic training involving the use of the other mirrors had been omitted and subsequently might have led to the further undervaluation of this technique.

According to the current study, the Van Herrick angle estimation technique is widely used to determine whether or not to perform gonioscopy, and therefore it is reassuring to note that 82.7% of participants indicate they make use of the technique. However, it is of concern that only 30.9% of respondents indicate they perform this technique at every visit their patient presents and 64.2% will only perform this technique when indicated. Elliott (2007) states The Van Herick method in itself is a screening method, and in most instances angle-closure glaucoma is asymptomatic until an acute angle-closure attack occurs. The technique should form part of a routine slit-lamp examination when assessing ocular health (Elliott, 2007).

Other methods such as the shadow test and OCT of the anterior chamber structures are largely underutilised as 67.3% and 76.5% participants respectively indicate they do not make use of these techniques. Radhakrishnan (2019) states that OCT technology has evolved since its initial release and may be utilised to assess the anterior chamber angle and depth without the use of diagnostic pharmaceutical agents. It has even been suggested that OCT technology could detect more angle closure than gonioscopy, which, according to Radhakrishnan (2019) is the gold standard. Even though the gonioscopy lens is cheaper, it was conceivable that the non-invasive, more accurate nature of the OCT may be considered a plausible replacement (Radhakrishnan, 2019).

6.6 The perceived barriers that exist which affect the usage of diagnostic techniques

The second objective of the research study was to determine what barriers exist, if any, that would affect the frequency with which South African optometrists in private practice settings use the diagnostic procedures.

6.6.1 Confidence

In 2009, Mashige and Naidoo found that 60% of optometrists in KZN are not confident with performing diagnostic techniques; however, their study does not consider the confidence in skills of the different techniques separately. It is thus difficult to gauge which technique optometrists are not confident with (Mashige, 2009).

The preferred method of tonometry in this study as indicated by participants is the non-contact method and nearly two-thirds of participants do not perform applanation tonometry at all. It is suggested by Aziz and Friedman, that the advantages of non-contact tonometry justify performing the alternative technique as a screening test; however, practitioners should be aware of the limitations and shortfalls of using NCT exclusively (Aziz and Friedman, 2018).

When it comes to confidence with applanation tonometry, 21.4% of participants indicate they are confident in performing GAT and 30.6% are very confident. It is, thus, evident from the participants' responses that confidence in performing applanation tonometry is not lacking; however, a large portion of participants prefer to make use of an alternative method to measure IOP rather than using GAT.

When it comes to confidence with dilated fundus examination techniques, 32.7% of practitioners indicate they are confident with using a 78D/90D condensing lens and 31.6% are very confident. The phrase "practice makes perfect" when cautiously comparing the utilisation rates to those found by Mashige (2009), does explain to some extent an increase in usage of the technique. Creer *et al.* (2019) evaluated the confidence of optometrists when performing certain techniques and their subsequent treatment decisions. They found the optometrists' confidence levels are significantly affected by their experience levels (Creer *et al.*, 2019).

However, in contrast, participants in this study are less confident with using a BIO for fundus examination as 32.7% indicate they are only slightly confident and 29.6% were not confident at all with the technique. When considering the frequency in the usage of the BIO by participants, the lack of confidence is then an expected reason for its minimal usage.

Participants are the least confident with gonioscopy, when compared to the other diagnostic techniques, as only 30.6% of participants indicate they are confident, while 54.1% are less than confident in performing the technique, with 27.6% only slightly confident and 26.5% not confident at all. Even among ophthalmology trainees, gonioscopy is not an easy technique to master as found in a recent study conducted among candidates of the Ophthalmology Speciality Training programme in the United Kingdom (Feng *et al.*, 2019). Overall, nearly 20% are not confident with performing gonioscopy, and 82% of those lacking confidence, was junior trainees with less experience. Many indicate the lack of clinical experience as a significant barrier to gaining confidence in the technique as well as sufficient training in performing gonioscopy (Feng, 2019).

Among optometrists surveyed in the UK regarding the use of equipment, gonioscopy is performed by only 15% of the participants (Dabasia, 2014). Similarly, 22% of Australian optometrists and 43% of New Zealand optometrists indicate they are not confident with performing gonioscopy and as a result only 18% and 36% of optometrists respectively perform this technique (Zangerl, 2015).

6.6.2 Attitude towards diagnostic privileges and scope expansion

Even though the optometrists seem to have mixed opinions with regard to their confidence and utilisation rates of the different techniques, it is apparent they deem the diagnostic scope of practice for optometrists as an important area of practice. The overwhelming majority of participants (92.8%) agree it is appropriate for optometrists to have diagnostic privileges and 90.9% of participants believe the diagnostic techniques are not the exclusive territory of ophthalmology. Considering that in 2009, Mashige found that 55% agreed that diagnostic techniques belong under the banner of ophthalmology (Mashige, 2009). It is then encouraging to note that diagnostics privileges are more accepted among the participants of this study. This change in attitude towards diagnostic techniques may perhaps be due to the

changes made in the curriculum over the last ten years, where all undergraduate optometric students are exposed to the techniques by the time they qualified.

The further expansion of scope to include therapeutic prescribing privileges appears to be positively accepted by optometrists who have diagnostic privileges as 96.9% believe it to be an appropriate fit for optometry and 88.8% of the participants with diagnostics privileges indicate it encourages them to perform diagnostic techniques. The expansion of the scope of practice in New Zealand and Australia to allow for therapeutic privileges has led to an increase in the utilisation of diagnostic techniques. Zangerl *et al.* (2015) found that optometrists show increased rates of diagnosing glaucoma due to the increased utilisation of diagnostic techniques since the scope of practice expanded (Zangerl, 2015). Optometrists that have therapeutic privileges are also 3.4 times more likely to perform gonioscopy and 3.8 times more likely to prefer slit-lamp ophthalmoscopy than those optometrists who only have diagnostic privileges (Jamous *et al.*, 2014). This is perhaps due to the suggestion that an increase in knowledge base leads to an increase in confidence and utilisation.

Furthermore, optometrists in Australia have been able to utilise DPAs and perform techniques such as gonioscopy since the early 1960s and since the scope of practice was expanded in 2004 to include therapeutic privileges, their confidence in performing these techniques have increased (Cole, 2015). Kiely *et al.* (2017) found that the optometrists without therapeutic endorsement were less confident with techniques such as gonioscopy than those who have undergone therapeutic privileges training (Kiely *et al.*, 2017).

More than half of the participants in this study (47 of 92, 51.1%) indicate they have either started or completed the therapeutics training, which is encouraging as it indicates that optometrists are assuming a higher level of responsibility for the care of their patients and aspire to a deeper involvement in comprehensive primary eye care. When considering the international trend of utilisation rates of diagnostic techniques by optometrists who have embraced the therapeutic scope of practice expansion, it is to be expected that diagnostic techniques will be better embraced in future.

6.6.3 Financial implications of utilising diagnostic techniques

Once an optometrist obtains a diagnostic qualification and is able to perform diagnostic techniques, they will require a set of equipment items to enable them to perform these techniques and this equipment comes as an added financial burden (Mashige, 2009)

A large portion of participants (82.5%) indicate the cost of purchasing the equipment needed for diagnostic techniques are prohibitive and discourages them from performing diagnostic techniques. The cost of equipment has been shown to be a significant issue for optometrists when it comes to specific techniques. Myint *et al.* (2010) found that lack of access to equipment in itself was a barrier to performing the diagnostic techniques, which was further compounded by the lack of financial capacity to purchase the required equipment (Myint *et al.*, 2010). In Scotland, the cost of purchasing required equipment for specific diagnostic techniques remains a barrier in spite of government grants that are available to optometrists to acquire equipment. Additionally, Dabasia *et al.* (2014) found that gonioscopy equipment and its utilisation remain constant while the equipment for other techniques are increasingly purchased and used (Dabasia, 2014).

Admittedly, it is interesting to note that even though most participants agree that the cost of acquiring equipment specific to diagnostics is a barrier, 73.5% of participants indicate they have access to fundus cameras in their practices. The capital outlay for fundus cameras, as well as OCT scanners, come at a higher cost than for that of a BIO or even gonioscopy lenses, for instance (D'Angelo, 2016). With the advances in technology, fundus cameras have become more affordable and portable since they were first introduced, but are still considerably more expensive than basic diagnostic equipment. Furthermore, fundus cameras were clinically less essential than the equipment required for diagnostic techniques (Panwar *et al.*, 2016). The use of fundus cameras may perhaps enjoy high rates of access due to their less invasive nature as well as the fact that they produce results quicker and easier than a dilated fundus examination (Meszaros, 2012). The added benefit of having a record of the results and then being able to compare those across multiple visits provides a possible further explanation for why optometrists will rather invest in such a high-cost item instead of other more traditional diagnostic equipment.

Conversely, the cost of consumables such as the diagnostic drugs do not discourage 71.5% of participants from performing diagnostic techniques and similarly, 53.1% are not perturbed by the wastage of unused diagnostic drugs. In contrast, Kreuger and Trevino (1990) conducted a study among Canadian optometrists in 1990 to explore their use of diagnostic pharmaceutical agents since the 1978 scope of practice expansion to allow the use of DPAs. They found that the cost of DPAs, together with the cost of equipment is considered a barrier to the utilisation of diagnostic techniques (Krueger, 1990).

Financial sustainability is vital to the survival of an optometric practice within the private health sector, and for that the costs of acquiring a new skill or an equipment piece need to be weighed up against the return on investment (Needle *et al.*, 2008). The lack of remuneration for specific techniques used in the course of diagnostic practice then becomes a significant barrier to optometrists. Nearly three-quarters of the participants (63.3%) indicate the lack of remuneration for diagnostic techniques is a barrier to performing the techniques. Similarly, Mashige and Naidoo (2009) found that 61% of optometrists were discouraged from performing diagnostic techniques due to the lack of remuneration (Mashige, 2009). In South Africa, optometry largely exists in the private health system and services are funded by the patients themselves, either out of pocket or by their medical aid. Even though the codes do exist for diagnostic techniques to be paid by medical aid schemes, most have their benefit structures set up in such a way that these additional tests are not covered by the schemes (Kriel, 2017). Subsequently, costs for additional tests for diagnostic purposes would leave the patient liable to pay for additional charges levied for the service. Barrett *et al.* (2018) found that optometrists in Ireland considered this a significant obstacle when asked about barriers in performing diagnostic tests for glaucoma case finding (Barrett, 2018). Furthermore, in 2006 Scotland effected a change in legislation which allowed for GAT to be remunerated separately from a routine consultation. Following this, the use of GAT saw an increase from 11% to 50% for IOP measurement (Barrett, 2018).

Comparatively, the longer chair time needed to perform diagnostic techniques is not a concern for 53.4% of the participants in this study. Yet, Mashige notes that 60% of optometrists in KZN consider the extended chair time as a concern when it comes to performing diagnostic techniques (Mashige, 2009). However, when looking at the

demographic profile of the participants of this research study, they are mostly self-employed practitioners within independent practices, which give them a higher level of autonomy to dictate time allocated for appointments. Additionally, many respondents (59.9%) in this study indicate they allow for 30 to 45 minutes or longer for routine consultations and have the ability to be flexible in their schedule to allow for longer appointments. When viewed in light of the available time allocated for appointments and flexibility within their scheduling, it is understandable that chair time then becomes less of an issue.

6.6.4 Patient experiences and its impact on utilising diagnostic techniques

The perceived contentment of the patient factors high for practitioners as the majority of the respondents (90.7%) agree that patient satisfaction impacts on their clinical decision-making. This is in agreement with Mashige's finding in 2009 where patient satisfaction features prominently for optometrists when considering the use of diagnostic techniques. Optometrists do seem to be conscious of the value of diagnostic techniques when it comes to patient care (Mashige, 2009).

Additionally, optometrists are sensitive to the patient's inconvenience and discomfort the patient may experience during the course of performing techniques such as a dilated fundus examination and gonioscopy. Patients may potentially experience an inconvenience when mydriatic and cycloplegic drops are instilled for a dilated fundus as this causes blurry vision, loss of depth perception and accommodation. Overall, optometrists are not deterred from performing dilated fundus examinations due to patient inconvenience; however, Group 2 participants are slightly more discouraged than Group 1 participants.

When it came to gonioscopy, the experience of the patient is a bigger consideration of whether or not to perform the technique. More than half of the participants (51%) feel discouraged to perform gonioscopy due to the perceived discomfort of the patient. Gonioscopy is an invasive technique which requires the use of a topical anaesthetic for a gonioscopy lens to make contact with the cornea and may cause discomfort for the patient, likely discouraging practitioners from performing the technique (Caceres, 2007). In the open-ended questions, one participant notes that performing an invasive diagnostic technique only to have that technique repeated again by an ophthalmologist, is an

unnecessary inconvenience to the patient. Another participant explains that subjecting a patient to a procedure in order to diagnose without the ability to treat seems frivolous, as they still need to refer to ophthalmology for management and treatment.

6.6.5 Other barriers affecting the utilisation of diagnostic techniques

In addition to the barriers mentioned in the questionnaire, participants are afforded the opportunity to record other barriers they perceive in the form of open-ended answers.

The most common barrier indicated, apart from lack of remuneration, is related to concerns with the respondents' training in diagnostics. Six practitioners state that not enough time is spent on these techniques in the course of their training, while three others note they prefer to undergo a refresher course. Mashige and Naidoo (2009) likewise related the lack of utilisation of diagnostic techniques to the disparity of training and subsequent incorporation of diagnostic techniques in practical clinical sessions. The training of diagnostic techniques was included as ancillary techniques and was not emphasised for its use within clinical settings, which subsequently did not allow for sufficient practical exposure for practitioners to confidently perform and integrate the techniques into their daily practice (Mashige, 2009).

6.7 HPCSA registration of optometrists who have qualified with diagnostic privileges

The last three objectives of the study relate to the registration of optometrists with the HPCSA; firstly to determine whether they were indeed registered correctly registered with HPCSA for diagnostic practice. The fourth objective was to determine the optometrists' awareness of the requirement to be correctly registered and lastly, to ascertain whether optometrists were aware of the implications of performing diagnostic techniques without being correctly registered

6.7.1 HPCSA diagnostic registration

Of the participants (n=98) who have undergone training for the use of diagnostic, pharmaceutical agents and techniques, only 49 (50%) are correctly registered for diagnostic practice with the HPCSA, while 31 are not registered for diagnostic practice and a total of 18

are unsure of their registration status. Those who indicate they are not sure of their registration status are treated as not registered correctly for the purpose of the questionnaire flow and the analysis of the data.

Consequently, this meant that 50% of the participants who have undergone diagnostic training are not correctly registered for diagnostic practice with the HPCSA. At the time of the study, only 16.9% of optometrists in South Africa (636 out of 3767) were correctly registered for diagnostic practice with the HPCSA, which is far less when compared to the participants of the study. Furthermore, all but one participant indicated they had not had any entity, such as the HPCSA, professional association or even patients, inquire as to their registration status. This raises concern as to administrative systems and processes around the HPCSA registration of diagnostically qualified optometrists as well as the monitoring and evaluation process of the implemented scope of practice expansion that took place in 2001.

Of those participants who are incorrectly registered for diagnostic practice (Group 2), 69.4% are indeed aware of the process involved to amend their registration to correctly reflect their diagnostic training. Subsequently, many respondents indicated in the open-ended questions that the administrative burden involved in amending their registration with HPCSA is just too cumbersome and the majority of Group 2 participants indicate they prefer the registration to be done automatically upon the completion of their diagnostic qualification.

6.7.1.1 Attitudes towards registration

The expansion of the scope of practice which enables optometrists to make use of diagnostic drugs and techniques brings with it a higher level of responsibility as well as accountability. Optometrists appear to be aware of the duty of care that accompanies diagnostic privileges as 81.3% agree it enables them to provide better patient care and 70.8% believe that by not performing diagnostic techniques their ability to provide sufficient care will be limited.

In addition, 41.7% of respondents indicate they will be more likely to perform diagnostic techniques if their registration is amended, which is in agreement with the fact that 52.1% of the participants are aware of the implications of performing diagnostic techniques without the correct registration.

6.7.1.2 Barriers to registration

Participants are asked to elaborate on the barriers they experience in the process to amend their registration with the HPCSA, and the most commonly stated barrier is the administrative nature of the process. Many report the process to be either unclear, tedious or too time-consuming with some participants stating they have tried numerous times to make contact with the HPCSA but to no avail.

Furthermore, one participant mentions there is no financial gain for optometrists to be registered for diagnostic practice. Optometrists who are registered for diagnostic practice with the HPCSA are not offered higher salaries for their additional skill when employed within a practice. Additionally, medical aid schemes do not remunerate optometrists with diagnostic privileges at a higher reimbursement rate than those without diagnostic privileges for rendering professional services to patients (Kriel, 2017).

In 2015, Isoleso, a medical scheme administrator for optometric practice, started a practitioner enhancement programme (PEP) for optometrists to undergo a skills enhancement short course (Isoleso, 2020). The premise of this short course was to improve the optometrists' skills and increase patient outcomes. Furthermore, it allowed for the so-called credentialing of practitioners, which then allowed higher remuneration for routine consultations on the assumption that the optometrists have a higher level of training and experience.

While this preferred reimbursement package was for practitioners who underwent additional training offered by a medical scheme administrator, there was no additional remuneration or acknowledgement for practitioners who had undergone training in diagnostic techniques as compared to those who had not. Furthermore, the services offered as part of an advanced scope of practice do not attract additional reimbursement from medical aid schemes either. When considering the administrator's reported uptake of the PEP programme (Isoleso, 2016, Personal communication, September 14), it would be of interest to see the impact of similar remuneration packages would have on the number of optometrists registered for diagnostic practice and if it would change should such packages be instituted for those who were registered for diagnostic practice.

6.7.2 MCC Section 22(A)15 permit

At the time of this study, the MCC Section 22(A)15 permit is required for optometrists to legally obtain and possess the diagnostic pharmaceutical agents. It is encouraging to note that most participants are aware of the process involved in applying for the permit.

Applying for the permit required optometrists to supply proof that they were indeed registered correctly with the HPCSA for diagnostic practice, which members from Group 2 would not have been able to do (RSA DOH, 2019).

Thirty-nine of the optometrists (79.6%) who are correctly registered for diagnostic practice (Group1) indicate they are aware of the process, and 47.9% of Group 1 participants point out they experience difficulties with applying for the permit. Even though it seems like most optometrists with diagnostic training are aware of the process of applying for the permit, the MCC (now known as SAHPRA) has indicated that at the time of the study, there are only 391 permits issued to optometrists in the entire South Africa (M Bhembe 2018, personal communication, 12 October), which translates to approximately 10% of optometrists in South Africa. It is, however, to be noted that the permit is provided to a practice site and it is conceivable that a practice with multiple optometrists would only hold one permit, instead of multiple permits for one site. Even so, the number is still small in comparison to qualified optometrists with diagnostic privileges.

The most common barriers participants mention when applying for the Section 22(A)15 permit is of an administrative nature. In the open question related to the challenges experienced, five participants indicate the process is too time-consuming. Some indicate the actual process is too cumbersome and they are discouraged by the fact that the permit needs to be renewed on an annual basis. Six participants mention they are not clear on what procedure to follow or where to obtain the necessary documentation from. However, the lack of communication and feedback from the Department of Health, who is responsible for the issuing of these permits, is the biggest barrier as 12 participants mention.

In February of 2020, legislation was changed and optometrists are no longer required to apply for a Section 22 (A) 15 permit in order to obtain DPA (RSA DOH, 2020). Although this is encouraging news for those optometrists who experienced the significant administrative

hurdle to apply for the permit, only time will tell if it will come at the cost of patient safety. The different levels of care provided by optometrists due to different levels of training, as well as the multiple scope changes, means now the door is open for unscrupulous optometrists who have not received the necessary training, to now use DPAs. Patients have no way of identifying the registration status of a practitioner unless they specifically ask to see an optometrist's HPCSA registration card. Patients will need to be educated on the existence of the different tiers of qualification and registration for optometrists, in order to know to enquire for such details in the first place. The monitoring and evaluation of optometrists and their use of diagnostic techniques and pharmaceutical agents are now more important than before, in the interest of protecting the public. This withdrawal of this permit may be placing patients at risk and will also make optometrists vulnerable to malpractice and litigation.

6.8 Conclusion

The expansion of the scope of practice for South African optometrists is essential to providing primary eye care. The study indicates that diagnostic techniques are generally underutilised, and alternative methods of gathering diagnostic information are primarily preferred over the gold standard. Optometrists consider the lack of financial incentive to extend patient examination time and the added burden of purchasing specialised equipment a barrier to engage with the extended scope of practice fully. However, the obstacles mentioned are not unique to this study and were also found in other studies, both locally and internationally.

CHAPTER 6: CONCLUSION

7.1 Introduction

To effectively address preventable blindness and visual impairment, optometry is obligated to embrace the full extent of their scope of practice. However, the expansion of the scope of practice to provide therapeutic prescriptions to patients assumes that optometrists are able to confidently and efficiently utilise diagnostic techniques and skills. Since the scope expanded to include monitoring and evaluation of optometrists' diagnostic privileges has not been assessed, and there has not been concrete evidence to impact diagnostic rights has had on the burden of disease in the primary eye care arena. In this chapter, a summary of the findings is presented, and the study's limitations and subsequent recommendations for future studies.

7.2 Summary of findings

The study was done to investigate the utilisation of diagnostic techniques and determine whether any barriers exist to hinder optometrists from performing procedures that require diagnostic pharmaceutical agents.

The study has found that generally, NCT tonometry was the preferred method of IOP assessment among participants with diagnostic qualifications, which may be explained by the fact that only a third of participants had access to GAT equipment compared to 88.8% who had access to NCT. Additionally, participants' confidence levels were relatively low with GAT, as only 30.6% indicated that they were very confident with the technique.

In terms of fundus examination, the preferred method was undilated indirect ophthalmoscopy (74.5%) even though it does not afford the same field of view and details as that of slit lamp assisted fundus examination or BIO through a dilated pupil. Slit-lamp assisted fundus examination was performed by less than half of the participants (40.2%), and only 18.6% performed this technique at every visit. The low indication of access to equipment (25.5%) required to perform BIO may have contributed to the techniques' low utilisation rate (14.3%).

Assessment of the anterior chamber angle is essential to the classification of glaucoma type (Tandon and Alward, 2015). It is only assessed at every visit a patient presents for a routine eye examination by 56.7% of the participants. Gonioscopy, the gold standard for anterior chamber assessment, was only performed on indication by 34.7% of participants while nearly two-thirds of participants did not perform gonioscopy at all.

The main barriers indicated to performing diagnostic techniques were; lack of confidence, equipment cost, lack of financial incentive, and extended consultation time. Confidence was lower with BIO and gonioscopy in comparison to GAT and slit lamp assisted ophthalmoscopy. Only 30.6% of participants were very confident in performing GAT, and 31.6% were very confident with slit lamp assisted fundus examinations. Regarding gonioscopy and BIO, only 15.3% and 14.3% respectively were very confident with the technique.

The cost of acquiring specialised equipment to perform diagnostic techniques was indicated as a barrier to performing techniques by 82.5% of participants. Interestingly, many participants (73.5%) had access to fundus cameras in their practices, which would be significantly more costly. The lack of remuneration for specific techniques was another barrier as 63.3% participants indicated that it discouraged them from performing diagnostic procedures.

Encouragingly, the prospect of further expanding the scope of practice to include therapeutic prescribing for optometrists may strengthen optometrists' diagnostic competencies. Many participants (88.8%) indicated that they were encouraged to perform diagnostics by the prospect of therapeutic privileges, and 96.9% of the participants indicated that they would be eager to pursue therapeutic endorsement qualification. This sentiment was echoed by Group 3, those participants who did not have diagnostic capabilities as 75.0% indicated that they would be willing to pursue a diagnostic qualification since the scope of practice expanded to include therapeutic endorsement.

The majority of participants (69.4%) were aware of the process involved in amending their registration with HPCSA; however, 52.1% of participants were not aware of the implications of performing diagnostic techniques without the correct registration status. The administrative burden amending their registration with HPCSA was indicated as a barrier,

and 93.9% of participants indicated that they would prefer their registration automatically be amended once they have completed a diagnostic qualification. Obtaining the MCC Section 22(A) 15 Permit was indicated as an administrative burden for 47.9% participants and was considered an additional barrier to practice to the full scope of practice. The requirement to hold the permit for acquiring DPAs has come to an end after completing the study. It no longer prevents optometrists from acquiring and utilising diagnostic pharmaceutical drugs.

7.3 Limitations of the study

The following limitations of the study were recognised:

- A low response rate to the questionnaire, which introduced a response bias, and as such needs to be taken into consideration when making inferences of the study to the population at large.
- Interest bias may have been introduced as those with a higher interest in diagnostic techniques and skills would be more likely to respond to the diagnostic procedures questionnaire.
- Limited literature and statistics exist on the registration of optometrists as well as the now-defunct Section 22(A)15 Permit.

7.4 Recommendations

The following recommendations are made:

- The research study indicated a mismatch between the number of optometrists who have completed a diagnostic qualification and the number of optometrists registered for diagnostic practice with the HPCSA. Furthermore, with the scope of practice expansion to incorporate therapeutic prescribing, an additional dilemma will be created. It is recommended that the HPCSA perform an audit on the registration status of practitioners and amend the register accordingly.

- With the further expansion of the scope of practice to include optometrists' therapeutic privileges, a deadline should be set for when all optometrists must undergo diagnostic training as a minimum. The disparity in different levels of care provided by optometrists, where some can therapeutically treat ocular diseases while others are untrained in diagnostic techniques, puts the public at risk and creates a further inequity of services. Further to this, an evaluation and monitoring process should be effected by the HPCSA to assess the impact of expanding the scope of practice.

- A future study is recommended to monitor and evaluate optometrists by the HPCSA, more specifically, the Professional Board of Optometry and Dispensing Opticians. Research must be aimed at the compliance of optometrists regarding registrations; the minimum required equipment list; and practising within the scope of practice for which they are registered.

- Training institutions need to offer refresher courses and workshops as part of CPD programmes, emphasising the hands-on practice of diagnostic techniques, which will instil greater confidence with optometrists regarding the methods and in return will result in better utilisation.

- Future studies should be directed at identifying the effect of compulsory clinical work exposure during training for diagnostic and therapeutic privileges within rural settings or public hospital settings and whether this will contribute to practitioner confidence and motivate them to practice more extensively within their full scope of practice.

- Medical schemes need to be lobbied for better remuneration for techniques separate from the routine bi-annual exam. Furthermore, they should be engaged with, to direct remuneration more towards providing professional services instead of vision correction devices. Reimbursement models should place a more considerable emphasis on ocular disease assessment and management, which encourage the use of diagnostic techniques.

- It is recommended that future studies be conducted to ascertain whether the generalisation of consultations exposes the public to inequitable services based on equipment, skill sets and qualifications of the optometrists

7.5 Conclusion

Diagnostic techniques are essential tools in the optometrist's arsenal to effectively provide primary eye care and reduce the burden of disease. This study indicates that the four diagnostic techniques that require DPAs are primarily underutilised by optometrists who have undergone diagnostic training. The research further suggests that although diagnostic techniques are considered the gold standard, optometrists prefer alternative approaches that are less invasive and quicker to perform.

Optometrists also consider time and money as influential factors when assembling an examination plan, and present a significant barrier. The expansion of optometrists' scope of practice enables optometrists to provide a high level of care to their patients. However, the filtering through this expansion to truly impact the burden of disease within eye care is questionable and requires further investigation.

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APPENDICES

APPENDIX A

University of Free State Johannette Fraser

Use of Diagnostic Techniques by Private Practicing Optometrists in South Africa

Mark as shown: ☐☒☐☐☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.

Correction: ☐■☐☒☐ Please follow the examples shown on the left hand side to help optimize the reading results.

Demographic Information

Please indicate your gender?

☐ Male ☐ Female

Please indicate your age.

In what province do you practice?

☐ Gauteng ☐ Free State ☐ Limpopo
☐ Northern Cape ☐ Eastern Cape ☐ Western Cape
☐ Mpumalanga ☐ KwaZulu-Natal

In what area is your practice situated?

☐ Rural ☐ Urban ☐ CBD
☐ Mall

What mode of practice do you work in?

☐ Independent Private Practice ☐ Franchise/Group Practice ☐ Private Hospital Practice
☐ State Hospital Practice ☐ Ophthalmology Practice

What is your employment status?

☐ Employed (Full Time) ☐ Self Employed ☐ Locum or Part time employment

☐ Unemployed

How many years have you practiced as an Optometrist?

How much time does your practice allocate towards a routine eye examination appointment?

☐ Up to 30 minutes ☐ Between 30 and 45 minutes ☐ More than 45 minutes

Is there flexibility in terms of time for the scope of diagnostic techniques to be incorporated into your practice routine

☐ Yes ☐ No

Please indicate which optometry qualification do you have

☐ Dip. Optom (Diploma) ☐ B. Tech Optometry ☐ B. Optom (Bachelors Degree)
☐ OD (Doctor of Optometry) ☐ Other

From which institution did you obtain your first optometry qualification?

☐ University of Johannesburg (UJ) ☐ University of Limpopo (UL) ☐ University of KwaZulu-Natal (UKZN)
☐ University of Free State (UFS) ☐ Rand Afrikaans University (RAU) ☐ Technikon Witwatersrand (Wits Tech)
☐ University of the North (Turfloop) ☐ University of Durban-Westville (UDW) ☐ Other

In what year did you obtain your first optometry qualification?

Do you have a post graduate optometry qualification

☐ Yes ☐ No

Please indicate what post graduate optometry qualification you have

Demographic Information [Continue]

Do you have a diagnostic privileges qualification?

☐ Yes ☐ No ☐ Not Sure

Where you trained at undergraduate to perform diagnostic techniques such as gonioscopy, binocular indirect ophthalmoscopy (BIO) and applanation tonometry together?

☐ Yes ☐ No

Diagnostic Privileges Qualification

How was your qualification in diagnostic privileges obtained?

☐ As part of Undergraduate Qualification ☐ As a post graduate certificate of advanced studies (CAS)

What year did you obtain your postgraduate diagnostic qualification

At which institution did you obtain your *postgraduate* diagnostic privileges qualification?

☐ University of Johannesburg (UJ) ☐ University of KwaZulu-Natal (UKZN) ☐ University of Limpopo (UL)

☐ Graduate Institute of Optometry in collaboration with New England College of Optometry (GIO - NECO)

Therapeutic Privileges: Have you completed or partially completed the training required for ***therapeutic privileges*?**

☐ Yes ☐ No

Diagnostic equipment available and techniques performed

Please indicate which of the following equipment related to diagnostic techniques and their possible alternatives you have in your practice?

☐ Tonometer (Non-contact or Rebound Tonometer) ☐ Applanation Tonometer (Goldmann Applanation Tonometer) ☐ BIO (Binocular Indirect Ophthalmoscope) Headset

☐ Handheld Direct Ophthalmoscope ☐ 20D/ 25D Fundus Lens (Volk) ☐ Slit lamp (Biomiscroscope)

☐ 78D / 90D Fundus Lens (Volk Lens) ☐ Gonioscopy lens ☐ Fundus Camera

☐ OCT (Optical Coherence Tomography)

Intra Ocular Pressure Measurement

How often do you perform *APPLANATION TONOMETRY* for IOP measurement?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

How often do you perform *NON-APPLANATION TONOMETRY for IOP* measurement?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

Fundus Examination

Which techniques do you use for Fundus Examination

☐ Direct Ophthalmoscopy (Undilated) ☐ BIO (Binocular Indirect Ophthalmoscopy) ☐ 78D/90D Volk Lens Slitlamp assisted fundus examination

☐ Fundus Photography ☐ OCT of retina & Posterior structures

How often do you perform *DIRECT OPHTHALMOSCOPY UNDILATED*?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

How often do you perform *BIO (Binocular Indirect Ophthalmoscopy)*?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

How often do you perform *78D/90D Slitlamp assisted fundus examination*?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

How often do you perform *FUNDUS PHOTOGRAPHY* for fundus examination?

☐ First visit only ☐ Every Visit ☐ Only if indicated

☐ Do not perform

Diagnostic equipment available and techniques performed [Continue]

How often do you perform *OCT of retina & posterior structures* for fundus examination?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

Anterior Chamber Angle/Depth Evaluation

How often do you evaluate the ANGLE & DEPTH OF THE *ANTERIOR CHAMBER ANGLE*?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

How often do you perform *Gonioscopy* to evaluate the anterior chamber angle?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

What alternative techniques do you use to evaluate the anterior chamber angle/depth

☐ Van Herick Angle Estimation with Slitlamp ☐ The Shadow test (with penlight) ☐ OCT of anterior chamber angle structures

How often do you perform *van Herick's Angle Estimation technique*?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

How often do you perform *Shadow or Eclipse technique* to evaluate the anterior chamber depth?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

How often do you perform *OCT of the Anterior Chamber* to evaluate the anterior chamber angle?

☐ First visit only ☐ Every Visit ☐ Only if indicated
☐ Do not perform

Barriers to perform diagnostic techniques

Please rate your confidence in performing the following techniques?

Rate your confidence in performing Applanation tonometry

☐ Very Confident ☐ Confident ☐ Slightly confident

☐ Not confident at all

Rate your confidence in performing 78D/90D Lens Fundus Examination

☐ Very Confident ☐ Confident ☐ Slightly confident
☐ Not confident at all

Rate your confidence in performing Gonioscopy

☐ Very Confident ☐ Confident ☐ Slightly confident
☐ Not confident at all

Rate your confidence in performing BIO (Binocular Indirect Ophthalmoscopy)

☐ Very Confident ☐ Confident ☐ Slightly confident
☐ Not confident at all

Do you co-manage patients with ophthalmology?

☐ Yes ☐ No

Do you feel the application of diagnostic techniques is needed by optometry?

☐ Yes ☐ No

A lack of monetary remuneration for specific services discourage you from performing diagnostic

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Chair time is an important factor in deciding whether a diagnostic technique is performed

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The cost of acquiring the required equipment is a deterrent to perform diagnostic techniques.

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Barriers to perform diagnostic techniques [Continue]

The wastage of unused and expired drugs discourages you from keeping them

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The costs of diagnostic drugs discourage you from keeping them

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The possibility of an adverse reaction occurring discourage you from using diagnostic pharmaceutical drugs

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Diagnostic Techniques should be left to ophthalmologists

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Enhanced patient satisfaction drives the motivation to perform diagnostic techniques

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Patient inconvenience discourages you to dilate the patient's for a dilated fundus examination

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Patient discomfort during the procedure discourages you to perform gonioscopy

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The prospect of therapeutic privileges for optometrists encourages the performance of diagnostic techniques

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Do you think it is appropriate for optometrists to acquire therapeutic privileges?

☐ Yes ☐ No

Would you be keen to prepare and obtain the qualification for a therapeutic license?

☐ Yes ☐ No

Are there any other barriers to performing diagnostic techniques that have not been mentioned

☐ Yes ☐ No

Please specify any perceived barriers to performing diagnostic techniques that have not been mentioned

Diagnostic Pharmaceutical Drugs used in practice

Which local anesthetic drops are used in the practice?

☐ Oxybuprocaine (Novesin Wander or Minims) ☐ Proparacaine (Ophthetic or Minims) ☐ Tetracaine (Covoset or Minims)
☐ None

Which mydriatic/cycloplegic drops are used in the practice?

☐ Tropicamide (Mydracyl, Mydriaticum or Minims) ☐ Cyclopentolate (Cyclogel or Minims) ☐ Atropine
☐ Homatropine ☐ None

Techniques and equipment used in lieu of diagnostic qualifications

Please indicate which of the following equipment related to diagnostic techniques and their possible alternatives you have in your practice?

☐ Tonometer (Non-contact or Rebound Tonometer) ☐ Applanation Tonometer (Goldmann Applanation Tonometer) ☐ BIO (Binocular Indirect Ophthalmoscope) Headset
☐ Handheld Direct Ophthalmoscope ☐ 20D/ 25D Fundus Lens (Volk) ☐ Slit lamp (Biomiscroscope)
☐ 78D / 90D Fundus Lens (Volk Lens) ☐ Gonioscopy lens ☐ Fundus Camera
☐ OCT (Optical Coherence Tomography)

Techniques and equipment used in lieu of diagnostic qualifications [Continue]

Intra Ocular Pressure Measurement

Which technique do you use to evaluate intra ocular pressure (IOP)?

☐ Non-contact tonometry (Huff & Puff) ☐ Rebound Tonometry (iCare tonometer or similar)

How often do you perform IOP measurements?

☐ At the first visit ☐ Every Visit ☐ Only if indicated
☐ Do not perform

Fundus Examination

How often do you perform *Direct ophthalmoscopy*?

☐ At the first visit ☐ Every Visit ☐ Only if indicated
☐ Do not perform

How often do you perform *fundus photography*?

☐ At the first visit ☐ Every Visit ☐ Only if indicated
☐ Do not perform

How often do you perform *OCT of retina and posterior structures*?

☐ At the first visit ☐ Every Visit ☐ Only if indicated
☐ Do not perform

Anterior Chamber Angle/Depth Evaluation

How often do you evaluate the anterior chamber angle/depth?

☐ At the first visit ☐ Every Visit ☐ Only if indicated
☐ Do not perform

What techniques do you use to evaluate the anterior chamber angle/depth

☐ Van Herick Angle Estimation with Slitlamp ☐ The Shadow test (with penlight) ☐ OCT of anterior chamber angle structures

Barriers to Diagnostic Privileges Qualification and Techniques

Do you co-manage patients with ophthalmology?

☐ Yes ☐ No

Do you feel the application of diagnostic techniques is needed by optometry?

☐ Yes ☐ No

Would you as optometrist want to have diagnostic privileges?

☐ Yes ☐ No

What would motivate you to obtain a qualification in diagnostic privileges

Diagnostic techniques should be left to ophthalmology

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Alternative techniques, without the use of pharmaceutical agents, used for disease detection is deemed sufficient for effective patient care

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The lack of monetary remuneration for specific diagnostic techniques discourage you from obtaining a diagnostic privileges qualification

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

The extended chair time involved in performing diagnostic techniques is a important factor in deciding whether to obtain and perform diagnostic accreditation

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Patient inconveniences and discomfort that accompany diagnostic techniques discourages the use of diagnostic techniques

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Barriers to Diagnostic Privileges Qualification and Techniques [Continue]

The risks and obligations that accompany diagnostics techniques are a deterrent to obtaining diagnostic privileges

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Obtaining a diagnostic privileges qualification would be too time consuming to pursue

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Obtaining a diagnostic privileges qualification would be too expensive to pursue

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

I am too close to retirement to pursue a diagnostic privileges qualification

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Are there any other barriers to obtaining a diagnostic privileges qualification that have not been mentioned

☐ Yes ☐ No

Please specify any perceived barriers to obtaining a diagnostic privileges qualification that have not been mentioned

The prospect of therapeutic privileges for optometrists encourages the pursuit of diagnostic privileges qualification

☐ Strongly Agree ☐ Agree ☐ Disagree
☐ Strongly Disagree

Do you think it is appropriate for optometrists to acquire therapeutic privileges?

☐ Yes ☐ No

Registration for Diagnostic Privileges and Associated Permits

What does your HPCSA registration card state?

☐ Independent practice
☐ Independent practice - Diagnostic (Optometry)
☐ Independent practice - Therapeutic (Optometry)
☐ Not sure - need to verify

Registration for Diagnostic Practice with HPCSA

What deters you from registering for diagnostic with HPCSA?

What would you say is the reason that you have not yet amended your registration with HPCSA to reflect your diagnostic qualification?

Are you aware of the process to amend your registration with HPCSA to that of diagnostic practice?

☐ Yes ☐ No

Registration for Diagnostic Practice with HPCSA [Continue]

Would an automatic registration on completion of the diagnostic course be preferred?

☐ Yes ☐ No ☐ It makes no difference

Would being registered with HPCSA for diagnostic privileges encourage you to perform the diagnostic techniques?

☐ Yes ☐ No ☐ It makes no difference

Has anyone* contacted you since your diagnostic certification to establish whether you are registered for diagnostic privileges?

*Anyone from the HPCSA, the professional association (SAOA), academic institution, patients or others

☐ Yes ☐ No

Do you believe holding the diagnostic privileges qualification would allow you to provide better patient care?

☐ Yes ☐ No

Does not using the diagnostic techniques in your routine eye examination limit your investigation of the patient's ocular health?

☐ Yes ☐ No

Are you aware of the implications of practicing diagnostic techniques in the absence of the correct registration?

☐ Yes ☐ No

Are you aware of the application process for a Medicine Control Council Section 22A(15) Permit for the acquisition of diagnostic drugs

☐ Yes ☐ No

Do you experience challenges in information on how to obtain the forms to apply for the Section 22A(15) permit?

☐ Yes ☐ No

Please specify the challenges you experience to obtain the Section 22A (15) permit?

Medicine Control Council - Section 22A (15) Permit

PERMIT NUMBER:

MEDICINES AND RELATED SUBSTANCES ACT, 1965
(ACT NO 101 OF 1965)

JOHN DOE

01 JANUARY 2016 TO 31 DECEMBER 2018

Are you aware of the application process for the medicine control council Section 22A (15) Permit for the acquisition of diagnostic drugs?

☐ Yes ☐ No

Do you experience challenges in information on how to obtain the forms to apply for the Section 22A (15) permit?

☐ Yes ☐ No

Medicine Control Council - Section 22A (15) Permit [Continue]

Please specify the challenges you experience to obtain the Section 22A (15) permit?

APPENDIX B

UNIVERSITY OF THE FREE STATE
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YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

10-Sep-2018

Dear **Mrs Johanna Fraser**

Ethics Clearance: **Use of Diagnostic Techniques by Private Practicing Optometrists in South Africa**
Principal Investigator: **Mrs Johanna Fraser**
Department: **Optometry Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2018/1009/2509**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

APPENDIX C – INFORMATION LETTER

Dear Colleague

You are invited to participate in my research study. Currently, I am a postgraduate student at the University of Free State completing a Master of Optometry degree.

Title of Study: *The use of diagnostic techniques by private practicing optometrists in South Africa*

Ethics approval no: UFS-HSD2018/1009/2509

Researcher: Johannette Fraser Email: johannette@gmail.com

Tel: 082 924 7425

Supervisors: Nashua Naicker Email: naickern@ufs.ac.za

Tel: 051 405 2684

Prof Tuwani Rasengani Email: RasenganeTA@ufs.ac.za

Tel: 051 405 2680

Before you decide to participate in this study, please take the time to read the following information carefully.

Seeing that it is almost two decades since the introduction of diagnostic privileges within the scope of optometry, the current status and reflection on the usage of diagnostic techniques such as applanation tonometry, binocular indirect ophthalmoscopy and gonioscopy amongst South African optometrists needs to be explored as well as optometrists' views towards these techniques.

To participate in the study, you will be required to complete an online questionnaire, by clicking on the link below, which will take approximately 30 minutes to complete.

The questionnaire looks at the use of the diagnostic techniques and others factors that impact on the use of diagnostic techniques such as your registration. It would be helpful if you have your HPCSA registration card at hand, alternatively, you could follow this link to check up on your HPCSA registration status.

You will find the questionnaire is divided into different sections. Your answers to certain questions will determine which sections you are required to answer. This will mean that some sections will appear and others will disappear.

Ethical Considerations and Rights of Participants

Please note that the survey and all answers collected are strictly anonymous and at no time will your answers be traced back to you.

The anonymity of participants is vital to this study where the ethical considerations has be examined and endorsed by the Health Sciences Research and Ethics Committee. In accordance with the POPI act, no personal details, such as name, address and contact numbers will be collected or made available to any other parties, other than the principle investigator. No individual identifiable data will be reflected in the publication or presentation of the results. Committees such as the Ethics Committee at the University of the Free State may inspect the research records for quality assurance and data analysis. You will not be compromised in any way should you complete the questionnaire or if you choose not to participate.

Participation in this study is completely voluntary and you may withdraw from the study at any time during the completion of the questionnaire, should you decide to do so. If you do decide to withdraw from the study, all the data collected from you will be removed and discarded and therefore excluded from this study.

Please note that by completing this questionnaire and clicking on the "submit" button at the end of the questionnaire, you are voluntarily agreeing to participate in this research study and you give consent to the use of the information that you have provided for the study. The results of the study may be published.

To participate in the study Click Here

Or copy and paste this link into the web browser's address bar: http://surveys.ufs.ac.za/evasys/online.php?p=WUG6N

Should you have any questions about the research or any related matters, please contact the researcher during regular business hours. For questions about your rights as a research participant or for the reporting of complaints, contact the Secretariat of the Ethics committee of the Faculty of Health Sciences, University of the Free State at 051 401 7795 or at ethics@ufs.ac.za.