REFRACTIVE ERROR AMONG PRIMARY SCHOOL CHILDREN OF MOPANI DISTRICT, LIMPOPO PROVINCE, SOUTH AFRICA

by

VOSTER HLAWULANI AUSTINE BALOYI

Student Number: 39692108

Submitted in accordance with the full requirements for the degree of

DOCTOR OF PUBLIC HEALTH

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF ON MAKHUBELA-NKONDO

DECEMBER 2021

DECLARATION

I Voster Hlawulani Austine Baloyi, declare that: **Refractive Error Among Primary School Children of Mopani District, Limpopo Province, South Africa** is my own work, and that all the sources that I have used have been indicated and acknowledged by means of complete references.

Signature: Date: 13 December 2021

(Mr VHA Baloyi)

DEDICATION

I dedicate this thesis to my late pastor, Samuel Vhulahani Munyai the founder and leader of Holy City Christian Assembly, who was also an educator in the Limpopo Province Department of Education.

I have seen his sacrifices and dedication in ensuring that the body of Christ, which is the church, is well taken care of. He personally ensured that many of us make it through higher education by means of his tireless motivation and dedicated financial assistance.

Moya wa nwina awu etleli hi kurhula Mfundisi, mintirho ya nwina yileku vulavuleni.

May your soul rest in peace Pastor, your deeds are still continuing to speak louder than words.

ACKNOWLEDGEMENTS

I wish to express my heartfelt gratitude to the below-mentioned individuals and government departments for their continued support and motivation throughout the journey of this thesis. Many others have contributed to the completion of this study in various ways. However, limitations of space have prohibited all their names being mentioned here.

- Above all, I give all the glory to the Almighty God, who made this dream come true.
- My supervisor, Prof ON Makhubela-Nkondo of UNISA for patiently and consistently giving me all the necessary guidance, motivation and support.
- The Limpopo Departments of Health and Education, for granting me permission to conduct the study in the Mopani District Municipality. I highly appreciate the cooperation of the Mopani District Municipality officials, principals and educators for allocating time in their very busy schedules and voluntarily availing themselves for participation in this study.
- I deeply appreciate the willingness of the parents/ legal guardians and learners, for their unqualified involvement and making the study a complete success.
- Dr B Chabalala of the Medical Research Council, his academic guidance ensured improvement in the quality of this thesis. Dr TJ Mkhonto, for going beyond the parameters of editing to ensure the quality of this document. Prof. H.L Sithole of the University of Limpopo, for encouraging me to further my studies and engage in eyecare research. Dr TJ Mabunda of the University of Venda, for her encouragement, support and advice in the selection of the research topic for this thesis. Prof PRS Nyasulu of the University of Stellenbosch and Dr N Myburgh, for their academic guidance and ensuring that this study is a success. Mrs R Matatiela for tirelessly rendering the required UNISA library services for the purpose of this study.
- Mrs NE Mutandanyi-Mulaudzi, who has always believed in me. Her mentorship and guidance have eventually yielded the desired results. Dr IN Sibuyi, who has

encouraged me to undertake the study, and continued to make valid inputs throughout the thesis.

- My colleagues from the Health Professions Council of South Africa's Complaints Handling Department under the management of Dr M Kwinda and Mrs Mabaso KJ, for their continued support, motivation and assistance.

- My former colleagues from Nkhensani Hospital Eye Clinic, Messrs E Monareng, J Masingi and SD Kubayi, for believing in me and providing me with the necessary assistance. I am also immensely grateful to Messrs WO Maluleke and P Nkuna for their continued administrative support.

- All my friends, who have always supported and encouraged me to undertake this study.

- My father, Mr Samuel Magezi *Sam-bal* Baloyi for instilling the sense of discipline, patience hard work and independence in me. My late mother, Rhambanani Rose Ngobeni, for her unconditional love, care and support. I am who I am, because of the values she instilled in me. May her soul rest in peace!

- My in laws, Pastor Willie and Betty Mthombeni, for your continued support, guidance and most importantly, prayers. May God keep you for us!!!

- My beloved wife, Masingita Mthombeni-Baloyi, for her unpretentious support and endurance. She has always been my pillar of support and strength. I am utterly thankful to my daughters, Nkuriso Baloyi and Enhlo Baloyi for their love and support. *Nimi rhandza ngopfu vana va mina. Xikwembu axi mi endli hi tintswalo. Inkomu.* ***I love you immensely, my daughters. May God's Grace be upon you. Thank you!***

LIST OF ACRONYMS

ActAD	Activity Analysis and Development
CF	Counting Fingers
Cm	Centimeter
D	Diopter
DC	District of Columbia
DoBE	Department of Basic Education
DIT	Diffusion of Innovations Theory
DoH	Department of Health
HPCSA	Health Professions Council of South Africa
ICD	International Classification of Diseases
ISHP	Integrated School Health Policy
LP	Light Perception
m	Metre
NSC	National Screening Committee (UK)
NYC	New York City
PHVA	Pin Hole Visual Acuity
PPM	Precede Proceed Model
RE	Refractive Error
SAC	Snellen Acuity Chart

SSCO State College of Optometry

SPSS Statistical Package for Social Sciences

SUNY State University of New York

TI Trachomotous Inflamation

UK United Kingdom

USA United States of America

UVA Unaided Visual Acuity

UVARE Unaided Visual Acuity Right Eye

UVALE Unaided Visual Acyuty Left Eye

VA Visual Acuity

VAA Visual Acuity Assessment

VI Visual Impairment

VKC Vernalkeratoconjunctivitis

WHO World Health Organization

WPR Western Pacific Region

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Ocular problems affect people of different ages across the world. The purpose of the study was to investigate the extent to which refractive error affects primary school children with the aim of determining its prevalence, risk factors, and associated experiences by educators in Mopani District Municipality, Limpopo Province, in order to propose strategies that could assist in the early detection and identification of refractive error.

The mixed-methods approach was utilised to provide for the quantitative and qualitative optimization of both the data collection processes and resultant outcomes. Three Mopani primary schools were chosen as research sites. A self-administered questionnaire survey was utilised to obtain quantitative data from the 327 randomly selected children (and their parents) who eventually took part in the study. Ocular examination was done to determine the refractive status of the children. Data was analysed using the Statistical Package for Social Science (SPSS) Version 24. The interview-based qualitative aspect sought to explore the educators' experiences in educating school children who manifest with ocular problems. Ten participants were selected by convenience sampling for participation in the interviews. The quantitative and qualitative data sets were integrated during discussion of the study findings.

The findings showed that the prevalence of refractive error was 35.8% (n=117). The most prevalent type of refractive error was found to be myopia (16.2%; n=53), followed by hyperopia (10.1%; n=33), and astigmatism (9.5%; n=31). There was strong association between refractive error and type of school, child's position in the family and near work activities. Weak evidence showed that refractive error increased with an increase in the parental education status. Refractive error and other sight related conditions affected teaching and learning in schools and there were observed challenges in the school health vision screening program.

The effect of uncorrected refractive error on teaching and learning was a major problem which poses risks on the overall quality of the children's lives.

It is recommended that strategies described by this study be implemented by the relevant departments (DoH and DoBE) and stake holders. These strategies need to be evaluated to ensure feasibility and applicability.

Keywords: refractive error, myopia, hyperopia, astigmatism, teaching and learning, visual impairment, educators' experiences, School Health Vision Screening

CHAPTER ONE: OVERVIEW OF THE STUDY

1.1. Introduction

This chapter presents the overview of the study by discussion of the literature. It further presents the problem statement, rationale, objectives and the significance of the study.

1.2. The Study Background

South Africa is a member state of the World Health Organization (WHO), having signed the international conventions, the South African Department of Health developed and implemented the School Health Programme in 2003. Paramount among other things, is the involvement of Optometrists in ensuring that the school health programme is a success, particularly in the early detection and management of refractive error to avert blindness. The importance of education in the success of an individual's life cannot be underestimated. For children, education provides skills that prepare them physically, mentally, and socially for meaningful participation in all aspects of life, and for career purposes in the future. However, in most cases, vision (eyesight) can be a barrier to education and consequently to success. For instance, approximately 85% of all learning is acquired through vision (Shabiralyani, Hasan, Hamad and Iqbal, 2015: 226). In fact, visual learning requires one-third of the brain to handle the images that we process (Churchill and Graw, 2011). It is in this regard that children with refractive error, experience coping difficulties with their schoolwork, therefore, their academic performance is placed in jeopardy. If uncorrected, refractive error could have a long-term impact on the learning abilities of school children, and ultimately on their future and quality of life (Chisanga and Funjika, 2016: 174; WHO, 2021). Additionally, refractive error could also reduce employability and productivity (Naidoo, Leasher, Bourne, Flaxman, Jonas, Keeffe, Limburg, Pesudovs, Price, White, Wong, Taylor and Resnikoff, 2016:277). Therefore, this highlights the importance of visual examination among school going children for possible early intervention where necessary.

In the modern era, the visual capabilities of individuals are often influenced by prolonged day to day activities. For example, the advent of laptops, and smart cellphones has resulted in changing teaching methods at schools from viewing from the blackboard to close-up work with reading. In some provinces such as Gauteng, the Department of Basic Education (DoBE) has already embarked on the paperless learning project, where the procurement and delivery of electronic learner support material processes has begun (Msiza, Malatji and Mphahlele, 2020: 300). It is, therefore, expected that, in future, children in provinces that might adopt the use of electronic devices for teaching purposes may experience multiple eye problems resulting in poor academic performance and other related challenges as indicated above. This is because even the traditional non-electronic teaching methods and engagement with hardcopy study materials have visual demands on the children's ability to maintain clear and comfortable focus, often resulting in asthenopia. Consequently, children were more likely to report symptoms such as eyestrain, headaches during or after school, visual fatigue, holding reading material very close, and squinting.

The global prevalence indicates that 2.2 billion people are visually impaired (near and distance vision), of which 1 billion (about 50%) of the cases of blindness or visual impairment that affect distance vision are mainly caused by cataract (94 million) and uncorrected refractive error (88.4 million) (GBD 2019 Blindness and Vision Impairment Collaborators and Vision Loss Expert Group of the Global Burden of Disease Study. 2021: e144). Most (90%) of the visually impaired people are found in developing countries such as South Africa (WHO, 2013: 4). Notwithstanding such a state of affairs, the good news is that 80% of the global visual impairment is both preventable and curable (WHO, 2013: 5). According to the GBD 2019 Blindness and Vision Impairment Collaborators and Vision Loss Expert Group of the Global Burden of Disease Study (2021: e144), other main causes of blindness and visual impairment include glaucoma (7.7 million 10%), age-related macular degeneration (7%), corneal opacity (4.2 million 4%), diabetic retinopathy (3.9 million 4%) and trachoma (2 million 3%). From these numbers, refractive error is reported to cause both visual impairment and avoidable blindness, something that can be eradicated with targeted elimination strategies.

According to a study by Naidoo *et al.* (2016: 227), visual impairment and blindness in 101.2 and 6.8 million people respectively was due to refractive error from the year 1990 to 2010. More outstandingly, the researchers noted that refractive error was still the leading cause of visual impairment in the year of the conclusion of their study. In sub-Saharan Africa, estimates showed that about 4.28 million people were blind whereas nearly 17.36 million people experienced mild and severe visual impairment. The main cause for the 40.1% of blindness was cataract, whereas (48.5%) of mild and severe visual impairment was due to uncorrected and inadequately corrected refractive error (Naidoo, Kempen, Gichuhi, Braithwaite, Casson, Cicinelli, Das, Flaxman, Jonas, Keeffe, Leasher, Limburg, Pesudovs, Resnikoff, Silvester, Tahhan, Taylor, Wong, Bourne and Vision Loss Expert Group of the Global Burden of Disease Study, 2020:1658).

Worldwide, uncorrected refractive error is also the primary contributor to visual impairment in children aged 5 (five) to 15 years (Resnikoff, Pascolini, Etya'ale, Parajasegaram, Pokharel and Mariotti, 2008: 63). An estimated 19 million children are affected by visual impairment, of whom 12 million have uncorrected refractive error as the ultimate cause of this impairment. In addition, there are 1.4 million children affected by irreversible blindness (du Toit, Courtright and Lewallen 2017:154). Refractive error remains a major public health challenge, and high refractive error in childhood can cause amblyopia, resulting in blindness if not corrected early (Naidoo *et al*., 2016). As much as the challenges of refractive error are overwhelming to school children, measures are in place to drastically reduce its deleterious effects and prevent blindness. These include (but are not limited to) provision of access to affordable adequate spectacles and contact lenses, and refractive surgery (GBD 2019 Blindness and Vision Impairment Collaborators and Vision Loss Expert Group of the Global Burden of Disease Study. 2021: e154) and availability of appropriately trained human resources (Naidoo *et al*., 2016; 233).

There are different forms of blindness between developed and developing countries worldwide (Casson, 2013: e311). For instance, a study among Peruvian communities showed that reduced visual acuity was caused by the prevalence of refractive error in 95% of the examined children (Latorre-Arteaga, Gil-Gonzalez, Bascaran, Nunez, Morales

Orihuela 2016: 656). In Africa, the developing status of the continent accounted for the discrepancies of up to 50 times differences in the prevalence of blindness between developed and developing countries worldwide (Casson, 2013: e311). The African continent had an estimated 5.888 million people afflicted with blindness, 20.407 million with low vision, and 26.295 million with visual impairment (WHO, 2010). Cataract is the major contributor to blindness, followed by trachoma, glaucoma and other causes. The bulk of blindness in Africa is preventable or curable (Lewallen and Courtright, 2001: 897). In Nigeria, for instance, it was reported that 80% of the causes of blindness, 83% of severe visual impairment and 88% of visual impairment were avoidable. Again, in Nigeria, cataract, uncorrected aphakia and refractive error were identified as the main contributors to visual impairment and blindness (Mpyet, Odugbo, Adenuga, Velle and Nyonkyes, 2010: 401).

In a study by Naidoo, Raghunandan, Mashige, Govender, Holden, Pokharel and Ellwein (2003: 3764), it was reported that the prevalence of uncorrected, presenting, and best-corrected visual acuity of 20/40 or worse in the better eye in South Africa was 1.4%, 1.2%, and 0.32%, respectively. Furthermore, refractive error was identified as the cause of reduced vision in 63.6% of the population, while other common causes were amblyopia, retinal disorders and corneal opacity. However, the same study found that the prevalence of refractive error was low among school-age African children (Naidoo *et al*, 2003: 3764). Although refractive error was reported to be low among black children, the need for early intervention strategies was emphasized in order to avoid the burden of avoidable blindness among the few children that were afflicted with refractive error (Naidoo *et al.*, 2003: 3764).

1.3. Statement of the Research Problem

The incidences of the impact of uncorrected refractive error have been widely reported in literature to the extent that it causes serious discomfort by reducing the level of confidence among peadiatric populations. To a greater extent, uncorrected refractive error has an indirect contribution towards the burden of health care services in many developing countries including South Africa. Although the Departments of Basic Education and Health have developed a framework that provides guidelines on early intervention to prevent unwarranted cases of avoidable visual impairment and blindness, these efforts appear to be inadequate owing to poor administrative rollout if this noble idea. To this end, the scourge of visual impairment and avoidable blindness continues unabated in most parts of South Africa.

As a practicing optometrist, firsthand experience reveals that many children from disadvantaged communities begin their school years without the much-needed eye health screening services thus resulting in serious eye conditions that could have been corrected early being missed. Often these children visit an eye health care professional’s office following poor results at school or deteriorating quality of life of the affected individuals due to constant headaches, eye strain, eye fatigue and poor distance vision in some instances. For example, the 2019 Optometry Statistics of Nkhensani Hospital in Mopani District (Limpopo Province), where approximately 15 public primary schools were visited. In terms of the afore-cited Nkhensani Hospital statistics, approximately 1066 Grade 1 children were screened for refractive error. The statistics further showed that 291 children required corrective lenses. Evidently, about 100% of the children who could have benefitted from the corrective lenses did not have them. In an attempt to resolve the challenge of early detection of eye problems, a number of possible solutions have been suggested by various authors to eradicate this cause of blindness, however, anecdotal evidence and personal experience suggest that these strategies are not being implemented or are not working. In view of this problem, the researcher sought to determine the extent to which refractive error affects primary school children in the Mopani District Municipality of Limpopo Province, South Africa, and to formulate a framework for new strategies that may expedite the activities of early detection and management of refractive error.

1.4. Rationale of the Study

The consequences of uncorrected refractive error - such as poor reading ability and subsequent poor academic performance and blindness among primary school children - give credence to the importance and contribution of this study. Therefore, the study has provided documented evidence on the prevalence and management of refractive error and the associated factors among primary school children in the Mopani District Municipality of Limpopo Province. In addition, the experiences and perceptions of educators in educating children who suffer from eye conditions were explored, which further provided evidence of the effects of refractive error on teaching and learning. The study has proposed strategies that will be beneficial for the early detection and management of refractive error. Furthermore, the study has proposed the strategies for early detection and management of refractive error in Mopani District, which will ultimately improve the affected children's quality of life. Lastly, the study has recommended areas that may require further research in order to close the identified gaps in the field of eyecare.

1.5. Purpose of the Study

The study endeavoured to gather data that will be used to develop/propose strategies that can be utilised to promote early detection and management of refractive error among primary school children in Mopani District of Limpopo Province.

1.6. Research Aim

The purpose of the study was to investigate the extent to which refractive error affects primary school children with the aim of determining its prevalence risk factors, and its associated experiences by educators in Mopani District Municipality, Limpopo Province, in order to propose strategies that could assist in the early detection and identification of refractive error.

1.7. Research Specific Objectives

Whereas the research aim articulated in the study's overarching purpose, the research objectives particularly related to specific processes or activities by which the research aim was to be actualized (Bryman, 2016; Creswell, 2013: 187). Accordingly, the research specific objectives were:

i. To determine the extent of refractive error among the primary school children in Mopani District;
ii. To assess the risk factors of refractive error among the primary school children in Mopani District;
iii. To examine the association between refractive error and the socio-economic status of parents.
iv. To explore the educators' experiences in educating school children who manifest with ocular problems.
v. To propose strategies for the early detection and identification of refractive error.

It is worth noting that the first two research objectives above collectively address the refractive error condition itself, while the third addresses the empirical dimension of the study. This fact is noteworthy, considering the mixed-methods approach adopted in the design and data collection methods of the study (Edmonds and Kennedy, 2012).

1.8. Research Questions

Research questions enquire on the relationship of variables which the researcher intends to know (Creswell, 2013: 187). In this study, the research questions provided a cogent basis for the articulation of the research objectives (Kumar, 2014). Therefore, in tandem with the research objectives, the study sought to answer the following questions:

- What is the extent of refractive error among the primary school children in Mopani District Municipality, Limpopo Province?
- What are the risk factors of refractive error among the children?
- Is there any association between refractive error and the socio-economic status of parents?
- What are the educators' experiences in educating school children who manifest with ocular problems?
- What stratergies can be used to detect and identify refractive error early.

It is worth noting that each above-mentioned research question has a corresponding effect on each research objective to which it is linked (Kumar, 2014: 134).

1.8. Theoretical Framework

A theoretical framework assists the researcher in providing philosophically interconnected concepts, principles, and paradigms for the purposes of explaining, describing or predicting the occurrence of an investigated phenomenon (e.g. refractive error in children), or the nature of the reality and ideas emanating from such a reality (Kumar, 2014: 583). As a result, the current study followed the Precede-Proceed Model (PPM) in providing the relevant philosophical grounding for the investigated phenomenon of refractive error among children.

1.8.1 Precede-Proceed Model

Lawrence Green first developed Precede in 1974 and in 1991, Green and Kreuter added Proceed. (Porter, 2016). In 1974, Lawrence Green developed the model as a framework for evaluation (Green, 1974), this was later followed by the addition of Proceed by Green and Kreuter to the Precede model to form the full framework of the Precede- Proceed Model (Green and Kreuter, 1991). Precede stands for the following phases: Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation. The goal for these phases was to map diagnosis and planning. It therefore provides guidance for socio-ecological assessment and planning. On the other hand, Proceed, encompasses Policy, Regulatory and Organisational Constructs in Educational and Environmental Development. The framework that the Precede–Proceed model provides comprises of eight different phases and is meant to assist in the determination, development, implementation and evaluation of health promotion programmes, and the application of health promotion theories that are in these programmes (Gielen, McDonald, Gary, *et al*., 2008, In Glanz, Rimer and Lewis).

The model is still one of the frequently used approaches in health promotion (Porter, 2016). The PPM was used as the conceptual framework of the program in a study to assess the interverntion of a long term and on going international academic service learning. The model's phases, which included assessment, diagnosis, implementation, and evaluation assisted in the identification of major target areas and to design a five-day intervention (Colodny, Miller and Faralli, 2015). Barasheh *et al*. (2017: S 59-65) used the PPM to evaluate the efficacy of an educational program in training type 2 diabetic patients. The study focused on the improvement of the predisposing, reinforcing and enabling factors and the self-care behaviour of the participants. The study results of the intervention group showed an improvement as compared to the control group.

1.8.2 Triangualtion of Frameworks

This study used the PPM as a conceptual framework to understand the extent of refractive error and its risk factors, however, since the model had gaps, the researcher used triangulation of frameworks to address the challenges of PPM (Green and Kreuter, 2005; Crosby and Noar, 2011: S15). The PPM was used together with Activity Analysis and Development framework to ensure that any shortcomings on the PPM had been addressed. The limitations included cost and time required to ensure the complete and practical application of the model in reality, and lack of detailed guidance for each step of the model, however, the authors of the model have advised that the model can be applied in parts to minimise the identified limitations (MacDonald and Mullett, 2009: 165; Sharma and Romas, 2012: 48). In addition, Diffusion of Innovations theory (DIT) was used to propose the strategies for early detection and management of refractive error as discussed in chapter 7. The researcher has used ActAD framework as a lens in the refractive error study, whereas this framework is commonly used in the field of Information Technology (Korpela, 2004).

1.9 Significance of the Study

Refractive error in children is the foremost cause of visual impairment (Naidoo *et al*., 2016) and can be a barrier to learning in schools (Chisanga and Funjika, 2016: 174). If left untreated, this condition could result in refractive blindness (Ambika and Nisha, 2013: 6). While numerous studies had been conducted on refractive error in children, most of these studies provided quantitative data. It is against this background that this study has provided documented and recent evidence on the prevalence of refractive error among primary school children in Mopani District which was validated by qualitative data collected from the educators. Therefore, the study further provided baseline data on the perceptions and experiences of educators in teaching children with vision problems. The data from the educators provided a broader overview of the effects of refractive error on teaching and learning. As such, the study did not only provide the prevalence of refractive error, but further validated the quantitative data by collecting qualitative data from the educators and provided evidence of the effects of refractive error on teaching and learning. In addition, the study findings assisted the researcher in the formulation of strategies that will enhance in the early detection and management of refractive error in the Mopani District. Also, the evidence provided by the study on the risk factors of refractive error will assist the parents, teachers, and health care providers (particularly in eye care) in preventing and properly managing refractive error. It is envisaged that these preventive and management measures will contribute towards improving primary school vision screening programmes to avoid visual impairment and preventable blindness and poor vision in children. The study will also inform eye care health providers on other common ocular abnormalities experienced by children. Most importantly, the study will allow for more research to be conducted, that will focus on the implementation and evaluation of the stratergies proposed by this study.

1.10 Research Design and Methods

Research design is defined as specific philosophically relevant processes and procedures adopted to guide the methods preferred for the collection, analysis, and interpretation of data pertinent to the investigated phenomenon (Kumar, 2014: 611).

1.10.1 Pragmatic Worldview

Worldview refers to "*a basic set of beliefs that guide action"* (Guba, 1990: 17) A paradigm is a shared belief system that influences the types of knowledge researchers seek to obtain and how they interpret any research evidence they may collect (Morgan, 2007: 49) A worldview can be seen as a general philosophical orientation about the world and the nature of research that a researcher brings to a study. In this study, Pragmatism was selected as a world view.

The researcher has selected Pragmatism as a world view because it does not focus on one system of philosophy and reality, as a result, the researcher drew assumptions from both the qualitative and quantitative approaches (Creswell, 2013). Pragmatism provided the researcher with freedom to select the appropriate methods and techniques for achieving the research objectives.

1.10.2 Study Design

In concurrence with Rani (2016:1-2), Creswell (2013) described research design as the overall or totality of plans and procedures for guiding research, spanning from broad philosophical or theoretical assumptions to detailed methods of data collection, analysis, and interpretation. Research designs are the types of enquiries within the quantitative and qualitative approach that provide specific direction for procedures in research designs. Research designs are essentially qualitative, quantitative, or mixed (triangulated) in their nature and functions (Kumar. 2014). In the context of this study, the mixed-methods (triangulation) research design was opted for.

The mixed-methods research design basically relates to an approach to inquiry which integrates and triangulates the direction of the collection of both quantitative and qualitative data, each with its philosophical assumptions and theoretical frameworks (Madrigal and McClain, 2012). Mixed methods research provides the means to compensate for the identifiable weaknesses of both quantitative and qualitative research (Edmonds and Kennedy, 2012). Moreover, the mixed methods design (triangulation) allows for the optimization of more evidence when studying a research problem than either quantitative or qualitative research alone, furthermore; in this regard, all the available tools for collecting data can be used rather than being strictly limited to either quantitative or qualitative research tools (Creswell and Plano-Clark, 2018; Madrigal and McClain, 2012). Accordingly, the mixed-methods approach selected for this study aims to validate both the quantitative and qualitative findings regarding refractive error and the experiences of educators with children that suffer from refractive error. The data collection process comprised of three stages, wherein stages 1 and 2 were quantitative and qualitative strands and stage 3 was the integration of the data collected using the two strands. The mixed methods design was used to collect, analyse and triangulate quantitative and qualitative data. However, stage 4 was also presented under the research methods chapter, whereas it did not entail any form of data collection. As such, to ensure the attainment of the study aim, the researcher has involved stake holders in the proposal of the strategies. As a result, stage 4 formed part of the research methods chapter which involved stake holders in the development of the proposed strategies.

1.10.3 Quantitative Research Strand

Quantitative research designs are mainly grounded on the *positivist* research philosophy and its attendant *deductive* reasoning derived from an *objective* outsider (observer) perspective of a given situation or reality from its *general* characteristics from which the specifics could be established (Hayes, Heit and Swendsen, 2010). This study included a quantitative research design for the purpose of generalising from a sample to a population so that inferences could be drawn from the general characteristic of the study population (Creswell, 2013; Madrigal and McClain, 2012). This design was advantageous for its cost effectiveness and quick turnaround of data collection (Hayes, Heit and Swendsen, 2010). In the context of this study, the collection of data at one point (designated research setting) in time can be thought of as a “snapshot” of health conditions (e.g., refractive error) at a particular moment (month or year); focusing on studying and drawing inferences from existing differences among people (Laura, Salazar, Crosby and DiClemente, 2015). Therefore, quantitative data was collected from the parents using a questionnaire. In addition, the actual ocular examination of the children was performed by the researcher to determine the refractive status.

1.10.4 Qualitative Strand

As opposed to quantitative (positivist) research designs, the qualitative research designs are mainly grounded on the *interpretivist* research philosophy and its attendant *inductive* reasoning derived from a *subjective* insider’s (participant) perspective of a given state of affairs or reality from its specific characteristics from which the generalities could be established (Hayes, Heit and Swendsen, 2010; Streubert-Speziale and Carpenter, 2011:20). It is in this regard that qualitative research designs are premised on an interactive and subjective approach that emphasizes belief in multiple realities, commitment to identifying, and approach of understanding; all of which support the phenomenon being studied and commitment to the views of participants for purposes of allocating intelligible meaning in accord with the study objectives (Creswell, 2013; Walliman, 2015). The qualitative design aspect in this study was used to collect data from the educators through interviews, by means of which the key variable, the educators' perceptions and experiences in educating school children who suffer from ocular problems were analysed. This study employed the phenomenological research as a design of inquiry. In-depth interviews were used to collect data from the educators.

1.11. Outline of the Study

The arrangement of the chapters in the study was in accordance with the mixed methods approach sequence that guided the study.

Chapter One: Overview of the study

Chapter Two: Literature review

Chapter Three: Theoretical frameworks

Chapter Four: Research Design and Methods

Chapter Five: Research findings

Chapter Six: Data synthesis, discussion and study's contribution to body of knowledge

Chapter Seven: Conclusions, insights and recommendations

1.12 Justification of Study Contribution to the Body of Knowledge

The researcher believes that this study has provided a deeper understanding and rigor on the phenomenon of refractive error in children, in the context of Mopani District Municipality; its associated risk factors and how it affects learning and teaching in schools. In particular, the study has proposed strategies for the early detection and management of refractive error in the area. Furthermore, the relevance of the findings of this study to the community, Departments of Health and Education, and Policy development were highlighted.

The study has used triangulation of quantitative and qualitative data, the main strength of this study was through the use of mixed methods to ensure that the limitations of each method were reduced. This has increased the credibility of the findings in this study. The strength of this study was derived from ensuring that the private, rural and public clusters were included in the sample, thus providing a deeper understanding of the phenomenon.

The study used the PPM as a framework to understand the extent of refractive error and its risk factors, however, since the model had gaps, the researcher used triangulation of frameworks to address the challenges of the PPM. The PPM was used together with ActAD as a lense during data analysis; and the DIT proposes the strategies for early detection and management of refractive error. Therefore, triangulation of frameworks was was the theoretical contribution provided by the study to the body of knowledge, particularly for studies related to refractive error.

1.13 Definitions of Key Concepts

The key concepts defined below are centripetally connected with the critical and core variable of the investigated phenomenon, namely, refractive error.

Astigmatism: A type of refractive error that occurs when the anterior surface of the eyeball, the cornea, has an irregular curvature which results in distorted images. Astigmatism will refer to the dioptric power of ≤ 0.50D (Grosvenor, 2007).

Blindness: A presenting visual acuity of less than, or equaling 3/60 in the better eye (WHO, 2007).

Hyperopia/hypermetropia: A type of refractive error where the images are formed behind the retina, resulting in a blurred image. Hyperopia will refer to the dioptric power of ≥ +2.00D (WHO, 2007).

Myopia: A type of refractive error in which the eye fails to see distant objects properly. Myopia will refer to the dioptric power of ≤ 0.50D (Bhattacharyya and Bhattacharyya, 2009).

Refractive error: A condition of the optical system of the non-accommodating eye failing to bring parallel light rays to focus on the retina (Grosvenor, 2007).

Visual Impairment: A presenting visual acuity of less than, or equal to 6/18 in the better eye (WHO, 2007).

1.14 Scope of the Study

The scope of this study is characterised by both its geographic area of focus or reach, as well as its conceptual or methodological parameters (Creswell, 2013; Walliman, 2015). As reflected in its research topic – as well as in the research setting - the scope of the study covers the Mopani District Municipality, rather than all the Limpopo Province's district municipalities, and includes the four local municipalities of Greater Giyani, Greater Tzaneen, Greater Letaba, Maruleng, and Ba-Phalaborwa. Considering the geographic spread of Mopani for its data collection purposes, the study only focused on children in Grades 5 (five) to 7 (seven) and did not extend the scope to high school learners. In this regard, the scope of the study was on all the male and female children (from Grades 5 to 7) who were registered for the 2018 academic year in the primary schools of Mopani District Municipality and whose parents completed the questionnaire and the parents of the sampled children who completed questionnaires and provided the background information of the child and demographic information of both parents. In addition, the qualitative data was obtained from the primary school educators from foundation, intermediate and senior phases.

1.15 Conclusion

The chapter provided an introduction and background to the study as derived from literature. It is important to mention that all the critical units of analysis or variables referred to in various headings and sub-headings of this chapter are presented, discussed and explained in more detail in subsequent chapters. In this regard, the following chapter premises largely on the pertinent refractive error issues accruing from the multiple literature sources and perspectives.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Literature review pertains to the critical examination of existing research relating to the phenomena of interest (i.e., refractive error among children) and its associated theoretical rootedness (Bryman, 2016). Furthermore, the review of relevant literature basically entails the systematic search, identification, synthesis and summarizing the consulted studies relevant to the topic being researched (Creswell, 2013: 60). In this context, the literature review process provided a theoretical background of refractive error in children, which will also assist in establishing a link between this study and what has already been studied by other researchers and scholars in this field (Kumar, 2014). These scholarly perspectives on refractive error and other vision-related conditions enabled the researcher to provide a framework for the presentation of the ultimate results of this study with other comparable studies, to narrate a continuing discussion in the literature (Creswell, 2013: 60). Essentially, the current chapter presents and discusses the broader parameters of vision and blindness, followed by the state of refractive error globally, in the African continent, in the South African context, in Limpopo Province and in Mopani District in compliance with the research topic, as well as limited human and other resources, only 3 (three) primary schools were selected for involvement in the study's empirical aspects.

2.2 Visual Impairment and Blindness

The visual system is regarded as a sensitive neural network that provides the sensory input needed for one's interaction with the environment (Ambika and Nisha, 2013; Marsden, Stevens and Ebri, 2014). The importance of vision in the lives of children is not only limited to school activities, but to their general well-being and that of the society they live in. Therefore, the impact of visual efficiency must not be underestimated, considering that vision plays a very crucial role in the development, wellbeing, knowledge and quality of life of children. In essence, visual ability directly impacts on the mobility of individuals and generally enables them, regardless of age, socio-economic background, race and gender, to appreciate their surroundings. It is estimated that 75% of learning, particularly in the classroom, takes place through the visual system (Raiyn, 2016: 115). In addition, educators make use of various formats to transmit information to school children, which may include images, graphs, posters, videos, etc. This type of learning is called visual learning and is easily understood by the learners. Visual learning further assists in the development of visual thinking (Raiyn, 2016: 115). However, visual problems usually present at their school age, thus, children's lives in the classroom could then be impacted negatively. Since vision is also a fundamental aspect of communication and learning, eye problems and morbidities could significantly affect the child's learning ability, personality, and adjustment in the classroom (Ambika and Nisha, 2013; 6).

Visual impairment is defined as a presenting visual acuity of less than or equal to 6/18 in the better eye, whereas blindness is defined as a presenting visual acuity of less than or equal to 3/60 in the better eye (Pascolini D and Mariotti SP. 2012: 615). According to Resnikoff *et al*. (2008: 63), "Childhood blindness refers to a group of diseases and conditions occurring in childhood or early adolescence, which, if left untreated, result in blindness or severe visual impairment that is likely to be untreatable later in life". The 1965 definition of blindness by the international classification of diseases (ICD) focused on congenital blindness and excluded visual impairment caused by refractive error in that it considered best corrected visual acuity and not the presenting visual acuity (Lim, 2006: 215, WHO, 2016). Therefore, the use of presenting visual acuity, which refers to visual acuity measured with habitual prescription of the patient, is more suitable since it enables refractive error to form part of the causes of visual impairment (Dondana and Dondana, 2006). Blindness was defined as a central visual acuity of 3/60 or worse with best correction, or a visual defect resulting in widest diameter of visual fields subtending an angular distance of no more than 10 degrees around fixation or 20 degrees in diameter (WHO, 2000). Dondana and Dondana (2006) also indicate that the definition of visual impairment categories by the 10th revision of the International Statistical Classification of Diseases and Related Health Problems was based on WHO Study Group recommendations of 1972, which was never reviewed for decades (WHO, 2004). Despite these varied definitions and perspectives, the discussions concerning the definition of blindness and visual impairment in this study, together with the classification of visual impairment, will influence the prevalence rates.

As much as visual impairment remains a challenge, it is very important to note that 40% of the causes of visual impairment and blindness in children can be prevented or treated, especially when diagnosed early (WHO, 2010). Approximately 75% of blindness in the general population can be avoided, and if not, the blindness is treatable with the use of established and affordable technologies (WHO, 2010). A study conducted in South India by Kemmanu, Hegde, Giliyar, Shetty, Kumaramanickavel and McCarty (2016: 185) confirmed that almost half of childhood blindness could be caused by avoidable causes.

According to WHO (2010), lack of awareness, poor accessibility in the form of distance, affordability, anxiety, and competing demands for limited resources in the household often contribute to accessing eye care services. This explains the high number of school children with visual conditions remaining undiagnosed. Furthermore, school-age children are not able to explain or communicate their symptoms to teachers and parents. Consequently, children with visual conditions will usually perform poorly at school, leave school and abandon education, resulting in a negative social and economic impact (Yamamah, Alim, Mostafa, Ahmed, and Mahmoud, 2015: 246**)**. Delayed diagnosis also manifests in the child's school performance and socialisation, and that ultimately negatively impacts on the career opportunities (Latif, Asif and Kashif, 2018: 628).

Notwithstanding that childhood blindness is rather uncommon, Vision 2020 prioritizes childhood blindness prevention mainly because it affects children's development, education, mobility, employment opportunities, families and quality of life (Titiyal, Pal, Murthy, Tandon, Vajpayee and Gilbert, 2003: 941). In support of the latter assertion, Solebo and Rahi (2014:375) state that "visual impairment has a significant impact on the affected child's psychological, educational and socio-economic experiences, during childhood and beyond". The lasting effects of visual impairment and blindness in children are enormous. These children must live their entire lives with blindness or visual impairment, which will impact negatively on their emotional, social and economic state (Heijthuijsen, Beunders, Jiawan, de Mesquita-Voigt, Pawiroredjo, Mourits, Tanck, Verhoeff and Saeed, 2013: 812). A significantly high percentage (90%) of children with visual impairment, particularly in low-income countries, are deprived of education because of factors such as unavailability of suitable infrastructure, affordable health care, suitable and accessible school resources and adequately trained personnel (Vision 2020).

Meanwhile, Soni, Durrani and Jadoon (2015: 262) indicate that factors such as education, socio-economic status, accessibility to health resources, nutrition, customs, traditions, and health awareness of a particular population have a bearing on the pattern of ocular diseases. Vishal, Gupta and Pathak (2017:1079) affirm this latter view, and state further that the seemingly minimal 4% occurrence of blindness among children as compared to adults, has potentially devastating health effects on the national economy, individuals, families and communities. A change in the pattern of childhood blindness causes is noted in a study conducted at the National Eye Centre, Kaduna, Nigeria. In this study, the major causes of blindness were cataracts (52.6%), retinal disorders (14.1%) and trauma (11.7%). These were followed by glaucoma (10.3%), corneal opacity (5.7%) and refractive error (5.6%). Corneal scarring and refractive error seem to be low as opposed to other studies cited earlier in this sub-section (Ezinne, Nnandi, Mashige and Onoikhua, 2018: a544).

The nutritional status of patients has been found to have a correlation effect with visual impairments (Jones and Bartlett, 2018:17). Children with visual impairments and their parents reported that pediatric vision impairment has significant effects on health-related quality of life. A study by the latter authors on the impact of nutritional status on visual impairment, revealed a higher prevalence of obesity and malnutrition among visually impaired individuals, who also experienced difficulties in shopping, eating, and preparing meals (Jones and Bartlett, 2018:17). Furthermore, many of the ocular conditions that cause blindness in children also result in child mortality (e.g., Vitamin A deficiency, meningitis, premature birth, congenital rubella syndrome and measles). Therefore, management of blindness in children is not only limited to visual function and functional vision, but it also relates to the survival of the child.

2.3 Refractive Rrror in Primary School Children

The increasing understanding of the massive need for refractive error correction has resulted in the prioritisation of this condition as one of the worldwide initiatives to eliminate avoidable blindness (Razia, Hassan and Naheed, 2011). The refractive state of the eye is determined by four variables: corneal curvature, lenticular power, depth of the anterior chamber and the axial length (Nelson and Clitsky, 2005:117). The refractive status of the eye is the locus within the eye conjugate with optical infinity during minimal accommodation (Benjamin, 2006). In the case of ammetropia, the incident parallel rays of light are brought to focus upon the retina. The parallel light rays, in the cases of myopia and hyperopia, fall in front of the retina and behind the retina respectively. In this regard, refractive error could then be defined as a state in which the optical system of the non-accommodating eye fails to bring parallel light rays to focus on the retina (Razia, Hassan and Naheed, 2011). School-age children could experience three types of refractive error, namely: myopia, hypermetropia (hyperopia) and astigmatism, depending on their refractive media power and axial length (Mohammad, Mohammadreza and Mohammadi. 2009). In the context of this study, refractive error refers to myopia (near sightedness) of -0.50 diopters and less, hyperopia (farsightedness) of +2.00 D and more, and astigmatism (distortion of images due to irregular curvatures of the cornea) of -0.50 D or less.

2.3.1 Myopia

Myopia is a type of refractive error which occurs when the eye does not see far-off objects well (Chung, Mohidin, Yeow, Tan and O'Leary, 2006:695). Myopia occurs commonly among children, and the most common symptoms are frowning, squinting and not seeing objects from distances (Al-Nuaimi, Salama and Elijack 2010: 42). Myopia results from an eye experiencing excessive refractive power for the axial length. Such refractive power may be due to the eye having either a long axial length, or one or more of the refractive elements having increased dioptric power (Gale and Sebag, 2014:116).

Clinical classification of myopia

This study described two classifications of myopia, which are pathological and pseudo myopia. Pathological myopia is present at birth and has extremely long axial length. It is usually stationary, with dioptric power that may be up to -10.00D (Bhattacharyya and Bhattacharyya, 2009). Myopia at birth is the most common type, and usually develops in the early stages of life (Bhattacharyya and Bhattacharyya, 2009). It increases until the middle or late teens and remains relatively stable thereafter (Chuah, 2014). The dioptric power of up to -6.00 characterizes the condition (Bhattacharyya and Bhattacharyya, 2009). This type of myopia however is not associated with any complications seen in pathological myopia (Chuah, 2014).

Chuah (2014) describes pathological myopia as a strongly hereditary myopia that develops between the ages of 5 and 10 years. In pathological myopia, the eyeball is abnormally long. This particular type of myopia tends to progress steadily until the age of 30 years. The dioptric power of -6.00 is usually present and may progress up to -15.00 to 20.00 of myopia, depending on age. It is also characterized by degeneration changes in the posterior pole of the globe. In most cases, patients that are diagnosed with keratoconus are more likely to have pathological myopia. Chuah (2014) indicated that pathological myopia is largely associated with the following complications:

- early cataract formation;
- higher incidence of primary open angle glaucoma (POAG);
- retinal tears and retinal detachment;
- myopic chorioretinal degeneration of the macula; and
- bleeding behind the retina.

Pathological myopia refers to the type of myopia that is caused by, or associated with trauma, systemic diseases, inflammation of the eye, cataract formation and changes in the blood sugar level (Reddy, Babu, Reddy, and Reddy, 2015). The changes in sugar level that occur in patients with poorly controlled sugar levels result in changes in sugar levels in the vitreous humor and aqueous humor as well. These fluctuations cause refractive index changes in the eye, and subsequently, secondary myopia (Artini, Riyanto, Hutauruk, Gondhowiardjo and Kekalih, 2018; Ram and Sukhija, 2010).

Pseudo myopia occurs as a result of over accommodation most commonly observed in young individuals who are under pressure and perform a reasonable amount of work (Chuah, 2014). However certain drugs, such as pilocarpine used in eye care, have the potential to cause pseudo myopia mainly because they stimulate the ciliary muscle of the eye and result in more accommodation (Chuah, 2014). Night myopia occurs if a patient experiences myopia, or the current myopia is exaggerated in dim illumination (Chuah, 2014). Night myopia occurs due to the following reasons:

- Poor illumination resulting in increased accommodative response (Chuah 2014);
- The shift in the wavelength of the predominant light present. This is explained by the light shift to blue wavelength in the evening. As the blue wavelength is refracted more than the other wavelength, the images formed are ultimately located behind the retina of the eye, causing myopia (Chuah, 2014).

2.3.2. Hyperopia/ Hypermetropia

Hyperopia is far-sightedness and occurs when images are formed behind the retina resulting in a blurred image (Al-Nuaimi, Salama and Elijack 2010: 42). Hyperopia results when the eye has insufficient power of the axial length. It may be the result of the eye having short axial length or reduced dioptric power of one or more of the refractive elements (Benjamin, 2006). This results in difficulty seeing clearly at near distance. It may also result in reduced reading interest, rubbing of eyes, headaches, dizziness, or nausea (Al-Nuaimi, Salama and Elijack 2010: 42). At birth the eye is approximately 3 (three) diopters hyperopic (Nelson and Clitsky, 2005:118). However, hyperopia is the normal state of refraction of the eye in childhood.

Classification of hyperopia

Hyperopia is categorized into manifest and latent hyperopia. Latent hyperopia is a condition in which all or part of the patient's hyperopia is compensated for by the tonicity of the ciliary muscle (Grosvenor, 2007: 17), and usually results in asthenopia (eye strains). It can only be discovered clinically by cycloplegic refraction, where the accommodation is paralyzed or at its minimum. However, as people age there is a decrease in amplitude of accommodation and latent hyperopia will be less compensated for and thus becoming manifest hyperopia. Manifest hyperopia is the hyperopia that is corrected by strongest convex lens required for optimum clear distance visual acuity (Bhattacharyya and Bhattacharyya, 2009: 121).

Manifest hyperopia is determined clinically by non-cycloplegic refraction (Nelson and Clitsky, 2005: 119). Latent hyperopia and manifest hyperopia together amount to total hyperopia. Manifest hyperopia could also be further classified as facultative and absolute. In facultative hyperopia, the amount of hyperopia present could be overcome by accommodation of the lens, in terms of which the patient uses extreme effort to maintain focus through accommodation. In turn, this results in asthenopia (Nelson and Clitsky, 2005:119). However, the difference between latent and facultative hyperopia should be noted. Regarding facultative hyperopia the patient uses accommodation at will to overcome hyperopia. In latent hyperopia, the increased tonicity of the ciliary muscle automatically (not at patient's choice or effort) compensates for the hyperopia (Grosvenor, 2007). In the case of absolute hyperopia, the maximum available accommodation fails to compensate for the patient's hyperopia, this type of hyperopia is characterized by reduced vision.

Effects of hyperopia

Far-sighted children can compensate by excessively focusing their eye muscles to make near objects clear. The excessive focus does not trigger irreversible damages but can result in discomfort. Far-sightedness can result in blurring of vision, vision fluctuation, eyestrain and fatigue, headaches, and difficulties in concentrating. Other people would also suffer from a burning sensation, redness of eyes, or dry eyes. Amongst children, uncorrected hyperopia usually causes amblyopia, inward turning of the eye, or even lead to difficulties in learning (ICEE, 2009).

The effect of visual impairment as a result of myopia is different to that of hyperopia, because myopes are more likely to have better vision at near range than hyperopes. Hyperopia, however, is the cause of poor reading since it results in difficulties forcing the eyes on near objects, so hyperopes are more vulnerable to headaches, eye strain and blurred vision when doing near work (Saw *et al*., 2002). Hyperopes may often misunderstand the text that they read, since extra effort is used to maintain the clarity of the text being read (Mabaso, Oduntan.and Mpolokeng (2006: 132). Table 2.7 below presents a summary of the symptoms, signs and risks of hyperopia.

Table 0.1 summary of symptoms signs and risks of hyperopia

Symptoms	Signs	Risks
Eye strains	Shallow anterior chamber	Amblyopia
Blurred vision	Small eyeball	Primary angle closure glaucoma
Frontal headaches	Amblyopia	Accommodative convergent squint
Convergent squint	Divergent squint	
Latent convergent squint	Small optic disc	
Pseudo-myopia		

2.3.3. Astigmatism

Astigmatism is a refractive condition in which the eye's optical system is incapable of forming a point image for a point object (Grosvenor, 2007). When the cornea (the anterior surface of the eyeball) has an irregular curvature, astigmatism usually occurs, mostly with near-sightedness and far-sightedness. Essentially, astigmatism means that one has a variation or disturbance in the shape of one's cornea. It is believed that almost every individual has a certain degree of astigmatism, often from birth, which may remain the same throughout life (The University of Michigan Kellogg Eye Centre, 2013). Astigmatism normally results in blurred or distorted vision to some degree at both near and distance range. People with uncorrected astigmatism will complain of eye strains and headaches, especially after performing near work or other prolonged visual tasks. Squinting can also be one of the common symptoms of uncorrected astigmatism (Emerole, Nneli and Osim, 2013).

Myopic astigmatism is a condition in which, with accommodation relaxed, one image is located on the retina and the other image either in front or behind the retina. In the case where, with accommodation relaxed, one image is located on the retina and the other image is located in front of the retina, the condition is called simple myopic astigmatism. On the very same note, if one image, with accommodation relaxed, is located on the retina and the other image is located behind the retina, the condition is then called simple hyperopic astigmatism.

In compound astigmatism, with accommodation relaxed, both the images fall either in front of the retina or behind the retina. If the two images, with accommodation relaxed, fall in front of the retina, the condition is called compound myopic astigmatism. However, in the case where, with accommodation relaxed, the two images fall behind the retina, the condition is called compound hyperopic astigmatism. Regarding mixed astigmatism, one image is located in front of the retina and the other image is located behind the retina, with accommodation relaxed.

Since astigmatism is usually caused by the cornea, the lens also accounts for small amounts of astigmatism. In cases where astigmatism is caused by the shape of the lens, it is called lenticular astigmatism (Emerole *et al*., 2013). Lenticular astigmatism can be due to variations in the curvatures of one or more surfaces of the lens, the refractive index inequalities in different lens sections and the displacement of refractive elements (Bhattacharyya and Bhattacharyya, 2009:129). Most corneas are steeply curved in the vertical meridian than the horizontal meridian, resulting in the convergence of light being greater on the vertical meridian than the horizontal meridian (Grosvenor, 2007). Therefore, with the rule astigmatism occurs when the refractive power of the vertical or near vertical meridian is maximum (Bhattacharyya and Bhattacharyya, 2009). On the other hand, when the opposite occurs, where the maximum refractive power of the horizontal or near meridian is at maximum, it is now called against the rule astigmatism. However, if the two principal meridians aligned at 90 (Bhattacharyya and Bhattacharyya, 2009), but are 30 degrees from 90 degrees or 180 degrees, this astigmatism is called oblique astigmatism (Grossvender, 2007). Bhattacharyya and Bhattacharyya (2009) stipulates some of the symptoms of astigmatism as follows:

- diminished distance visual acuity;
- asthenopia;
- headache and eye ache; and
- blurring of letters.

In the event that there is a significant spherical difference in the refractive statuses of the two eyes, usually of 1.00D or more, the refractive error condition is termed anisometropia. However, if the refractive errors in the two eyes are of the same type, it is called isometropia, whereas the term antimetropia is used when the refractive errors in the two eyes are different (Grossvender, 2007). Color is often used as an aid to teaching in pre-primary and primary schools. Many teaching materials for reading and mathematics are color-coded in pre-schools; hence, children with color vision impairment may have difficulties in their early education (Reddy *et al*., 2015). In the study conducted by Sehlapelo and Oduntan (2007), it was found that many uncorrected refractive errors resulting in decreased visual acuity (VA) worse than 6/24 could affect color vision. The above-cited authors further recommended that workers, such as train drivers, whose occupations require keen color vision, must have their vision examined regularly and their refractive errors compensated for to avoid color misperception which otherwise might result in fatalities.

2.4 Global Overview of Refractive Error in School Children.

Although the purpose of this section is to present the overview of refractive error, the researcher deems it necessary to begin by discussing the occurrence of both blindness and visual impairment as they might be the resultant of uncorrected refractive error in certain cases. According to the WHO, it was estimated that in 2007, 1.4 million children between 0 and 15 years of age were blind globally, with Asia and Africa contributing 1,3 million to the total number of childhood blindness (WHO 2007). It was further reported that the prevalence of blindness ranged from 0.3/1000 for wealthy countries to 1.5/1000 children for extremely underprivileged countries. It was also noted from the same report that approximately 500 000 children became blind every year (approximately one child every minute), with most of the children either born with or acquiring blindness prior to the age of 5 years (WHO, 2007). In support of these estimates, Khandekar, Kishore, Mansu and Awan (2014: 338), also reported that the prevalence of childhood blindness differs greatly from country to country, depending on the economic status of the particular country. In wealthy European countries, the USA, Canada and Japan, a prevalence of 0.3 to 0.4/1000 children is estimated, and 0.2 to 0.7/ 1000 in middle- to low- income countries, including the Western Pacific Region (WPR). The prevalence appears to be higher in poor countries that includes Asia at 0.9/1000 children, whereas the prevalence of childhood blindness is the highest at approximately 1.2/1000 children in very poor regions, including Africa.

The following statistical information further illustrates the preponderance of visual impairment and blindness in various parts of the world. For instance, visual impairment and blindness had the prevalence rate of 4.9/1000 children and 0.62/1000 children respectively among children of West Uttar Pradesh (Singh, Malik, Malik and Jain, 2017: 500). The prevalence of blindness was 0.99%, and was mostly caused by unavoidable factors, as corneal scarring was no longer the leading cause of blindness (Kemmanu, Giliyar, Shetty, Singh, Kunaramanickavel and McCathy, 2018: 1590). In Osoba, Nigeria, 24% of the school children presented with low vision, and 20.0% had mild to moderate visual impairment, while 0.4 % had severe visual impairment (Isawumi, Agboola and Ayegoro, 2016: 147). Similarly, the study conducted among school children of South Sinai revealed that the prevalence of visual impairment was 29.4% for uncorrected visual acuity of 6/9 and 2.0% for moderate to severe visual impairment with visual acuity of 6/24 (Yamamah *et at.*, 2015: 246). Further afield, the major cause of visual impairment was identified as uncorrected refractive error in Shangai, China, with amblyopia, congenital cataract, congenital nystigmas, ocular prosthesis and opaque cornea accounting for a small rate of prevalence (He, Lu, Zou, He, Li, Wang and Zhu 2014: 1). Comparably to the above studies, visual impairment was caused by amblyopia and refractive error with a prevalence of 26.0% and 32.50% respectively in Amanat Eye Hospital of Rawalphindi, Pakistan (Amir, Khan, Asrar and Jalis, 2017: 251). However, a lower prevalence of 6.4% for visual impairment was observed in a study conducted in India, of which refractive error was the major cause in 2.77% of the reported cases (Kemmanu *et al*., 2018: 1590). Similarly in another study conducted among 10–14years old school children in Puducherry, India, the prevalence of visual impairment was found to be 6.37%, with refractive error cited as the leading cause of blindness; visual impairment was found in 71.56% of the children, and corneal diseases were second in the list as a cause of visual impairment. However, congenital, and developmental eye defects were second in the childhood blindness list (13.4%). Malnutrition and Vitamin A deficiency then followed in 5.6% of the children with blindness with ocular injury, eye infections and hereditary causes contributing 4.4%, 2.1% and 2.7% respectively (Vishnuprasad, Bazroy, Madhanraj, Prashanth, Singh and Samuel, 2017: 58).

The prevalence of refractive error

Uncorrected refractive error was found to be the most common cause of vision impairment in 13 million children between the ages of 5 (five) and 15 years worldwide (Shrestha and Shrestha, 2017: 49; WHO, 2006). In addition, Vision 2020 (2006) also reported that the prevalence of myopia was increasing intensely among children, predominantly in urban parts of South East Asia. This was supported by the comparative studies on refractive error conducted in a number of countries which showed that, in rural India, the prevalence of refractive error among the children was 2.7%, in Nepal 2.9%, in urban India 6.4%, in rural China 12.8%, in Chile 15.8%, and in urban China 22.3% (He *et al*. 2014: 5). These comparative findings demonstrate that myopia and hyperopia prevalence differ significantly throughout geographical regions.

Further to the above findings, in a study conducted between 1988 and 1998 in China, refractive error was the most prevalent cause of decreased vision in 89.5% of the eyes, amblyopia in 5% of the eyes, other causes in 1.5% of the eyes, and in the remaining 4% of the eyes whose causes could not be explained (Zhao, Pan, Sui, Munoz, Sperduto and Ellwein, 2000: 427). Furthermore, a study conducted in Hong Kong between 1998 and 2000 to assess the prevalence of myopia and its progression in children, showed that this visual impairment was the most occurring refractive error among 36.71% of school children, which was lower than the two studies presented above (Fan, Lan, Lam, Lau, Chong, Cheung, Lai and Chew, 2004: 1071). These findings were similar to the prevalence that was noted in a study conducted in 2013 in Shanghai, China, which showed that refractive error was still the most prevalent cause of visual impairment at 89.48% (He *et al.*, 2014: 1). Additionally, a study conducted between 2011 and 2012 among children in Nanjing revealed that refractive error was the major cause of reduced visual acuity, with a prevalence of 66.8% (Pan, Chen, Gong, Yu, Ding, Bai, Chen, Zhu, Fu and Liu, 2016: 152). Recently, a study conducted in Southernmost China in 2018, showed that the prevalence of refractive error was 59.6%, with myopia as the most common type of refractive error among the children (Peng, Gao, Zheng, Dai, and Xie (2021:1).

In addition to the above, a study was conducted between 2000 and 2001 to assess the refractive error prevalence and associated visual impairment in rural school aged children of the Indian community (Shrestha and Shrestha, 2017: 49). It was found that refractive error was the main cause of visual impairment in children aged between 7 (seven) and 15 years. The visual impairment in 61% of the eyes was caused by uncorrected refractive error, with amblyopia and other causes contributing to a lower percentage (Ravi Sekhar Rao, Krishna and Vasantha, 2016: 21). A review of articles on refractive error that were published between 1990 and 2017, showed a low prevalence of myopia (5.3%), hyperopia (4.0%) and astigmatism (5.4%) (Sheeladevi, Seelam, Nukella, Modi, Ali and Keay, 2018: 495). In contrast to this lower prevalence, there was a significant prevalence of refractive error in school children of Nizmabad district, India, accounting for 46.8% of poor vision in the years 1996 to 2000 (Ravi Sekhar Rao, Krishna and Vasantha, 2016:

21). Furthermore, in a study conducted between 2012 and 2014, refractive error accounted for 17.36% of the 29.35% children with ocular morbidity in West Ulttar Pradesh, India (Singh, Malik, Malik and Jain, 2017:500). Similarly, a study conducted between 2012 and 2013 showed that refractive error was the most common ocular morbidity in 10.0% of children attending in government schools of Kathamandu Valley, India, with myopia presenting as the most prevalent type of refractive error among the students at 74.7%. (Shrestha and Shrestha, 2017: 49). A similar prevalence was observed in 2012, wherein only 97 of the 1 378 children in a school of South India were found to be having significant refractive error (Pavithra, Hamsa, and Madhukumar, 2014: 147), However in Delhi, North India, a lower prevalence of 13.1% was reported (Saxena, Vashist, Tandon, Pandey, Bhardawaj, Menon, and Mani, 2015: 1).

A study conducted in Doha, Qatar in 2008 aimed at measuring the refractive error among primary school children and to identify the risk factors among them found that refractive error was at a prevalence of 19.7% (Al-Nuaimi, Salama and Elijack 2010: 41). Myopic astigmatism was found to be the most prevalent type of refractive error, followed by myopia, hyperopic astigmatism and hyperopia (Al-Nuaimi, Salama and Elijack 2010: 41

A study conducted in 2006 in Malaysia showed that the prevalence of uncorrected visual impairment was 7.7% (Guggenheim, Pong-Wong, Haley, Gazzard and Saw, 2007: 781). Refractive error was found to be the leading cause of the visual impairment, which contributed 7.0% prevalence of the studied population (Syaratul-Emma, Hui-Ken, Wan-Hazabbah and Mohtar, 2008: 940). However, a study conducted in 2003 by Goh, Abqariyah, Pokharel and Ellwein (2005: 678) among school-going age children of Malaysia, showed that reduced vision was caused by refractive error in 87.0% of the eyes, which was much higher compared to the above studies conducted in Malaysia. This study further indicated that reduced vision was mainly caused by myopia (63.5%) wherein hyperopia and astigmatism accounted for 11.2% and 20% respectively.

An ocular morbidity study conducted from 2013 to 2014 among street children in Kathmandu Valley, Nepal, revealed that the most common ocular morbidities were refractive error and ocular infections (Rajesh and Gauri, 2017: 243). As such, another study conducted in Nepal, in 2009, on the patterns of refractive error among school children in three public schools and a private school showed that 8.5% of the children had refractive error (Shresthaa, Sujakhub and Joshib, 2011: 49). In the same study, refractive error was found to be at 11.6% with the prevalence of 87.3%, 87.9% and 96.1% for uncorrected, aided and corrected visual acuity 6/9 in both eyes respectively (Mukund, Gauri and Niraj, 2014: 356).

In assessing the refractive error that caused amblyopia among 2 500 children in Pakistan between 2014 and 2016, it was found that 2000 children had refractive error, while the remainder, 500, had normal vision in Amanat Eye Hospital of Rawalphindi, Pakistan (Amir *et al*., 2017: 251). Another study in Lahore City, Pakistan in the early 2000s, revealed that 19.8% of the children had refractive error, which was found to be the main cause of visual impairment (Ayub, Imran and Saima, 2007: 203). Similarly, among the Karachi children of Pakistan, the prevalence of refractive error was 16.85% between 2010 and 2011 (Qureshi, Ahmed and Ahmed, 2016: 246). Also, in the Pediatrics Eye OPD of Al-Shifa Trust Hospital in Rawalpindi, Pakistan, 21.76% of the school children were found to have refractive error, wherein myopia prevalence was found to be 43.24%, hyperopia was 24.32%, and astigmatism was 32.43% (Muhammad, 2016: 27). Contrastingly, in 2017, the occurrence of significant refractive error was found to be low among the children of Malakand Tehsil of Pakistan because 91% of them did not suffer from any visual impairment (Latif, Asif and Kashif, 2018: 629). However, Soni, Durrani and Jadoon (2015: 262) indicated that refractive error in children consulting at the Eye Department of Naseerullah Khan Babar Memorial Hospital, Pakistan, was the third common eye problem, surprisingly, hypermetropia prevalence was the most common type of refractive error at 26.5%, and astigmatism and myopia were at 15% among the children. Ayub, Imran and Saima (2007: 203) also found myopia to be the most common refractive error at 43% among primary school children in Pakistan in the 2000s, followed by astigmatism at 35.5% and hyperopia at 21.5%. This was consistent with another study conducted in Gujranwala, Parkistan, which showed that 21% of the children suffered from refractive error in 2018, of whom 35% were myopic, 24% astigmatic, and 21.5% hyperopic (Mehboob, Nisar and Khan, 2018: 701). The study further showed that a significant number of children that experience unexplained headaches had refractive errors. Similarly, myopia (77%) was the leading refractive error type in a study conducted between 2010 and 2011 in Karachi, Pakistan, on the prevalence of ocular problems among school children (Qureshi, Ahmed and Ahmed, 2016: 246). In support, in the school survey conducted in 2019, the prevalence of refractive error myopia (6.64%), astigmatism (9.75%) hyperopia (2.17%) was reported in Bhutan (Sharma, Lepcha, Lhamo, Ellwein, Pokharel, Sapkota, Dorji, T and Peldon S, 2020: e0239117). However, the second prevalent type of refractive error in the study was hyperopia at 23% and astigmatism at 10% (Qureshi, Ahmed and Ahmed, 2016: 246), as opposed to the study by Ayub, Imran and Saima (2007: 203) above and the study conducted between 2014 and 2016 to determine the extent of a causal relationship between refractive error and myopia in children, wherein myopia had the highest prevalence of 26.08%, followed by hyperopia at 18.0%, with astigmatism accounting for 9.92% and anisometropia at 5.8% (Amir *et al.*, 2017: 251). In addition to the refractive error prevalence, in Lahore, Pakistan, a study to determine the association between the duration of playing video games and different types of refractive error among children between the ages of 6 (six) and 15 years showed a prevalence of 18% (Rasheed, Khan and Khan, 2010: 125: 125).

Further to the above studies, a study conducted on refractive error among school children between 2008 and 2009 in Shiraz, Iran, found the prevalence of 6.46% for uncorrected, 0% for best corrected,1.49 for presenting and 0.9% for spectacle corrected visual acuity (Yekta, Fotouhi, Hashemi, Dehghani, Ostadimoghaddam, Heravian, Derakhshan, Yekta, Behnia and Khabazkhoob, 2010: 242). Whereas in 2010, in North-Eastern Iran, the prevalence rates were lower at 2.2% for uncorrected, 1.0% for habitual, and 0.2% for optimal visual acuity of 6/ 12 or worse in the better eye (Rezvan, Khabazkhoob, Fotouhi, Hashemi, Ostadimoghaddam, Heravian, Azizi, Khorasani and Yekta , 2012: 25). As opposed to most studies discussed above, a higher prevalence of hyperopia (20.5%) was reported in Shahrood, Iran, which was followed by astigmatism (19.6%), myopia (1.7%)

and anisometropia (2.2%) (Jamali, Fotouhi, Hashemi, Younesian and Jafari, 2009: 364). Contrastingly, in Shiraz, Iran, the occurrence of myopia between 2008 and 2009 was 4.35%, hyperopia was 5.04% and the most prevalent type of refractive error was astigmatism at 11.27% (Yekta *et al.*, 2010: 242). Alomair, Alghnam, Alnasser, Almuhawas, Alhoshan, Altamimi, Alshaye, Almuayli, Alokiliy, Alfawaz, and Alghamdi (2021: 273) reported that about a third of the school children were diagnosed with refractive error in the study conducted in 2020 in Riyadh, Saudi Arabia. Again, in the rural community in Saudi Arabia, Dariyah, a higher prevalence of refractive error (69.7%) was reported, with the most common refractive error type being astigmatism (Alghamdi and Ovenseri-Ogbomo, 2021: a579).

Yingyong (2010: 1288) conducted a study on refractive error in Thailand between 2008 and 2009 and found that myopia was the most prevalent refractive error in primary school children. Myopia was also the common cause of visual problems in the study conducted in Tafila City from 2004 to 2005 by Bataineh and Khatatbeh (2008: 86). However, in Turkey, a study conducted in 2009 showed that the prevalence of astigmatism was 7.7%, which was followed by anisometropia at 6. 2%, then myopia at 6% and lastly hyperopia at 0.6% (Azizoglu, Crewther, Serefhan, Barutchu, Goker and Junghans, 2017).

In the Brčko District of Bosnia and Herzegovina, the prevalence of myopia, hyperopia, and astigmatism with retinoscopy was 17.3%, 3.0% and 12.9% respectively, whereas autorefraction showed 20.4%, 3.3% and 18.1% respectively (Popović-Beganović, Zvorničanin, Vrblijanac and Zvorničanin, 2018: 858). Again in Tuzla city of Bosnia and Herzegovina, the occurrence of refractive error in children was seen to be very low, at 1.95%, however, astigmatism, as opposed to most studies, was the most occurring refractive error at 54.2%, followed by myopia at 36.2%, which contradicts the findings from Brčko District (Nadarević Vodenčarević, Halilbašić, Međedović, Jusufović, Pilavdžić, Drljević and Burgić, 2021:96). Another study conducted between 2011 and 2012 in Arad, Romania, revealed that 315 of the 1 121 screened children suffered from refractive error, while 48 were myopic, 159 were hyperopic, and 108 were astigmatic (Turcin and Jompan, 2013: 265). The distribution of refractive error in this study was constant with the one conducted in Brčko District.

In North Carolina, USA, a school-based screening programme conducted between 2009 and 2010 showed that of the 106 children who underwent comprehensive eye examination, 22.6% were myopic, 11.3% were hyperopic and only 1,9% were astigmatic (Kemper, Helfrich, Talbot, and Patel, 2012: 24). The study was also supported by another study conducted in 2013 among primary school children in the communities of Concepción and La Florida in Chile which showed that uncorrected visual impairment with both eyes open was present in 12.77% of the children, of which 8.76% had normal vision with best correction (Barria, Conte, Muñoz, Leasher and Silva, 2018: e61).

A study conducted in 2005 in Asuncio, Paraguay, showed that children were hyperopic, and had very low occurrence of myopia. For the Mennonite group and mixed-race groups, myopia was only 1.2% and 1.4 % respectively. The study further showed that similar occurrence of hyperopia was relatively higher at 40.6%, 34.2%, and 46.3% for children of the Mennonite indigenous and mixed-race groups, with astigmatism corresponding with 3.2%, 9.5% and 12.7% respectively (Carter, Lansingh, Schacht, Río del Amo, Scalamogna and France, 2013: 94). Furthermore, the others concluded that the children were mostly hyperopic and free from myopia. The prevalence of myopia in Asuncio was consistent with myopia prevalence of 37.7% (1.5% of the sample) in a study conducted in the rural areas of Paraguay in 2011. However, the hyperopia prevalence of 5.2% (0.2% of the sample) in the rural areas contrasted the findings in Asuncio (Signes-Soler, Hernández-Verdejo, Estrella Lumeras, Tomás Verduras, and Piñero, 2017: 467). However, another study in Brazil, conducted in 2012, showed that the prevalence of hyperopia was higher at 71.8%, and only 2,8% for myopia (Lira, Arieta, Passos, Maziero, Astur, do Espírito-Santo, Bertolani, Pozzi, de Castro, and Alvaro 2017: 29), which was consistent with the findings in Asuncio, even though the prevalence was much higher. In the same Caceres community, the prevalence of refractive error among school children between 2017 and 2018 was found to be low at 8.99%. Refractive error was the main cause of reduced visual acuity among 17.4% of the children that had low visual acuity of 20/30 and below (Thiago, Denise, Miura and Matsuhara, 2019: 37).

2.5 Refractive error in Sub-Saharan African Children.

The researcher found that there was limited refractive error literature for children in Africa, which was also supported by Kawuma and Mayeku (2002: 69). A 2009 study found that refractive error prevalence in school children of Bayelsa State, Nigeria, was low. Only 27 pupils had refractive error, giving a prevalence of 2.2% and was detected in both eyes in 22 school children (Opubiri and Pedro-Egbe, 2012: 129). This is comparable to the study conducted in Abia State of Nigeria, which reported the prevalence of refractive error among school children to be low at 8.0% and the prevalence of myopia was just 2.7% (Atowa, Munsamy and Wajuihian, 2017: a369). Similarly, the occurrence of refractive error was 2.4% among the school children in the rural areas of Malawi, with hypermetropia being the common type of refractive error (1.4%), followed by myopia (0.8%) and astigmatism (0.1%) (Msiska, Njuguna and Kariuki, 2020)

In contrast, the above findings were opposed to those of a study conducted in the same state in 2000, which showed that 57.98% of the school children had refractive error and myopia was found to be having the highest occurrence, followed by hyperopia, while astigmatism was the least prevalent (Kawuma and Mayeku, 2002: 72). Again, between 2011 and 2015, visual impairment was as a result of refractive error among 86.6% of the children with decreased vision in Onitsha, Nigeria, with myopia (46.4%) being the most occurring type of refractive error, which was followed by astigmatism at 36.1% and lastly hyperopia at the prevalence of 17.5% (Ezinne and Mashige, 2018: a455). In Egypt Assiut District, 66.9% school children were diagnosed with significant refractive error of ±0.50, which affected over half of the children. Myopia was the most prevalent type of refractive error (Mohamed, Wasfi, Kotb and Khalek, 2014: 101).

The prevalence of refractive error in the year 2000 was 11.6% among the children of Uhanda, wherein, as opposed to most studies discussed above, the most common refractive error was astigmatism, which was responsible for 52% of refractive error.

Astigmatism was followed by hypermetropia, and lastly myopia (Kawuma and Mayeku, 2002: 72).

In Kenya, a study conducted among primary school pupils aged between 12 and 15 years showed that the prevalence of refractive error was 5.2% around the year 2000 (Muma, Kimani, Kariuki-Wanyoike, Ilako and Njuguna, 2009: 165). In a study conducted in 2000 to determine the prevalence of refractive error in preschool and primary school children in Debark and Kola, North-Western Ethiopia, the results showed that 7.6% of the children had low vision due to refractive error, and myopia was observed to be dorminant with 98% of the children affected (Yared, Belaynew, Destaye, Ayanaw and Zelalem, 2012: 372). Sewunet, Aredo, and Gedefe (2014: 5) conducted a study on children that were attending school in Debre Markos District, North-West Ethiopia, and the results showed that the prevalence of refractive error was 10.2%, with myopia being the most prevalent type of refractive error at 5.47%, followed by hyperopia (1.9%) and astigmatism (1.4%). These findings are comparable to the study that was conducted in Gondar Town, North Ethiopia, where the prevalence of refractive error among school children was reported to be 9.4%, wherein the most prevalent refractive error type was myopia, which accounted for 31.6%, followed by hyperopia at 26.4% and 22.4% for astigmatism (Yared *et al*., 2012: 327). In Ghana, the prevalence of hyperopia, myopia, and astigmatism were 5.0%, 1.7%, and 6.6% respectively (Ovenseri-Ogbomo and Assien, 2010: 86). Also, the most common ocular morbidity was found to be refractive error at a prevalence rate of 26.3% in East District of Ghana in 2014 (Ben, Abdul-Kabir, Victor and Samuel, 2015: 111). In Darnah City, Libya, the prevalence of refractive error in 2017 was found to be 11.6%, with hyperopia (53.2%) being the most common type of refractive error. Astigmatism and myopia followed at 31.7% and 14.9% respectively. Furthermore, the study showed an association between refractive error and the female gender (Elmajri, 2017: 378). In Morocco, the study on refractive error on children showed a low occurance of myopia (6.1%). The hyperopia’s prevalence was found to be 18.3% while the most frequent type of refractive error was astigmatism at 23.5% (Anera, Soler, de la Cruz Cardona, Salas and Ortiz, 2009: 191). A similar trend in the prevalence of refractive error among school children in Fada N'Gourma, Burkina Faso, was observed, with myopia of 2.5%, hyperopia of 17.1% and astigmatism of 18.4% (Jiménez, Soler, Anera, Castro, Pérez and Salas, 2012: 33). A prevalence of 3.1%, 10.4% and 32.5% for hyperopia, myopia and astigmatism respectively, were found among school going children of Malabo, Equatorial Guinea (Soler, Anera, Castro, Jiménez and Jiménez, 2015: 53). The leading cause of visual impairment was uncorrected refractive error among the children attending school in Kenya, which accounted for 62% (Muma and Obonyo, 2020: 1).

2.6 Refractive Error in Children of South Africa

In South Africa, the KwaZulu-Natal Child Eye Care Programme screened 239 606 primary school children from February 2007 to May 2008. Of the 15 944 children that failed the vision screening, 10 707 were examined by optometrists, and 1 083 had refractive error and were provided with corrective lenses (Mahraj, Naidoo, Dabideen and Ramson, 2011: 67). Naidoo *et al.* (2003: 3764) conducted a study in 2002 in Durban, South Africa to assess the prevalence of refractive error and visual impairment in school-aged black African children aged 5-15 years. Reduced vision in 63.6% of the eyes was as a result of refractive error. Myopia was also associated with children aged 14-15 years (with auto-refraction). Hyperopia was found in at least one eye for 1.8% of children when a retinoscopy procedure was performed.

The occurrence of decreased vision was low among black African children, mostly because of refractive error (Naidoo *et al*, 2003: 3764). The study conducted in the Eastern Cape Province, in the rural communities of Motherwell Township, showed that the rate of refractive error among school children was 43.9%, with astigmatism (58.0%) being the most occurring type of refractive error followed by hyperopia at 25.2% and myopia at 18.7% was the least common (Akuta, 2015).

2.7 Refractive Error in Limpopo Province.

In a study conducted by Raliavhegwa and Oduntan (2000: 54), the prevalence of myopia (48.15%) was found to be higher than hyperopia (35.67%). Myopia was found to be more common than hyperopia in males, but higher in females. Also, refractive error in primary school children of Malamulele community was found to be 20.1% in 2015, of which myopia contributed 60.0%, hyperopia followed at 21.4%, and astigmatism at 18.6% (Baloyi, Akinsola and Mabunda, 2018: 142). The study conducted in Sekhukhune District included children from both primary and high schools. Nonetheless, the prevalence of visual impairment was 12.3%, of which refractive error 80% were caused by refractive error, with myopia being the most occurring refractive error type (Magakwe, Xulu-Kasaba and Hansraj, 2020: a551). Based on the above, there seems to be limited rigor in refractive error studies among primary school children in Limpopo Province.

2.8 Refractive Error in Mopani District.

There was limited data on refractive error studies conducted among primary school children in the district of Mopani. In a study conducted to determine the causes, prevalence, and distribution of ocular disorders among rural primary school children in Mopani District Municipality, it was reported that the prevalence of hyperopia, myopia, and astigmatism was 73.1%, 2.5% and 31.3% respectively, with hyperopia being the most prevalent refractive error (Mabaso, Oduntan.and Mpolokeng (2006: 125).

2.9 Factors Associated with Refractive Error

2.9.1 Heredity

Chua, Ikram, Tan, Lee, Ni, Shirong, Gluckman, Chong, Yap, Wong and Ngo (2015: 8101) have reported that the contribution of genetic factors on the early onset of refractive error may be much higher than the environmental factors. As such, the study found a strong association between myopia and the occurrence of myopia in both parents. Although most studies presented in this section show a correlation between myopia and heredity, a meta-analytic study among school-aged children by Castagno, Fassa, Carret, Vilela and Meucci (2014: 17) showed that there was no association between hyperopia and parental refractive error. In contrast, a study conducted in 2012 at the Children's Ophthalmology Outpatients Department of Kauno Klinikos Hospital, Lithuania, showed that there was an association between hyperopia and parental refractive error (Čiumbaraitė and Liutkevičienė, 2017: 83). On the other hand, heredity could be viewed as the primary cause of myopia (Yingyong, 2010: 1289). This was supported by Jiang, Tarczy-Hornoch, Cotter, Matsumura, Mitchell, Rose, Katz, Saw, and Varma (2020: 501), who reported that there is an important role played by the genetic susceptibility in early-onset myopia and that there is also a contribution made by parental myopia to the children's myopic conditions by setting up a baseline that is more myopic before the school age. Similarly, the 1991-1996 Orinda longitudinal study on myopia conducted by Mutti, Mitchell, Moescheberger, Jones and Zadnik, 2002: 3633) in California, USA revealed that heredity was the most essential factor associated with juvenile myopia, with lesser independent contributions from more near work, higher school performance, and less time spent in sports activities (Lanc, Serra and Prista, 2014: 115). In addition, a study conducted in India between 2014 and 2015 indicated that children presenting a positive family history of spectacle use were more likely to have visual impairment (Vishnuprasad *et al.*, 2017: 58). Similarly, a study conducted in Lahore, Pakistan in 2000 showed a strong correlation between a positive family history of wearing glasses and myopia (Ayub, Imran and Saima, 2007: 203). A study conducted in Thailand further corroborates that myopia was positively correlated with parental myopia (Yingyong, 2010: 1288). In addition, a Mexican study of 2014 showed that about 16.1% of the children with myopia had a family history of wearing corrective lenses, and approximately 22.6% of the children were also wearing spectacles.

2.9.2 Position of the Child in the Family

Position of the child in the family simply refers to the birth order, whether the child is a first born, second born, etc. The occurrence of myopia was found to be higher amongst the first-borns as compared to the non-first-born participants in the study conducted in the United Kingdom, Israel, Singapore and Australia, while its risk was low (Odd Ratio < 1.3) among the same group (first-born). The study further showed that the strong association was only seen in the areas wherein the participants were over 4000 (Guggenheim, McMahon, Northstone, Mandel, Kaiserman, Stone, Lin, Saw, Forward, Mackey, Yazar, Young and Williams (2013:375). Similarly, the first-born children were at the highest risk of poor vision among the children in England, Scotland and Wales, and also in Britain (Rudnicka, Owen, Richards, Wadsworth and Strachan, 2008: 1392). It was suggested that the cause for association between myopia and birth order might be due to the effects of investing more educational resources on the first-born than the children that are born later, which then predisposes the children to factors like, near work, that are associated with myopia (Morgan and Cotch, 2013: 333).

2.9.3 The Environment

The environment may include biological or external factors that if exposed to, may affect the refractive status of the child. While heredity may be the primary cause of myopia, the effect of the environment in myopia development remains critical, as shown by the consequences of maternal rubella, certain drugs and prematurity in the development of myopia in the newborn (Verma and Verma 2015:1). The environment plays an important part in the development of myopia (Pan, Ramumurthy and Saw, 2012: 3) and its effects in producing refractive error are further suggested by the significant association of myopia and intellectual achievement (Verma and Verma, 2015). The environment alters the penetration and expressivity of genes, resulting in refractive error (Nelson and Clitsky, 2005). Biologically, it is still unclear how the refractive status is influenced by the environmental factors; however, the effects of the time spent outdoors have been evident in trying to prevent the development or progression of myopia in children (Pan, Ramumurthy and Saw, 2012: 3).

A global and regional meta-analysis study conducted in South-East Asia by Hasemi, Fotuohi, Yekta, Pakzad, Ostadimoghaddam and Khabazkhoob (2018: 3) on the effects of the environment on refractive error, showed that children had the lowest prevalence of myopia, hyperopia and astigmatism; whereas the adults had the highest prevalence worldwide. This indicates that the refractive error occurance among the adult population may have developed over time due to environmental factors (Hasemi *et al.,* 2018: 3). Furthermore, Asian children, especially those from China, have more chances of developing myopia, as opposed to children in the West (Jin, Hua, Jiang, Wu, Yang, Gao, Fang, Pei, Wang, Zhang, Tao and Tao. 2015: 1; Pan *et al*., 2012: 2).

Refractive error was found to be more prevalent among children from urban areas than the rural areas of India (Sheeladevi *et al*., 2018: 495). In support, Sharma *et al*, (2020: e0239117) found that myopia among the school children in Bhutan was associated with urban schools.

2.9.4 Parental Education and Economic Status

The educational and economic status of the parents tend to have an impact on the refractive status of their children. Higher educational levels, higher individual income, professional occupations, and enhanced housing were all significantly associated with higher prevalence of myopia (Wong, Foster, Hee, Ng, Tielsch, Chew, Johnson, and Seah, 2000: 2486). This finding was also supported by the study conducted in Bhutan in 2019, wherein myopia was associated with higher parental education (Sharma *et al.,* 2020: e0239117). In addition, a study by Goh *et al*. (2005: 678) showed that in Malaysia, myopia among school children was associated with the high levels of parents' educational backgrounds. A study conducted in 2000 in Poland showed that hyperopia was significantly higher among children whose parents had attained higher educational levels (Czepita, Mojsa, Ustianowska, Czepita and Lachowicz, 2007: 5). In Malabo, Equatorial Guinea, there were significant differences found in the distribution of the refractive error with a significantly higher prevalence among private school children with higher educational and socio-economic demand (Soler *et al.,* 2015: 53).

A study conducted in California, USA (1991-1996) showed that myopia occurance rose concomitantly with the levels of income and educational level in the family (Mutti *et al*., 2002: 3633). The importance of income and educational level may have resulted from the association with tasks performed at near work, a factor that has been implicated in the development of myopia (Mutti *et al*., 2002: 3638). Still in Southern California, another study conducted between 2008 and 2013 still showed a degree of correlation between higher income of the parents and the prevalence of myopia among school children (Theophanous, Modjtahedi, Batech, Marlin, Luong and Fong, 2016: 1581).

2.9.5 Near Work

Near work, refers to activities like reading, writing, coloring, drawing and computer games that are usually performed at a close range of plus/minus 40cm. In the study conducted by Yingyong (2010: 1288), refractive error among primary school children was significantly associated with time spent on near work tasks. Saw, Chua, Hong, Wu, Chan, Chia, Stone and Tan (2002: 332) also reported a correlation between myopia and extended exposure to reading. In addition, the time that the children spend engaging in activities that require near-work was closely correlated to the refractive error status of the children (Guggenheim *et al.*, 2007: 781). Although the correlation between near work activities and myopia was significant among school children, there was no indication whether the near-work induced myopia or myopic individuals chose to do near-work (Hepsen, Evereklioglu and Bayramlar, 2001: 2511-2).

The study by Ayub, Imran and Saima (2007: 96) also reported an association of refractive error and watching of television (TV) at a very close range, near work tasks like reading and the time spent on computer and video games. This was also supported by Rasheed, Khan and Khan (2010: 125), who reported a strong correlation between refractive error and the time spent on playing video games by school children. Furthermore, the study did not report any correlation between the video game types and refractive error. In North-west Ethiopia, the study showed that children that use computers regularly had an increased chance of 4.5% of being diagnosed with refractive error compared to their counterparts who were irregular or non-users (Sewunet, Aredo and Gedefew, 2014: 5).

2.9.6 Age, Gender and Race

Various studies have shown a nexus between age, gender and race on the one hand; as well as the prevalence and associated factors of hyperopia (Al-Nuaimi, Salama and Elijack 2010: 41; Castagno *et al*., 2014: 17). For instance, a study conducted in Pradesh, India between 1992 and 2000 showed a significant increase in the occurrence of anisometropia, myopia (including high myopia) and astigmatism, with an increase in the children’s age (Krishnaiahi, Srinivas, Khanna and Rao, 2009: 17). Contrastingly, a study conducted from 2011 to 2012 in Tetovo, Macedonia, showed no evidence of association between gender and the occurrence of refractive error (Mahmudi, Mema, Burda, Selimi and Zhugli, 2013: 52).

A study conducted in Paraguay showed higher prevalence rates of hyperopia among female children than males (Carter *et al*., 2013: 94), which was comparable to the findings in Bhutan, in a study conducted in 2019, which showed an association between the female gender and hyperopia (Sharma *et al.,* 2020: e0239117). In 2014, a Mexican study found that myopia prevalence was higher among males than females at 10.3% (Garcia-Lievanos, Sanchez-Gonzalez, Espinosa-Cruz, Lernandez-Flores, Salmeron-Leal and Torres-Rodriguez, 2016: 53). A 2000 Polish study reflected that hyperopia had meaningfully lower prevalence among male children as compared to their female counterparts, and for black children compared to white children (Czepita *et al*., 2007: 5). Still in Poland, another study (2000-2009) conducted among older school children showed that myopia was more associated with female than male school children; whereas with the younger age group, no statistical difference was observed between males and females in the younger-age category (Czepita, Czepita and Safranow, 2019: 1). The study conducted by Anera, Soler, de la Cruz Cardona, Salas and Ortiz (2009: 191) in Morocco, showed no significant differences between refractive error distribution with gender, however, refractive error occurrence was significantly associated with age. In Fada N'Gourma, Burkina Faso, the occurrence of hyperopia and astigmatism were significantly higher among the children of younger age groups (Jiménez *et al*., 2012: 33). In Malabo, Equatorial Guinea, there was evidence of differences in refractive error distribution by age but not by gender among school children (Soler *et al*.2015:53). Similarly, in southern China, the refractive error prevalence, particularly myopia, appeared to be constant with an increase in age, however, hyperopia decreased with age. (Peng *et al.*, 2021:1). Also, older children were found to have significantly lower rates of hyperopia compared to the younger children (Carter *et al.,* 2013: 94)

A study conducted among Irish school children (2006-2008) showed that there was a significant correlation between age and myopia and hyperopia; and hyperopia was seen to decrease with a decrease in age (Theophanous *et al*., 2016: 1581). Furthermore, the study found that hyperopia was also associated with ethnicity; however, there was no correlation with gender (Harrington, Stack, Saunders and O'Dwyer, 2019: 1112).

Additionally, myopia rates of prevalence were 2.8% in younger children, and 17.7% among the older children; and the corresponding rates for hyperopia were 26% and 14.7% respectively (Donoghue, McClelland, Logan, Rudnicka, Owen and Saunders, 2010: 1155).

Kawuma and Mayeku (2002: 72) reflect that in Uganda, significant refractive error was detected among primary school children aged 6 to 9 years in 2000. Meanwhile, in the same year (2000), myopia was mostly detected among 14-15-years old children than those aged 12-13 years in Kenya (Muma et al., 2009: 165). Further afield, a 2012 study in Sydney, Australia showed a strong correlation between myopia and age, with myopia increasing with age (Junghana and Crewther, 2003: 339). Similarly, a 2012 study showed that there were trends towards myopia prevalence with increasing age in a study conducted in Brazil (Lira *et al*., 2017: 29).

In Markos District, Northwest Ethiopia the prevalence of refractive error, particularly myopia increased from less than 2% before 7 or 8 years and reached 20% at 15 years (Sewunet, Aredo, and Gedefew, 2014: 5). In support, the Southern California health plan (2008-2013) in the USA found that older children had higher chances of being myopic than the younger ones (Theophanous *et al*., 2016: 1581). The same study further reported that Asian/Pacific Islander school children had a higher prevalence of myopia, compared to their white counterparts (Theophanous *et al*., 2016: 1581). In addition, in 2012, a European study on the characteristics of refractive error among children found that myopia was mostly associated with the female gender and older age, whereas hyperopia was associated with the younger age and male gender (Čiumbaraitė and Liutkevičienė, 2017:83). Refractive error among the school children of Kenya was associated with older age (Muma and Obonyo, 2020: 1). Msiska, Njuguna and Kariuki (2020) reported that female children were associated with hyperopia whereas the male children were significantly associated with the risk of myopia in the rural areas of Malawi. In Darnah City, Libya, there was a strong correlation between refractive error and the female gender (Elmajri, 2017: 378). In South Africa, the study conducted by Akuta (2015) showed a significant association between hyperopia and the female gender. In India, the refractive error occurance was more prevalent among the female than the male gender, even though the occurrence of hyperopia was higher among the male than the female gender (Sheeladevi *et al*., 2018: 495).

2.10 Early Detection of Refractive Error

Vision screening is a method that could be used to identify school children who experience ocular conditions with the potential to cause visual impairment, thus necessitating referral for appropriate eye examination and treatment by relevant healthcare practitioners (Latorre-Arteaga, Gil-Gonzalez, Bascaran, Nunez, Morales, and Orihuela. 2016: 652). Visual problems always have a significant impact on the physical, intellectual, social and emotional development and wellbeing of the child. Therefore, early detection of vision problems has the potential to provide more opportunity for the child’s good performance in the classroom. Since visual loss may hamper the child’s normal development, the early the detection of visual impairments and enhancement of diagnosis and treatment, the better the correction and improvement of the child's life (State University of New York, 1992). Although screenings can help to identify children with eye disorders, it is still crucial for a comprehensive ocular examination to be conducted in making a proper diagnosis before the commencement of any form of treatment (WHO, 2000).

School health vision screening programmes are of vital importance to inform the epidemiology of the foremost ocular conditions, since they are comparatively easily planned and cost effective (Thiago *et al.,* 2019: 37). A study conducted between 2011 and 2012 in Arad, Romania, recommended computerized examination under cycloplegic refractometry in order to fully detect refractive error during vision screenings (Turcin and Jompan, 2013: 269). In Caceres, Mato Grosso in Brazil, a study conducted among children highlighted the importance of detecting visual changes and the need for preventive measures for eye conditions among school children in order to obtain better results. This was further supported by a study conducted in Turkey (Azizoglu *et al*., 2017).

The occurrence of refractive error in children in the 12 to 15 years age range, in the Makueni Kilungu division, was significantly high to rationalise consistent primary school eye screening in Kenya (Muma *et al.,* 2009: 165). This was further supported by Sethi, Sethi and Iqbal (2009: 114), who suggested mass screening for diagnosing and treating children with refractive error early. Padhye, Khandekar, Dharmadhikari, Dole, Gogate and Deshpande*,* (2009: 69) also recommended vision screening due to a high prevalence of uncorrected refractive error in rural and urban Maharashtra, India. Ayub, Imran and Saima (2007: 96) recommended that adequate preschool examination of the children should be made a mandatory part of the admission policy of all the schools, and that periodic examination of the school children should be done in Pakistan at least on an annual basis. In addition, the program for visual screening of school children has proven to be valuable in the identification and management of refractive error in Thailand, and it was recommended that the program should be developed further (Wangtiraumnuay, Trichaiyaporn, Lueangaram, Surukrattanaskul and Wongkittirux, 2021: 235)

According to the United Kingdom (UK) based National Screening Committee (NSC), screening is a publicly rendered health service to at-risk groups in society who are either facing or are already affected by symptoms of a disease or its advanced manifestation. The particular group/s is/are identified through oral questions or bodily examination to determine relevant treatment and to reduce the further spread or risk of complications (NSC; in Carlton and Czoski-Murray, 2010: 96). In the context of the present study, the purpose of a school vision screening programme is to continuously identify school children with visual impairment problems, with different screening components occurring for each child in the school (Bell, Rodes and Keller, 2013: 241-2). The screening process reveals eye disorders that can be managed in primary care and helps in the discussion of these eye conditions with parents/ guardians and teachers. The ultimate goal of vision screening is basically to detect visual conditions that can be treated and to identify children who require further assessments to the next levels of care for proper management (Bell, Rodes and Keller, 2013: 241-2).

Ferebee (2004) indicated that at 21%, the rates of screening for preschoolers were very low in the United States of America (Ferebee, 2004). Furthermore, the eye test rates for school-age children were low as well, ranging from 5% to 14%. Thirty-nine states, including the District of Columbia (DC), either recommended vision screening subsequent to school entry and occasionally thereafter. However only Kentucky State mandated comprehensive eye examination subsequent to school admission (Lanc, Serra and Prista, 2014: 118). Between 2002 and 2010, Prevent Blindness America’s certified vision screeners conducted eye screening on 18 million children and more, of which about 1.6 million were referred for further examination and management. The majority may have been unidentifiable (Prevent Blindness America, 2010). A prominent study for preschool vision screening noted that the screening and appropriate treatment of school children’s vision is crucial to their wellbeing, and also impacts on their productivity and advancement in society (Kemper, Bruckman and Freed, 2004: 7). In this regard, the USA Preventive Services Task Force recommended eye screening in order to identify amblyopia, strabismus, and thus decrease visual acuity in children of five years and below (Lanc, Serra and Prista, 2014: 118).

The screening of schools in rural communities of South Africa was strongly recommended by Mabaso, Oduntan.and Mpolokeng (2006: 132). These authors further argued that the result of such mediations would improve the children’s quality of life in general, and academic performance in particular. It was further suggested that intervallic screenings should be conducted. However, given that children of primary school-going age and their parents are usually unaware of this problem, they ought to be knowledgeable on refractive error and its signs and symptoms, ocular hygiene and of the risk factors associated with refractive error development; in particular, amblyopia and other eye conditions (Mohammad, Mohammadreza and Mohammadi, 2009; Goh, Abqariyah, Pokharel and Ellwein, 2005: 678). Ovenseri-Ogbomo and Omuemu (2010: 65) recommended that the education department, in partnership with the District Health Directorate, introduces appropriate actions to guarantee obligatory ocular assessment for school children within the Cape Coast Municipality. Kawuma and Mayeku (2002: 72) indicated that it was necessary to conduct routine and easy vision assessment among children commencing their primary school learning for detecting those who might have visual challenges.

In order to prevent visual impairment and blindness, there must be an effective and yet suitable vision screening programme for primary school children (Atowa, Munsamy and Wajuihian, 2017: a369). Ben *et al*, (2015: 114) also recommended more awareness and sensitization by educating the public and incorporating school eye screening into the health education programme. Furthermore, parents must be educated about their children's ocular status. In support, WHO (2007) recommended preventive measures such as ongoing awareness among parents and the community members. These strategies will significantly reduce childhood blindness and visual impairment. The biggest challenge is that most ocular conditions among primary school children go unnoticed. Therefore, it is very crucial to identify these eye problems early for easy management and prevention of complications (Atowa, Munsamy and Wajuihian, 2017: a369). In addition, the primary school children's vision screening programmes should be conducted regularly and in a simple manner at the commencement of the school term. Such screening has the advantage of identifying potential threats to vision early and manage them accordingly (Ravi Sekhar Rao, Krishna and Vasantha, 2016: 25).

A study by Ambika and Nair (2013:6) confirmed that vision testing was a significant aspect of public health and supervision of school children. The purpose of the afore-cited study was to ascertain the awareness of primary school teachers on refractive error and its timely detection among children in primary schools. Periodic eye examination will also assist in evaluating changes in the pattern of ocular morbidity and planning for intervention strategies that will help prevent childhood blindness and visual impairment (Shrestha and Shrestha, 2017: 49).

Clinically, the method for detecting visual problems, particularly in children, is through eye examination by competent eyecare practitioners. This suggests that children would most probably need to visit either the public or private eyecare institutions. However, this is not practically possible, since in most countries, the accessibility to eyecare services is dependent on their socio-economic status (Tielsch *et al*., 1991, in Azizoglu *et al*., 2017).

In this regard, vision screening would therefore be the most crucial method for detecting eye conditions that may result in preventable blindness. For example, a focus-group study with educators, nursing personel and the parents showed that there was inadequate provision of eye care services in the form of school vision screening, ocular examinations and provision of corrective lenses (Kodjebacheva, Maliski, Yu, Oelrich, Coleman, and Decreasing, 2014: 24).

In a study by Ore, Tamir, Stein and Cohen-Dar's (2009: 257) in which the reliability of vision testing by school nurses was examined, three potential screening risks loomed large: lack of screening consistency (the vision changed between the two measurements); lack of screening precision (the testing procedure yielded different results); and lack of objective screening (the nurses had different ways of performing and recording the vision measurements).

A screening test's significance lies in its capacity to distinguish between a diseased and non-diseased state. Such a test ought to preferably have sensitivity, specificity, and positive predictive value at 100%; however, no screening tests exist for vision that contain this accuracy level (Chou, Dana and Bougatsos, 2011: 345). The KwaZulu-Natal Child Eye Care Program detected numerous problems affecting a vision screening programme, including decreased acceptance of the services of refractive error by school children, the unavailability of a proper system of referral and the extreme loss of skilled vision screening officials (Mahraj *et al.,* 2011: 67).

The problems with visual acuity screenings are based on their failure to identify children with reading, hyperopia or even astigmatism challenges (Artini *et al.,* 2018: 215). This view was supported by a study conducted by Bradfield (2010: 1114), which found that uses of visual acuity procedures during screening was not reliable in identifying hyperopia or astigmatism, despite its (screening) effectiveness in identifying myopia with high specificity and sensitivity. Children with significantly high hyperopia (above 5 diopter (D)) and astigmatism (less than 1.5 diopter) could still read the 6/6 (20/20) Snellen equivalent during the visual acuity testing. This is because uncorrected hyperopia can be temporarily accommodated by children, but this capability decreases with an increase in age (Bradfield, 2010: 1114).

The State University of New York State College of Optometry (SSCO) established a course for screening and a programme for education that is used in public schools in New York City (NYC). Different tests were used to screen children. The study concluded that distance vision testing should not be the only focus of vision screenings. If screenings focused on reduced visual acuity at distance alone, about 40% of children with potential ocular conditions like binocular anomalies, hyperopia and other ocular pathological conditions, may remain undetected (Bodack, Chung and Krumholtz, 2010: 477). Therefore, all screening programmes need to be thoroughly analysed using a gold-standard comparison for both the referred children, and at least a fraction of the children who were successful in the screening test (Ore *et al.*, 2009: 258).

Owing to the elevated costs, screening programmes seldom gather assessment and management outcomes from practitioners whom the children are referred to. This causes challenges for the reason that when assessment and management outcomes are not considered by studies, the information regarding the false negatives will absolutely not be accurate (Hartmann, Bradford, Chaplin, Johnson, Kemper, Kim and Marsh-Tootle, 2006: e233-5). Vision screeners often assume that children who have corrective lenses have been appropriately treated. Contrarily, a New York City study by the SSCO found that, when comparing the referral of children who wore eye spectacles with those who did not, children with corrective lenses had a higher referral rate than those without corrective lenses (Bodack *et al*., 2010: 483). Therefore, it might be incorrect to assume that children with corrective lenses have obtained an appropriate ocular examination lately.

2.11 Management of Refractive Error

It is very crucial to correct refractive error early in the child's life in order to prevent the development of amblyopia and tropia at school-going age (Isawumi, Agboola and Ayegoro, 2016: 147). The treatment of refractive error is easy, accessible and inexpensive (Isawumi, Agboola, Ayegoro, 2016: 153). The most commonly used options for correcting refractive error are spectacles, contact lenses and refractive surgery. Spectacles are the easiest, most affordable and mostly used method of correcting refractive error (Vision 2020, 2007; Isawumi, Agboola, Ayegoro, 2016: 153). Contact lenses, on the other hand are advantageous for cosmetic reasons and in societies where there are limitations to using spectacles (Isawumi, Agboola, Ayegoro, 2016: 153). They are most suitable for children with high amounts of refractive error; however, they are not appropriate for all patients or their surroundings (WHO, 2007). The use of spectacles can result in discomfort and less than ideal visual results, especially in those with very high refractive error, whereas contact lens use escalates the risk of corneal complications like ulcerative keratitis (Vision 2020, 2007). Corneal refractive surgery which implicates reshaping the cornea by laser is not a very popular method in the management of refractive error (Vision 2020, 2007).

While most refractive errors are correctable by means of corrective lenses (contact lenses or spectacles), the financial problem of refractive error correction is massive. The vision of all school children with refractive error improved with lenses in the study conducted by Sethi, Sethi and Iqbal (2009: 114). Mabaso, Oduntan.and Mpolokeng (2006: 132) reported that refractive error could be managed effortlessly with corrective lenses; therefore, the unfavorable effect of visual impairment on a child's development and education could be obviated. Meanwhile, Saxena *et al*. (2015: 2) stated that affordability and availability issues still presented a problem for developing countries' capacity to provide spectacles.

However, management of refractive error does not end at the provision of spectacles, but rather on spectacle wear compliance. So, it is very important for parents and teachers and the general public to ensure the compliance of spectacles wear of the children (Pavithra, Hamsa, and Madhukumar, 2014: 150). Kodjebacheva *et al*. (2014: 29) indicate that schools should develop eye care policies that impact positively on children's attitudes towards spectacle wear compliance, which will in turn improve the academic achievement of children with refractive error. In Chile, it was noted that some of the primary reasons for spectacles wear non-compliance included breakage or loss of spectacles in younger children and disliking the appearance in teenagers (von-Bischhoffshausen *et al.*, 2014). Therefore, compliance can also be increased by prescribing appropriate spectacles that are attractive and of good quality (Pavithra, Hamsa, and Madhukumar, 2014: 150). There is also an increased need for awareness and provision of eyecare services in the community in order to improve spectacle wear compliance. Factors like socio-economic and cultural factors attribute to poor spectacle wear compliance (Yamamah *et al.*, 2015: 251).

2.11.1 Overview of Refractive Error Correction

A study on the prevalence and determinants of spectacles non-wear among rural Chinese school children concluded that about 62.3% did not wear proper corrective lenses, despite that half of the rural Chinese secondary schools had the potential of improved vision with corrective lenses (Congdon, Zheng, Sharma, Choi, Song, Zhang, Wang, Zhou, Li, Liu, Liu and Lam, 2008: 1717), it is therefore clear that the prevalence of spectacles non-wear was quite high. Similarly, in urban Chinese school children, approximately half of the children that needed spectacles for the first time did not have them, which is a high proportion (He *et al.,* 2004: 1). This study further suggested that parental education and improved screening programmes may be essential to solve the problem of the need for correcting refractive error in school children.

Among the school children of migrant workers in Shangai, China, the frequency of spectacle wear was 15.50%; however, 26.05% of these spectacles had incorrect prescriptions (He *et al*., 2014: 1). In the study conducted in Turpan, China, even though inadequately corrected and uncorrected refractive errors were the major causes of presenting visual impairment, the spectacles coverage was 39% (Chin, Siong, Chan, Do, Chan and Cheong, 2015: 263). Of the 105 children that had presenting visual impairment and blindness in urban and rural settings of Cambodia, 90.5% could be managed with appropriate optical correction. Unfortunately, 54.7% did not have the necessary optical correction (Gao, Meng, Muecke, Chan, Piseth, Kong, Jnguyenphamh, Dehghan, Selva, Casson and Ang 2012: 16). The use of glasses by children does not only benefit children, but the teacher as well since it is difficult to educate children with visual impairment (Kodjebacheva *et al.*, 2014: 29). Treatment of refractive error by providing spectacles in childhood may promote better eye care as children grow to become adults (Kodjebacheva *et al.*, 2014: 29).

The spectacle wear prevalence was 24% among urban school children that were found to be having refractive error in Delhi, North India (Saxena *et al*., 2015: 1). A study of the prevalence and determinants of spectacles non-wear in rural China showed that 50.1% of children who could potentially benefit from wearing spectacles did not own them. And for the children that owned corrective lenses, 17% were not wearing them at school. More than 50% of the children that needed corrective lenses did not have them in a study conducted in Malaysia (Goh *et al*., 2005: 678). Children with low visual acuity could improve to visual acuity of 6/6 on refraction (Shresthaa and Shresthaa, 2017: 243). Similarly, Alomair et al. (2021: 273) reported that 60% of the children that required correction with spectacles did not have them in the study conducted in 2020 in Riyadh, Saudi Arabia. The same prevalence of spectacles non wear (60%) was reported in the rural community of Saudi Arabia, Dariyah (Alghamdi and Ovenseri-Ogbomo 2021: a579). Similarly, in Nepal, about 57% of the school children diagnosed with refractive error were having spectacles at first presentation (Rai, Thapa, Sharma, Dhakhwa and Karki, 2012: 90). Unsurprisingly, from a higher prevalence of about 87.5% of the children that complied with spectacle wear, an improvement in the childrens' school related activities was reported by the educators. (Pavithra, Hamsa, and Madhukumar, 2014: 148).

There was inadequate information regarding the spectacle utilization rate among school children in the African continent, as the few studies that were conducted were not focused on the African continents (Ezinne, Mashige, Akano, Ilechie and Ekemiri, 2020: a544). Regardless of how easy managing refractive error is by means of spectacles, only less than a quarter of children affected by refractive error had spectacles in Aba, Nigeria (Atowa, Munsamy and Wajuihian, 2017: a369). Similarly, in Onitsha, Nigeria, the rate of spectacle wear was 20.6% among the school children with refractive error, of which the main reasons for spectacle non-wear included disapproval by the parents of the children (Ezinne *et al*., 2020: a544). The spectacle utilization rate was 4.6% in Markos District, Northwest Ethiopia (Sewunet, Aredo and Gedefew, 2014: 5).

Only a limited number of studies that reported on the spectacle wear or refractive error correction among primary school children in South Africa were available. A study that was conducted in South Africa showed that the prevalence of spectacle wear was 31% (149), which included children that either carried or wore spectacles (Congdon, Patel, Esteso, Chikwembani, Webber, Msithini and Ratcliffe, 2008: 13). In the KwaZulu-Natal Province 81% of the children that were diagnosed with refractive error did not wear any corrective lenses due to inadequate provision of eyecare services to primary school children in the area (Naidoo *et al*, 2003). Similarly, the spectacle wear rate among the school-going children of Malamulele community, Limpopo Province, was 5.7% (Baloyi, Akinsola and Mabunda, 2018: 142).

In the study conducted by Mabaso, Oduntan.and Mpolokeng (2006: 125) in Mopani District, none of the children wore spectacles. Poor knowledge of visual challenges and the cost of corrective lenses were thought to be the causes of spectacles non wear.

2.12 Review of the Current Strategies for Managing Refractive Error

The study conducted in Bhutam reported that there was a need for effective school eye health strategies that can be utilized to eliminate refractive error, which is an easily manageable visual impairment cause (Sharma *et al.,* 2020: e0239117). In addition, the study conducted in Sekhukhune District, Limpopo Province, also identified a need for strategies to address visual impairment and refractive error among school children in the area (Magakwe, Xulu-Kasaba and Hansraj, 2020: a551). Most importantly, WHO (2010:14) has emphasised the need for research in order to capitalise on the evidence that is already available, putting more focus on the evaluation, interventions and variety of strategies that are utilised to identify and screen the major or common causes of visual impairment among different groups, which also include the children. Therefore, it was crucial to review the current strategies that are utilised to identify and manage refractive error in South Africa, particularly in Mopani District, in line with the WHO recommendation above. In trying to address the major challenge of childhood blindness, WHO (2007) recommends preventive measures such as ongoing awareness among parents and the community members. One of the preventive strategies of visual impairment and blindness rests on the promotion of school health programmes, with a deliberate focus on the following guidelines by WHO (2007):

- the diagnosis and treatment of common conditions, including refractive errors, and trachoma and Vitamin A deficiency in endemic areas;
- the promotion of a healthy environment;
- children’s eyecare education should be incorporated into the school curriculum; and
- in areas where the prevalence of refractive error is above 2% amongst school children between 11 and 15 years of age, simple vision screenings and spectacles should form part of the health programme in schools.

2.12.1 The School Health Programme

The role of school health services across the world has been significant in contributing to the health of the school children, as well as their educational status (Bundy, 2011). As a result, all countries, including South Africa, have made school health services a priority. The main focus of the school health program includes addressing health issues that act as barriers for children to enter school, particularly at the appropriate age and ensuring their stay until they complete. In addition, it addresses health issues that may increase the absenteeism of learners and improve on performance of children by reducing health-related learning barriers (Bundy, 2011). South Africa, as a developing country, has about 50% of children living in disadvantaged provinces, which are also noted to be rural provinces (South African Child Review, 2013). These provinces include Limpopo, KwaZulu-Natal and Eastern Cape, and as a result, the socio-economic impact on the children may be seen to take its toll in the health and education of the children and the ultimate distribution of and access to health.

2.12.2 The National Health Policy and The Integrated School Health Policy.

The National School Health Policy was developed in 2003 to address amongst other challenges, the inequalities faced by the South African children regarding the provision and access to school health and health services. However, the evaluation of the policy performance showed that the school health service was less prioritised and resulted in unsatisfactory universal coverage. In addition, it was reported that the school health services did not have adequate managerial support and resources (Shung-King, 2012). This led to the development of the Integrated School Health Policy in 2012. The ISHP ensured that there is an increase in the number of school health screening assessments. These were further extended from grade 1 to other grades. However, this seemed contrary to the trends that are observed internationally, wherein the screening services are reduced in order to ensure a stronger health promotion and education (Shung-Kingi, Orgilli and Slemming, 2014: 69). The ISHP emphasised the importance of strong collaboration amongst the departments of Basic Education, Health and Social Development as the key role-players in ensuring that the services reach all schools and all learners (Departments of Health and Basic Education, 2012). Furthermore, the policy focused on ensuring that the focus is not only screening, but also the provision of additional or specialised services may be required by children that have health problems. These services would include optometry services that can be provided in the form of mobile clinics or in the hospital facilities. The school health package of services incorporates Health education and Promotion, and Learner Assessment and Screening.

Health Education and Promotion

Health education which is a key component of the ISHP is included in the school curriculum. The Life Orientation Learning Area ensures the provision of health education to learners and is a compulsory component of the curriculum at primary school level

(UWC 2006). However, issues covered by this learning area exclude eyecare education. The policy has therefore missed on an opportunity to incorporate refractive error in the school curriculum as recommended by WHO. As a result, the learners and educators do not have an opportunity to gain knowledge about refractive error in the classroom. Yasmini, Minto and Chan (2015: 14) explained that health education is critical in vision school health as it increases awareness among the educators and the children and ensures the reduction of the impact of ocular diseases.

Learner Assessment and Screening

The ISHP provides that assessments of the children should be done to all learners once during each educational phase. In the context of primary schools, vision assessments are focused on all grades 1 and 4, however, it is further provided for that further assessment can be provided to all learners that repeat grades, identified by the educator, parent or self-referral. It is on the basis of this provision that the researcher acknowledges exclusion of eyecare education as a gap, as learners and educators may not be knowledgeable enough to identify eye problems, particularly refractive error, in order to refer or self-refer for additional assessment as provided for in the ISHP (Departments of Health and Basic Education, 2012). Therefore, all children that may have not been assessed or missed in both grades 1 and 4 run the risk of suffering from unidentified and uncorrected refractive error while in grades 2, 3, 5, 6 and 7. This may result in a serious impact on the academic performance of the learner.

2.12.3 Implementation of the ISHP in Mopani District

Although the DOH, DBE and DSD are the main role players in the implementation of the policy, intersectoral collaboration remains key in the success of school health programs. This may include other departments, private sector community involvement amongst others. The ISHP implementation mainly focuses on conducting grade 1 health assessments at primary school level (Shung-Kingi, Orgilli and Slemming, 2014: 66-7).

Challenges like staffing and resources have been seen to impact on the implementation of the ISHP due to the additional service health package in the policy. It was therefore recommended that the addition of these services in the service health package should be done carefully due to issues related to staffing. This is supported by the fact that, in most cases, professional nurses are responsible for conducting school health screenings. Other recommendations have included involvement of educators in some of the ISHP activities. These may include the early identification of health problems among learners and monitoring the referral of learners.

The School Vision Program in Mopani District

School-based eye health programs have been identified as an effective way to ensure the early detection, prevention and treatment of common ocular conditions. Refractive error in children can be effectively addressed by early detection and treatment (School Health Integrated Programming, 2020). Shung-Kingi, Orgilli and Slemming (2014: 65) recognised three models of school health services that are currently implemented internationally, which include a school health service that is placed at the school and managed by a nurse, an outreach service that conducts visits and screenings periodically and the last one being school health services that are conducted by trained teachers at the school. In addition, Mopani district has adopted the outreach service model for school health services, the use of trained educators has been seen to yield fruits in some countries in the early identification of refractive error (Latorre-Arteaga *et al*, 2016: 652).

Gaps identified in the Mopani School Health Vision Screening Program.

The current school vision program of the ISHP in the district of Mopani has focused on vision assessment of grade 1 learners. Due to the availability of Optometrists in the hospitals, the District Department of Health has collaborated with the hospitals to form a school health care team, which comprises of the Allied Health Team and PHC professional nurses. The Allied Health Team comprises of Dieticians, Occupation Therapists and Optometrists. The Optometrists are responsible for the provision of vision screening in the district. The main challenge is that the optometrists are not able to cover all schools covered by the PHC team, due to the current number of optometrists. Each hospital in the district only allocates 3 – 4 days for school vision screening monthly, while different PHC teams may cater for more schools in a month. Therefore, although the current school vision program, focuses on grade 1 only, it is unable to cater for all schools in the district. This implies that more schools remain unattended. As a result, when a child misses the opportunity to be screened in grade 1, they may not get another opportunity, and more children with refractive error may remain unidentified.

While the current vision screening program in the Mopani District provides for the prevalence of eye conditions, the same cannot be said about responding to the detected eye conditions, particularly refractive error. Currently, children who are screened are referred to hospitals, however, the available information on vision screening does not provide details pertaining to the further management of refractive error by the attending hospital. The same observation was made by Shung-King (2012). Therefore, there is no appropriate record of how many children were identified through the school vision screening that were provided with appropriate spectacles. It is therefore safe to conclude that the focus of the current vision screening program is the identification of vision problems than the management thereof, which clearly shows the lack of follow ups and appropriate monitoring of the referral system. In actual fact, the data relating to the prevalence of refractive error for children that are assessed by optometrists is kept at hospital level. This shows some level of inadequate reporting to the district and poor coordination between the district and the optometry clinics at hospital level, which are responsible for school vision screening. There is a serious demand strategy development to ensure the enhancement of both the detection and management of refractive error in the Mopani District. These strategies should also incorporate coordination and monitoring of the school vision program in the district of Mopani. It is for this reason that this study sought to propose strategies to enhance the early detection of refractive error in Mopani District.

2.13 Educators' Experiences and Perceptions on Refractive Error

The overall knowledge of refractive error in children, including its symptoms, management and impact is critical for educators. The refractive error knowledge assists the educators to accurately identify children with refractive error (Gupta, Gupta, Chauhan and Bhardwaj, 2009:133; Ambika and Nair, Nisha, 2013: 7) and to follow appropriate referral procedures. Furthermore, the educators play a crucial role in encouraging the children to acquire spectacles and also wear them for academic activities (Shukla, Vashist, Singh, Gupta, Gupta, Wadhwani, Bharadwaj and Arora 2018: 937). Educators also facilitate the development of school policies that positively influence the children's attitudes towards refractive error as a condition, the children that are affected by refractive error and their academic performance (Kodjebacheva *et al.*, 2014: 29). This may further be influenced by the educator's experience with children that suffer from refractive error, for example, educators that have children whose academic performance improved after refractive error correction are more likely to encourage the use of spectacles by the learners.

In a descriptive study that was conducted to examine the refractive error awareness of educators and the methods of detecting refractive error, it was reported that 80% of the educators had adequate awareness of the condition with no previous experience of identifying the condition thereof (Ambika & Nair, Nisha, 2013: 8). However, a study conducted among educators in rural China showed that disparities in the educators' understanding of spectacles and children's vision. The educators believed that spectacles have the potential to cause harm and should be avoided by children, furthermore, spectacles may result in reduction of uncorrected visual acuity overtime (Wang, Ma, Hu, Jin, Xiao, Ming, Yi, Ma, Wang, Varga, Huang, Rozelle and Congdon, 2019:179), although the study on safety of spectacles could not find any evidence that spectacles cause reduction in uncorrected vision (Ma, Congdon, Yi, Zhou, Pang, Meltzer, Shi, He, Liu and Rozelle, 2015: 897). In addition, in North India, the educators' reported symptoms of eye problems were mostly blurred vision when looking at the chalkboard, squinting of eyes and holding the books very close to the face (Gupta *et al*., 2009: 133), however, the educators were unaware of the other refractive error symptoms like failure to keep text within the lines while writing, headaches, etc. During a focus group discussion regarding the barriers to spectacle wear among primary school children, it was reported that educators have inadequate information on the need for children to utilise spectacles, and consequently the daily monitoring process of children's spectacle wear by educators becomes poor (Kodjebacheva *et al*., 2014: 29).

Although some countries like India have trained educators of refractive error in children, and the identification or screening of the children (Mettla, Keeffe, Yameneni, Khanna, Rao, Marmamula, and Pehere, 2018), the South African educators do not receive any training on refractive error. It will be interesting to find out their perception of refractive error, and whether they have noted the existence of refractive error among the children and their involvement in resolving the effect of refractive error on children. Although studies have shown how refractive error can affect academic tasks like reading and writing, there was limited rigor on the educators' experiences of the effects of refractive error on teaching and learning in South Africa, particularly in Mopani District. In addition, Wedner, Ross, Balira, Kajic and Fostera (2000) reported that, as opposed to blindness, there are no data of the visual impairment impact on the school performance of children in the context of rural African villages. It is therefore critical that the educators demonstrate the challenges that uncorrected refractive error brings to both the learners and educators with regards to teaching and learning.

2.14 Conclusion

This chapter discussed the dominant issues on visual impairment and blindness, as well as refractive error issues emerging from the reviewed literature. Consonant with the research topic, there was more emphasis on the state of vision and blindness among school children globally, in Sub-Saharan Africa, and in Limpopo Province. The discussion on refractive error in children included the different types, the prevalence, and the various treatment options. Furthermore, issues with regards to the importance of vision screening and its challenges were outlined. The following chapter (Chapter 3) specifically focuses on the theoretical grounding of the study.

CHAPTER THREE: THEORETICAL FRAMEWORKS

3.1 Introduction

The previous chapter's thrust was on the core aspects and contexts of children's eyecare conditions and challenges in general, with emphasis on refractive error as obtained from multiple perspectives and studies worldwide and locally. The thrust of the current chapter is on the theoretical framework or grounding of the study. As such, Swanson (2013: 1) illuminates that the theoretical framework relates to "the structure that can hold or support a theory of a research study. It introduces and describes the theory that explains why the research problem under study exists". In this regard, the theoretical framework or grounding relates to the centralisation of the investigated phenomenon and its core variables in accordance with an identified theory and its philosophical perspectives or assumptions (LoBiondo-Wood and Haber, 2010; Ramenyi and Bannister, 2013). It is to be noted further that those theoretical frameworks provide philosophically interconnected concepts, principles and paradigms for the purpose of explaining, describing or predicting the occurrence of an investigated phenomenon (e.g., refractive error in children), or the nature of reality and ideas emanating from such a reality (Kumar, 2014). In addition, the theoretical framework/ grounding of the study is helpful in providing a philosophical context of the data collection and analysis processes. In the context of this study, triangulation of frameworks was used, wherein the PPM was viewed by the researcher as providing the relevant philosophical grounding for the investigated phenomenon of refractive error among children. In addition, the Activity Analysis and Development framework and Diffusion of Innovations Theory (DIT) were used to address the limitations of the PPM in this study.

3.2 Theoretical Framework

3.2.1 Precede Proceed Model

Lawrence Green first developed Precede in 1974 and in 1991, Green and Kreuter added Proceed (Porter, 2016). In 1974, Lawrence Green developed the model as a framework for evaluation (Green, 1974), this was later followed by the addition of Proceed by Green and Kreuter to the Precede model to form the full framework of the PPM (Green and Kreuter, 1991). Precede stands for the following phases: Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation. The goal for these phases is to map diagnosis and planning. It therefore provides guidance for socio-ecological assessment and planning. On the other hand, Proceed, encompasses Policy, Regulatory and Organisational Constructs in Educational and Environmental Development. The framework that the PPM provides comprises of eight different phases and is meant to assist in the determination, development, implementation and evaluation of health promotion programmes, and the application of health promotion theories that are in these programmes (Green and Kreuter, 2005). The model does not aim to describe the relationship that exists among various factors assumed to be associated with the possible outcome. Instead, its primary aim is to give a structure for the application of theories in order to ensure appropriate planning and evaluation of programmes of health behaviour change (Gielen, McDonald, Gary, *et al*., 2008, In Glanz, Rimer and Lewis).

The researcher has paid attention to the concerns raised by other authors with regards to the practical limitation of the PPM. The limitations included cost and time required to ensure the complete and practical application of the model in reality, and lack of detailed guidance for each step of the model, however, the authors of the model have advised that the model can be applied in parts to minimise the identified limitations (MacDonald and Mullett, 2009: 165; Sharma and Romas, 2012: 48). In support of the limitation, Crosby and Noar (2011: S15) indicated that achieving health prevention through the PPM may not be easy as the processes require adequate resources, however, such efforts can be beneficial in the long term.

Despite the limitations identified above, the model is still one of the frequently used approaches in health promotion (Porter, 2016: 753). The PPM was used as the conceptual framework of the program in a study to evaluate a long-term on-going international academic service-learning intervention, wherein the model's assessment, diagnosis, implementation, and evaluation phases assisted in the identification of major target areas and to design a five-day intervention (Colodny, Miller and Faralli, 2015: 127). Barasheh, Shakerinejad, Nouhjah and Haghighizadeh (2017: S 59-65) used the PPM to evaluate the efficacy of an educational program in training type 2 diabetic patients. The study focused on the improvement of the predisposing, enabling and reinforcing factors and the participants' selfcare behaviour.

3.2.2 Precede Phases

The Precede phase has four stages/phases of assessment and planning that provide guidance to ensure that the health partners appropriately decide on what problem needs to be addressed. This will be followed by a thorough examination of the underlying causes of the selected problem for the purpose of planning for a suitable intervention by the health promotion partners (Green and Kreuter, 2005: 31).

Phase 1

Phase 1 is the social assessment and situation analysis, which ensures that critical areas that require health promotion are identified and assessed. This can be achieved by community involvement in the diagnosis process, which can be both objective and subjective (Green and Kreuter, 2005: 31). The information that assists in community diagnosis should be acquired from multiple sources, of which the goal is to ensure identification of the community's priorities for improving the quality of lives. The authors of the model suggested that these priorities are very relevant, same as the health needs that can be identified in the second phase of the model (Green and Kreuter, 2005: 38, 40). The planner of the program should start by identifying a health issue that in his/her opinion, affects the quality of life (Crosby and Noar, 2011: S9).

Phase 2

This phase includes epidemiological diagnosis that focuses on measurable factors that have the potential to affect the health of the population and quality of life (Sharma and Romas 2008). In the context of this study, these measurable factors affect the vision of the children, their education and career, and ultimately the quality of life. As the critical indicators of physical health can be assessed with reference to their incidence, intensity, distribution, duration, and prevalence (Green and Kreuter 2005), the goal of this phase was to understand the extent and type of the determinants of health in a particular community, and their ultimate effect on the health and behaviours of the population (Sharma and Romas 2008, Green and Kreuter 2005).

Phase 3

Phase 3 aims at the identification of factors that influence the epidemiological profile that may have been identified in the second phase of the model (Green and Kreuter 2005). These factors have been categorised into predisposing, reinforcing, and enabling factors as discussed below. Predisposing factors comprise of the individual’s attitude, beliefs, values, perceptions and knowledge (Green and Kreuter 2005). On the other hand, enabling factors may refer to skills and resources that are essential to make preferred change of behaviour and the environment. With regards to reinforcing factors, the performance of health behaviors is linked with rewards and feedback, that is, whether the actor obtains a negative or positive feedback (Green and Kreuter, 2005: 167).

Phase 4

In Phase 4, the phases focus on designing the plan to ensure the achievement of the set objectives, selecting intervention strategies that ensure success in attaining all objectives. The designed plan must be within the capacity of the program planner and the team (Green and Kreuter, 2005).

3.2.3. Proceed Phase

Proceed comprises of implementation and evaluation phases, and its goal is to ensure the availability, accessibility, accountability, and acceptability of the programme (Green and Kreuter, 2005: 245)

Phases 5-8

Phase 5 is implementation and involves administrative and policy diagnosis, where administrative processes are extensively reviewed together with all the relevant policies that concern the issues being assessed. This assists in ensuring that the planned interventions do not deviate from the existing administrative processes and policies (Green and Kreuter, 2005). The last three phases, 6-8, focus on three phases of evaluation that include the process, impact and outcome evaluations of the developed/planned interventions (Green and Kreuter, 2005).

3.4. Triangulation of Frameworks

To address the concerns related to practical limitation of the PPM highlighted above, the researcher has used triangulation of frameworks to enhance the innovative research designs by integrating the quantitative and qualitative approaches. Activity Analysis and Development framework and DIT were used to mitigate for the limitations of the PPM.

3.4.1 Activity Analysis and Development Framework.

Activity analysis and development (ActAD) framework, which is based on the Activity theory, was applied to integrate the qualitative and quantitative data that was collected and analysed separately by the researcher. The primary focus in the ActAD framework is on work processes by individuals that are performing a specific activity collectively, who ensure proper flow of information or communication during the activity. It is therefore important that communication of the information creates a common understanding among the actors about their work process, which includes the different roles of individuals, procedures, relevant tools, knowledge, policies, guidelines and skills amongst others (Mursu, Luukkonen, Toivanen and Korpela, 2007). Thus, each actor should have a clear purpose, tools, and rules while executing their allocated tasks in order to attain the intended outcome (Korpela, Mursu, Soriyan, Eerola, Hakkinen and Toivanen, 2004. In: Kaplan, Truex, Wastell, Wood-Harper and DeGross).

3.4.2 Diffusion of Innovation Theory

In addition to the above, the researcher employed the DIT (Rogers, 2013) to propose the strategies that may enhance the identification and management of refractive error in Mopani. The DIT, which was developed by Rogers E.M in 1962, explains how an idea or a product diffuses or spreads into a population over a different period, which simply refers to adoption of such a new idea or behaviour. Adoption of a behaviour or new idea refers to a process wherein some individuals are more likely to adopt a new idea or behaviour than others, which is determined mainly by certain characteristics of the respective individuals or population. This makes it more crucial for the researcher to have a better understanding of the population of Mopani District, and not limited to the target population. The researcher utilised four of the five main factors that influence adoption of an innovation as described in the theory to propose the strategies. Literature review and the study findings provided more insight to the overall development of the strategies.

3.5. Conceptual Framework

The structure of this study was presented within the context of the four phases of the Precede Phase of the model as discussed above and as presented in figure 3.1. In addition, the triangulation of frameworks was used by the researcher to reduce the limitations of the PPM.

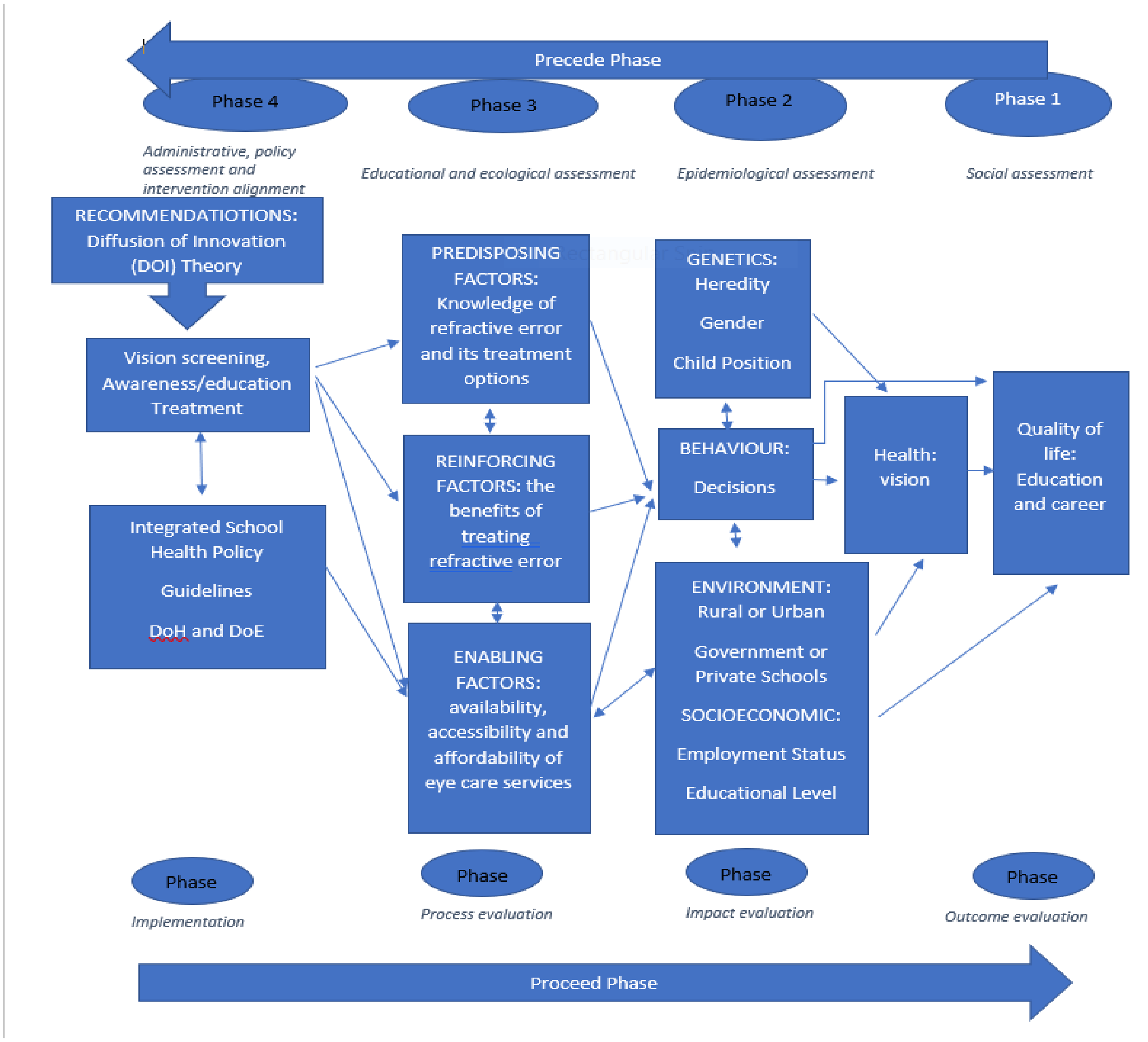

Figure 0.1 Precede Proceed Model adopted from Green and Kreuter (2005)

3.5.1 Phase 1

Phase 1 of the Precede Phase was relevant to this study as it assisted in the social diagnosis of the community in relation to refractive error in children. Social factors which included the education and economic status of the community have a potential effect on the refractive status of children. Therefore, demographic data collection of the children and the parents in the form of a questionnaire from the parents/guardians has assisted the researcher to explore the social diagnosis in detail. Phase 1 of the Precede Phase thus assisted in exploring data related to the risk factors of refractive error as discussed in chapter 2 of the study and to understand the association of these risk factors with refractive error in children during data analysis.

3.5.2 Phase 2

This epidemiological assessment phase was found to be critical in the attainment of objective 1 of the study, which was to determine the extent of refractive error in children. Therefore, the actual examination of the children's eyes was done by the researcher to determine the refractive status of the children as discussed in chapter 4 (data collection). This provided the prevalence of refractive error and the distribution of the different types of refractive error among the children in Mopani District. Other critical information like the child's ocular history, and that of the family, were collected through the questionnaire as detailed in chapter 3 of this study. This phase further explored the association of hereditary, environmental, socio-economic, behavioural and genetic factors with the prevalence of refractive error. As a result, community diagnosis was achieved through data analysis in chapter 5.

In addition, the researcher used the ActAD framework to integrate the quantitative and qualitative data sets during data discussion in chapter 6. It was assumed that identification and management of refractive error in children in the context of Mopani District is a work activity, which involves identification of symptoms of refractive error at different levels by different actors. These actors may include parents/guardians, educators, and healthcare practitioners. The action performed by the different actors on the subject (child) should be informed by their goal to achieve the intended outcome of the group (parents/guardians, educators, and healthcare practitioners). The frame further provides that information should flow amongst the actors in the activity as they share the same object (child) and motive. The researcher collected quantitative data about the subject from the actors (parents and guardians) and qualitative data from the actors (educators) regarding the subject, and in this chapter the two sets will be integrated by using the ActAD framework which elaborates the importance of information flow in the activity. This integration and interpretation of the two sets of data (qualitative and quantitative) by applying the ActAD framework as a theoretical enhanced the understanding of refractive error among primary school children in Mopani District.

3.5.3 Phase 3

Phase 3 was critical in ensuring that the researcher understands the factors that affect the occurrence, detection and management of refractive error in the community in a broader context. This was achieved by categorising the factors into predisposing, reinforcing, and enabling factors as discussed below.

Predisposing factors: A better understanding of refractive error with regards to its effect on the child, symptoms, and treatment would put the parents/guardians and the educators in a better position to identify the eye problem and seek the services of an eyecare practitioner timeously. This was supported by Mabaso, Oduntan.and Mpolokeng (2006: 132) who were of the idea that lack of knowledge by the parents of the children may have contributed to the spectacle non wear. It is important to note that the prescription of spectacles remains the most affordable and effective method of treating refractive error and prevention of avoidable blindness. In addition, an increased need for awareness of eyecare services in the community to improve spectacle wear compliance was reported by Yamamah *et at.*, 2015: 246. Therefore, during qualitative data collection from the educators as discussed in chapter 4, the experience and knowledge of refractive error and the treatment options were assessed, as the educators were identified to play a key role in the identification of refractive error in the classroom.

Enabling factors

The relevance of the enabling factors for the purpose of this study was attributed to resources and skills that are required to address the refractive error challenge among primary school children. In this study, these factors included availability, accessibility and affordability of the eyecare services, which directly affect the identification and management of this condition. In addition, factors such as affordability and availability of eyecare services have a direct impact on eyecare services (Ntsoane and Oduntan 2010:183).For example, availability of healthcare workers, which include optometrists and nurses, to ensure the identification of children that have refractive error by means of vision screening has remained a challenge. In the KwaZulu Natal Province of South Africa one of the challenges of vision screening included the extreme lack of skilled vision screening officials (Mahraj *et al.,* 2011: 67), which supports the challenges relating to the availability of skills and resources as an enabling factor. Currently in Mopani District Municipality, the required skills to detect refractive error in children only lie with the Health Practitioners. However, periodic eye examinations assist in evaluating changes in the pattern of ocular morbidity and planning for intervention strategies that will help prevent childhood blindness and visual impairment (Shrestha and Shrestha, 2017). This study has reviewed the current strategies used to manage refractive error among children in chapter 2 of this study. Furthermore, during qualitative data collection from the educators, the educators provided data regarding their experiences in teaching children that suffer from eye problems. Other enabling factors included failure by the children to consult with health care practitioners and accessibility, availability and affordability of the eye care services. Therefore, data related to the ocular history of the child, with more emphasis on previous ocular examination, reasons for ocular examination and spectacle wear history were collected from the parents through a quantitative data collection in the form of a questionnaire. And lastly, data relating to the socio-economic status of the parents/guardians of the children were assessed as discussed in chapter 4.

Reinforcing factors were addressed in chapter 4 of this study, wherein the researcher collected data to assess the prevalence of spectacles wear and history of eye test, particularly among the children that required visual correction. In addition, the underlying factors that influenced the decision for eye examination and wearing of spectacles were not fully explored by the study. The findings regarding the decision to have the children's eyes examined or to wear spectacles might be influenced by the ultimate feedback or results of taking such decisions. For example, children with poor vision who receive visual correction may improve in their academic performance resulting in educators motivating for eye examination and treatment sessions for children with eye problems.

3.5.4 Phase 4

After data analysis and discussion in chapters 5 and 6 as discussed in phases 1-3 above, phase 4 in this study, focused on the proposal of strategies that will assist in the early detection and management of refractive error. These strategies were proposed and discussed in chapter 7 of the study. However, to enhance the development of these strategies, triangulation of theoretical frameworks was used as discussed above, where the researcher made use of the DIT to propose these strategies based on the study findings. The researcher has applied three main factors of the theory which influence the adoption of an innovation to propose the strategies. Therefore, each strategy briefly described its relative advantage, compatibility triability and observability as described in the theory. These strategies will ensure the adaptation of the existing WHO strategies for early identification of refractive error among school children and management of such refractive errors and also the full implementation of the Integrated School Health Policy.

In addition, it was critical to review policies that related to school health to ensure that the proposed strategies were aligned to the relevant policies as recommended in phase 4 of the precede phase. In addition, proper assessment of current programs for school health in Mopani District Municipality were assisted in the identification of critical areas that required improvement for the purpose of proposing appropriate strategies. These strategies sought to address, among others, accessibility, availability, and affordability of eye care services at home and at the schools' health facilities with the main focus of ensuring early identification, examination, and management of refractive error in Mopani District.

3.5.5 Proceed Phase

Although this study did not implement the proposed strategies, phase 5 of the Proceed phase assisted the researcher in recommending strategies that addressed factors related to administration and policy as discussed below. In this study, the main focus of this phase was to identify the policies, resources, and circumstances within Mopani District Municipality that could enable or hamper the appropriate management of refractive error in children. Furthermore, it has assisted in the assessment of the availability of human resources (healthcare practitioners), equipment and assistive devices to ensure that the proposed strategies and programmes proceed accordingly, and also that plans are made to address challenges that were identified or anticipated (Ransdell, 2001: 278). This phase was critical in the proposal of the strategies in this study, however, the actual implementation of the proposed strategies did not form part of the scope of this study.

3.6 Conclusion

This chapter has described the theoretical and conceptual framework of the study. The researcher has used the PPM to explain community diagnosis of refractive error in Mopani District Municipality in the context of refractive error in children. Therefore, the three phases of the Precede phase were used to understand the extent of refractive error and its risk factors by the review of literature in chapter 2, collection of qualitative and quantitative data as described in chapter 4 and presentation of the study findings in chapter 5. Due to the gaps identified in the PPM, the researcher used triangulation of frameworks to close these gaps. As such, ActAD framework was used as a lens to synthesise qualitative and quantitative data sets in chapter 6 of the study. In addition, during phase 4 of the precede phase, proposal strategies were developed using DIT. These strategies were discussed in chapter 7 of the study. The following chapter discusses the research methodology of this study.

CHAPTER FOUR: RESEARCH DESIGN AND METHODS

4.1 Introduction

This chapter discusses the literature-based research design and methods, the study setting and its sampling imperatives, the data collection and analysis processes, as well as the measures of trustworthiness and ethical considerations attendant to the study. In this regard, the chapter presents and discusses the pre-empirical phase of the study according to which the eventual practical evidence of the study was obtained (Edmonds and Kennedy, 2012). From the perspective of this study, the terms 'research design' and 'research methods' are not viewed as synonyms, but viewed as two separate, but complementary concepts. The researcher has applied the first and second phase of the PPM as a framework for this chapter as described in chapter 3.

4.2 Pragmatic Worldview

Worldview refers to "*a basic set of beliefs that guide action"* (Guba, 1990: 17) A paradigm is a shared belief system that influences the types of knowledge researchers seek to obtain and how they interpret any research evidence they may collect (Morgan, 2007: 49). A worldview can be seen as a general philosophical orientation about the world and the nature of research that a researcher brings to a study. In this study, Pragmatism was selected as a world view.

The researcher has selected Pragmatism as a world view because it does not focus on one system of philosophy and reality, as a result, the researcher drew assumptions from both the qualitative and quantitative approaches (Creswell, 2013). Pragmatism provided the researcher with freedom to select the appropriate methods and techniques for achieving the research objectives. Creswell (2013) suggested that pragmatism creates an opportunity to utilise numerous methods, different assumptions and worldviews, and different methods for collecting and analysing data, which is appropriate in mixed methods research. Pragmatism assisted the researcher in this study as it provided a substitute that encompassed a positivist and constructivist world view and the research questions that informed the use of qualitative and/or quantitative research methods (Teddlie and Tashakkori, 2009), therefore providing a combination of quantitative and qualitative methods. To connect the theory of the study to data, pragmatism uses abduction, which has proven to be mostly beneficial for integrating the qualitative and quantitative results for this study, as mixed methods were employed. Furthermore, pragmatism assisted the researcher in ensuring that the subjective and objective inquiries were balanced during the entire study (Shannon-Baker, 2016). As the researcher employed the mixed method approach for the study, and pragmatism was the most appropriate paradigm for mixed method, the researcher was able to collect data relating to refractive error of the school children and also explore the experiences and knowledge of refractive error from the educators, allowing the researcher to have a broader understanding of the research problem.

4.3 Study Design

In concurrence with Rani (2016:1-2), Creswell (2013) describes research design as the overall or totality of plans and procedures for guiding research, spanning from broad philosophical or theoretical assumptions to detailed methods of data collection, analysis, and interpretation. Research designs are the types of enquiries within the quantitative and qualitative approach that provide specific direction for procedures in research designs. Based on the contention of authors such as Creswell (2013), Rani (2016) and many others, it is then clear that the term ‘research design’ specifically relates to the *processes*, whereas ‘research methods’ emphasizes the nature and context of the specific instrumentation or tools used for data collection. Research designs are essentially qualitative, quantitative, or mixed (triangulated) in their nature and functions (Kumar. 2014). In the context of this study, the mixed-methods (triangulation) research design was opted for.

The mixed-methods research design basically relates to an approach to inquiry which integrates and triangulates the direction of the collection of both quantitative and qualitative data, each with its philosophical assumptions and theoretical frameworks

(Madrigal and McClain, 2012). Mixed methods research provides the means to compensate for the identifiable weaknesses of both quantitative and qualitative research (Edmonds and Kennedy, 2012). Moreover, the mixed methods design (triangulation) allows for the optimization of more evidence when studying a research problem than either quantitative or qualitative research alone, furthermore; in this regard, all the available tools for collecting data can be used rather than being strictly limited to either quantitative or qualitative research tools (Creswell and Plano-Clark, 2018; Madrigal and McClain, 2012). The optimization or maximation of mixed methods affords the researcher the opportunity to better understand the nature of a research problem, compared to the use of just one of the two approaches (Creswell, 2013; Walliman, 2015). Accordingly, the mixed-methods approach selected for this study aims to validate both the quantitative and qualitative findings regarding refractive error and the experiences of educators with children that suffer from refractive error. The study comprised of three stages, wherein stages 1 and 2 were quantitative and qualitative strands and stage 3 was the integration of the data collected using the two strands. Mixed methods design was used to collect, analyse and triangulate quantitative and qualitative data. Table 4. 1 below shows the overview of the study.

Table 0.1 Stages, objectives and methos of the study

Stage 1

Objective 1: To determine the extent of refractive error among the primary school children in Mopani District.

Objective 2: To assess the risk factors of refractive error among the primary school children in Mopani District.

Objective 3: To examine the association between refractive error and the socio-economic status of parents.

Approach	**Population**	**Sampling**	**Data collection**	**Data analysis**
Quantitative	School children Parents/guardians	Probability	Questionnaire Ocular examination form	Descriptive and inferential statistics

Stage 2

Objective 4: To explore the educators' experiences in educating school children who manifest with ocular problems.

Approach	**Population**	**Sampling**	**Data collection**	**Data analysis**
Qualitative	Educators	Non-probability sampling	Interview	Thematic analysis

Stage 3

Integration of quantitative and qualitative data sets

Stage 4

Objective 5: To propose strategies for the early detection and identification of refractive error.

4.3.1 Quantitative Research Strand

Quantitative research designs are mainly grounded on the *positivist* research philosophy and its attendant *deductive* reasoning derived from an *objective* outsider (observer) perspective of a given situation or reality from its *general* characteristics from which the specifics could be established (Hayes, Heit and Swendsen, 2010). This study included a quantitative research design for the purpose of generalising from a sample to a population so that inferences could be drawn from the general characteristic of the study population (Creswell, 2013; Madrigal and McClain, 2012). This design was advantageous for its cost effectiveness and quick turnaround of data collection (Hayes, Heit and Swendsen, 2010). Furthermore, the survey design allows for a cross-sectional design, which entails the collection of data from a sample of cases simultaneously at the same place to collect a body of quantitative or quantifiable data in connection with two or more variables, which are then examined to detect patterns of association (Bryman, 2016). Additionally, cross-sectional studies portray a snapshot of the prevalent situation. In such studies, variables of interest in a sample are assessed only once in order to determine the relationships between them (Singh, 2007). The once-only aspect implies that the dominant aspect of cross-sectional designs should be time bound. In the context of this study, the collection of data at one point (designated research setting) in time can be thought of as a "snapshot" of health conditions (e.g., refractive error) at a particular moment (month or year); focusing on studying and drawing inferences from existing differences among people (Laura, Salazar, Crosby and DiClemente, 2015).

4.3.2 Qualitative Strand

As opposed to quantitative (positivist) research designs, the qualitative research designs are mainly grounded on the *interpretivist* research philosophy and its attendant *inductive* reasoning derived from a *subjective* insider (participant) perspective of a given state of affairs or reality from its specific characteristics from which the generalities could be established (Hayes, Heit and Swendsen, 2010; Streubert-Speziale and Carpenter, 2011:20). It is in this regard that qualitative research designs are premised on an interactive and subjective approach that emphasizes belief in multiple realities, commitment to identifying, and approach to understanding; all of which support the phenomenon being studied and commitment to the views of participants for purposes of allocating intelligible meaning in accordance with the study objectives (Creswell, 2013; Walliman, 2015). The qualitative design aspect in this study was used to collect data from the educators through interviews, by means of which the key variable, the educators' experiences in educating school children who manifest with ocular problems were analysed. This study employed the phenomenological research as a design of inquiry.

Phenomenological research design

The phenomenological research as a design of inquiry comes from a philosophy and psychology that assists the researcher to describe the lived experiences of participants regarding a phenomenon as explained by the subjects (Creswell, 2013:42). The phenomenological research draws its conclusions from the experiences of numerous participants who have all had an experience of the phenomenon. This design naturally requires interviewing the participants (Creswell, 2013:42) and was selected in this study in order to explore the educators' experiences in educating school children who manifest with ocular problems. The phenomenological research is predominantly effective in revealing the experiences and perceptions of participants from their own perspectives (Lester 1999).

STAGE 1: QUANTITATIVE STRAND

4.4 Study Population

A study population is defined as a group of people or entities that is/are being studied with definite characteristics or qualities in which the researcher is interested in because of their possible relation to both the research problem and the study objectives (Jha, 2014:182).

In this study, the population of interest to the researcher were primary school children registered for Grades 5 to 7 in the 2018 academic year in the Mopani District Municipality. The study population also included the parents of the children, whose role was to provide the demographic and background information of their children. The demographic information was critical in order to assess the correlation of the demographic factors of both the parents and children with the refractive status of the child. For example, it was crucial to assess the association of socio-economic status of the parents such as employment with the refractive status of the child. The same applies to the association of the parental or child's ocular history with the refractive error of the child. As a result, the parents were selected to provide such critical information for the purpose of assessing the risk factors associated with refractive error in Mopani District. However, due to the fact that children from grade 5 to 7 would not be in a position to provide the background information about themselves or their parents, the parents become participants in the study.

4.5 Study Site and Selection

Study setting refers to the specific place or places where the data was collected (Brink, van Rensburg and van der Walt, 2012). The study was conducted in the Mopani District of Limpopo Province, South Africa. Limpopo Province comprises of Capricorn, Mopani, Sekhukhune, Vhembe and Waterberg Districts. Mopani District is one of the five districts of Limpopo province which shares borders with Ehlanzeni, Sekhukhune, Capricorn and Vhembe Districts and the Republic of Mozambique to the east of Ba-Phalaborwa. The Mopani District Municipality is demarcated into 5 (five) local municipalities, namely: Greater Giyani, Ba-Phalaborwa, Greater Letaba, Maruleng and Greater Tzaneen. The population of Mopani District Municipality is approximately 1, 092,507 people, with the Vatsonga and Northern Sotho (Ba-Pedi) speaking people as the dominant ethnic groups (StatsSA, 2011).

Figure 0.1: Mopani District Municipality map; source: Municipalities of South Africa

School Health Programs in Mopani District are provided by the Department of Health, through Primary Health Care Services and the Allied Health Care Team from the hospitals. The Primary Health Care Team comprises of nursing personnel whereas the Allied Health Care Team comprises of Optometrists, Occupational Therapists and Dieticians. The Allied Health Care Team adopts the school health schedule for primary health care services, however, the PHC team has different mobile vehicles that conduct visits on the same day but to different schools, while the Allied health care team of each hospital usually has one group of professionals that conducts the school visits. Although professional nurses are trained to conduct vision screening, only Optometrists are responsible for vision screening due to shortage of nurses and their role in schools (Mopani District Department of Health, 2018).

4.5.1 Selection of Municipality

The sampling of sites is mention-worthy, considering that the eventual three research sites in this study (1 (one) urban, 1 (one) rural, and another 1 (one) private primary school) had to be sampled from the entire Mopani District with its geographic and demographic diversity. The diversity being referred to is expressed in the form of the 5 (five) local municipalities, that is: Ba-Phalaborwa, Greater Giyani, Greater Letaba, Tzaneen and Maruleng Municipalities.

Simple random samples were used to select one local municipality, and every circuit in the local municipality had an equal chance of being included in the sample (Treiman, 2014). The Greater Giyani local municipality was then selected, with a total enrolment of 19 333 school children in Grade 5 and Grade 6. The Greater Giyani local municipality consists of 5 (five) circuits, namely: Nsami, Man'ombe, Klein Letaba, Groot Letaba and Shamavangwa circuits. All circuits within this local municipality formed the critical part of this study's setting and sampling reference.

4.5.2. Selection of Schools

Treiman (2014: 212) explains stratified probability samples as complex random samples according to which the study population is stratified on the basis of certain characteristics (e.g. race, sex, place of residence, and so on). Creswell (2013) concurs, stating that stratification is the sampling process on whose basis specific characteristics of individuals are represented in the sample, which must also reflect the true proportion in that particular population of individuals with certain characteristics. In this study, simple random stratified sampling enabled the researcher to select the three primary schools within the Greater Giyani local municipality (in the Mopani District) on the basis of their three strata (i.e., private, urban and rural classification).

A list of schools from the Limpopo Department of Education's Mopani District was used to allocate numbers to each school from each stratum. The numbers were used as ballots and shuffled by a neutral person who was not involved in the study and in the preparation of the papers used for the balloting. One ballot was selected from each stratum. The schools represented in the selected ballots formed part of the study. Finally, the schools were selected respectively on the basis of their private, urban and rural strata (demographic characterization) across the Mopani District.

4.6 Sampling of Participants (Probability Sampling Strategies)

Sampling refers to the selection process of cases or people that are considered relevant for data collection to meet the study's objectives and answer research questions pertinent to the resolving of or addressing the identified research problem (Bryman, 2016). In such cases, sampling representativeness is ensured when the percentage or frequency distribution of elements, characteristics, or qualities/ traits within a sample are compared with those of the larger study population for any similarities that may prevail or occur (Creswell, 2013:247; Jha, 14:186). The decision to either study the entire population or its sample is largely dependent on three factors, namely: population size, the cost of the study, as well as accessibility and convenience of the participants or respondents (Jha, 2014; Madrigal and McClain, 2012).

The probability random sampling strategy was used in this study because it allowed for inferences to be made about a random sample to the population from which it is extracted (Bryman 2016:53). Fox and Bayat (2007) explain probability sampling as a sampling technique where every element of the study population has a known chance, (which is not-zero), of being included in the sample. There are three basic types of probability sampling, which are: simple random sampling, multistage sampling and stratified sampling (Treiman, 2014: 196). Bryman (2016:53) contends that the results obtained through probability sampling can only be generalised to the sample from which these results were taken. In this study, the results were generalised only within the Mopani District in Limpopo Province.

4.6.1 The Sample Size

For its data collection purposes, the study only focused on school children who were in Grades 5 (five) to 7 (seven) in 2018 and their parents and did not extend the scope to high school learners. In this regard, the scope of the study was on all the male and female school children from Grades 5 to 7 who were registered for the 2018 academic year in the primary schools of Mopani District Municipality, and whose parents had completed the consent forms and survey questionnaires. The examination of children was performed by the examiner alone, as a result fewer grades had to be selected for the study. The research then opted to select grades 5 to 7 as refractive error was found to be more prevalent in higher grades in some studies (Sewunet, Aredo and Gedefew, 2014). Also, children of older age seem to understand instructions easier than those from lower grades, which assisted the researcher to close the gap of resources (assistants or optometrists). Another considered factor was that accommodation decreases with age, and obviously with higher grades, which has benefitted this study as non-cycloplegic refraction was used.

Table 4.2 below shows the sample size that was calculated using the Sovlin's formula (Sevilla, Ochave, Punsalan, Regala and Uriarte, 2007), where N is the total number of the sampled school children, and e was to be the accepted level of error of 0.05. The confidence interval of 95% implies that the chances that the findings of the sample show the true situation of the population within a specified accuracy is 95 in the 100 range whereas the chances that it does not, is 5 in 100 chances.

The overall enrollment of grades 5 to 7 children in Greater Giyani municipality was 19 333, of which 3 465 were enrolled at Nsami Circuit, 4 550 at Mon'ombe Circuit, 3699 at Klein Letaba Circuit, 3 7721 at Groot Letaba Circuit and 3 721 at Shamayangwa Circuit. The total number of grades 5, 6 and 7 for Greater Giyani Municipality were 6 648, 6 457 and 6 228 respectively.

Table 0.2: Pupil enrolment at schools: Mopani District Department of Education, 2018

Circuit	Grade5	Grade 6	Grade 7	Total
Nsami	1 105	1 165	1 195	3 465
Mon'ombe	1 515	1 573	1 462	4 550
Klein Letaba	1 378	1 324	1 196	3 898
Groot Letaba	1 293	1 161	1 245	3 699
Shamavangwa	1 357	1 234	1 130	3 721
Total	6 648	6 457	6 228	19 333

If N = Total population, n= sample size and Ne^2= sampling error, then:

$$n=\frac{N}{1+(Ne^2)}=\frac{19333}{1+(19333\times0.05^2)}=392.$$

Therefore, 10% of the sample size (39) was added to the sample size of 392 to make it **441**. The addition of 10% to the sample size is for participants' non-response rate where, for instance, participants provided incomplete information on the questionnaire, refused to complete the questionnaire or withdrew from participating in the study due to unforeseeable circumstances (Walliman, 2015).

4.6.2 Sampling Procedure

Table 4.3 below presents the sample of 441 participants as determined above, of which 121 were from school A, 170 from school B and lastly, 150 from School C. A total of 142, 146 and 153 of the sampled children were from grades 5, 6 and 7 respectively of the 3 schools. The sample frame also shows that the male participants from Schools A, B and C were 5784 and 73 and female participants were 64, 86 and 77 respectively.

Table 0.3: The sampling frame

Variable	School A (n=121)		School B (n=170)		School C (n=150)		Total
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	
Grade 5	18	21	26	28	21	28	142
Grade 6	19	21	28	28	25	25	146
Grade 7	20	22	30	30	27	24	153
Total	57	64	84	86	73	77	441

In terms of the simple random sampling technique that was used to select the participants in each school, a start was selected randomly from a list. The interval K was determined by dividing the sample size (N) by the sample (n) in each grade, which were then used to complete the sampling process. A total number of the children in the class list was divided by the sample size to find the K value = number of children/ the sample size. Every Kth child formed part of the study. Proportional sampling was used to ensure that the number of participants that were recruited from each grade were equal to their proportion in the population. In a proportionate stratified design, the percentage of the elements that a stratum contains in the population is the same even in the total number of the sample elements (Bryman, 2016; Jha, 2014). After determining the number of participants from each grade of each school, simple random selection was applied, in terms of which each child in the class list had an equal probability of being part of the study (Creswell, 2013).

Inclusion Criteria

Primary school children that were enrolled for the academic year 2018 and were in grades 5-7, whose parents/guardians returned the completed questionnaires and the signed consent form were included in the study. Furthermore, children who signed the assent forms and were available for ocular examination on the appointment date were included in the study. All parents/guardians whose children have been sampled and signed assent forms were included in the study.

Exclusion Criteria

All children whose parents/guardians did not complete the questionnaire and sign the consent form. Children who did not sign the assent forms or decided to withdraw from the study were excluded from the study. Furthermore, all parents whose children did not sign the assent forms were not included in the study.

4.7 Data Collection Methods and Procedures

Data collection is the systematically conducted process of gathering data on whose basis the eventual findings of the study are based (Arkkelin, 2014; Bryman, 2016). This study entailed two data collection processes in the form of a questionnaire survey to be completed by the parents/guardians of the children (see Appendix 12) and an ocular examination form for recording the children's ocular examination findings (see Appendix 11).

4.7.1 Preparation for Data Collection

For the purpose of gaining access to the participants, the researcher obtained permission to conduct the study from the departments of health and education, and subsequently the permission was provided to the Mopani Department of Education for consideration. The researcher then visited the school premises of the three schools and engaged with the school principals. During the engagements with the school principals, the researcher presented the intention of the study. The school principals were further provided with the information leaflet that provided the information regarding the study, permission letters from the provincial departments of Health and Education and lastly letters requesting permission for the researcher to collect data or conduct the study in the schools (see Appendix 5). The researcher made appointments with the school principals on days that were allocated for school health programs.

During the engagements with the school principals, the researcher explained that he was conducting a study regarding eye problems of primary school children and would like to obtain consent from the parents of the children that will form part of the study, and further request them to complete the questionnaires. Furthermore, the researcher explained that sampled children whose parents will consent to the study and complete questionnaires will be examined by an optometrist (researcher) after they have completed assent forms. The principals and the educators responsible for all matters related to school health programs assisted the researcher in ensuring that all the logistics pertaining to the study, including providing class registers and contact numbers of parents, were done.

4.7.2. The Research Instruments and Pre-testing

The researcher, after an extensive review of literature, devolved two data collection instruments, which were questionnaires and ocular assessment forms for the study (Artino, La Rochelle, Dezee and Gehlbach. 2014). Expert inputs were sought from recognised experts in the field of eye care to improve the developed instruments.

The questionnaire and pre-testing.

The questionnaire was pre-tested with 29 parents/ guardians whose children were sampled to undergo an eye examination at one primary school in the Mopani District. The 29 parents/guardians were invited to the school premises by the researcher on days allocated for school health programmes by the department of education. The researcher provided the parents/guardians with the information letters that detailed the purpose of the study. All parents/guardians that agreed that they together with their children will form part of the study, signed consent forms and completed the questionnaires. The school did not form part of the actual implementation of the study questionnaire (Creswell, 2013). The main purpose of the pre-tested questionnaire was to refine those areas of the questionnaire items that were inimical to the objectives of the study, as well as to establish the validity and reliability of the measuring instrument (Bryman, 2016).

The main findings of the pre-tested questionnaire showed that the follow-up question of the fathers, mothers or children who did not wear spectacles was confusing. In its original state, the question could suggest that the father, mother, or child were supposed to wear spectacles. In essence, the questionnaire statement required *reasons* for not wearing spectacles by the mother, father or child. The rationale for the question was premised on the need to establish the barriers for spectacles wear for those that needed them (e.g. affordability). Therefore, the misinterpretation of a few terminologies was observed and corrected. Those questions that generated vagueness were subsequently removed from the final questionnaire.

Following the findings of the pre-tested questionnaire with the parents/ guardians, the final self-administered research questionnaire focused on the systematic investigation of the opinions, perceptions, experiences, attitudes and knowledge of the 327 respondents regarding the family and child's ocular history; as well as the activities that the child engages in after school, which would assist in determining the risk factors of refractive error (Jha, 2014). The questionnaire was translated into Xitsonga and back into English by language experts in the African Languages Department of the University of South Africa to ensure that the content did not conflate the meanings in Xitsonga. The questionnaire comprised of open-ended (subjective, opinion-based) and closed-ended (objective, fact-based) questions (Rubin and Babbie, 2012). Basically, this final research questionnaire comprised of two sections. The first section mainly comprised of the demographic factors of the 327 respondents. The second section consisted of specific characteristics as it pertains to the children in the sampled primary schools. Appendix 12 depicts the entire contents of the research questionnaire.

The Ocular assessment form and its pre-testing.

As explained above, the sampled children whose parents/guardians completed the questionnaires formed part of the pre-testing process for the ocular assessment form. Therefore, the information letter was presented to the 29 children whose parents consented to the pre-testing and completed the questionnaire. The children who signed the assent forms were examined by a qualified optometrist (the researcher) to determine their refractive status. The pre-testing findings assisted the researcher in determining the average number of children that can be examined in a day and also to refine the ocular assessment form. The final ocular assessment form included the visual acuity, refraction and ophthalmoscopy examination. The ocular assessment form was used to collect the optometry findings after the examination of the school children's eyes. The refraction results comprised of objective (retinoscopy) and subjective results of the trial frame and lenses used. The examination results were used to determine the final diagnosis of the child's ocular status. The following equipment were required to perform the eye examination:

- Snellen acuity chart for distance visual acuity assessment.

- Tape measure for measuring the distance between the participant and the Snellen acuity chart.

- Ophthalmoscopy for examination of the external and internal ocular structures.

- Retinoscopy to perform objective refraction.

- Trial frame and lenses to perform subjective refraction.

4.7.3 Procedure for Data Collection from Parents

All parents whose children were sampled to form part of the study were invited to the school through letters which were given to their children and by telephone, to confirm availability on days allocated for school health programs. During the meeting with the parents, the researcher presented and provided the information letter (Appendix 7), which detailed all the information about the study, to the parents. The parents that agreed to form part of the study were provided with the questionnaires and consent forms for them to complete while at the school premises. The parents that opted to complete while at home were requested to return the documents in a sealed envelope to the school on particular days wherein the researcher would be available to personally collect the questionnaires and consent forms.

The questionnaire, which comprised of the general close-ended questions, allowed the participants to choose from the options of responses provided by the researcher. The key questionnaire variables in this regard were the risk factors of refractive error among the primary school children in Mopani Municipality District of Limpopo Province. The researcher personally collected the filled-in questionnaires after their completion by the parents. The availability of parents/guardians to complete questionnaires and sign consent forms at schools posed a possible challenge, which was mitigated by the researcher visiting the parents/guardians in this category to administer the filling-in of the assessment forms. In some instances, induced by logistical difficulties and the availability of parents at home, the school children of such households were given the forms in sealed envelopes to give to their parents/guardians. All the parents/guardians that consented for themselves and their children to form part of the study and completed the questionnaire, had their children subjected to ocular examination of the eyes as detailed below.

4.7.4 Procedure for Data Collection from the Children (Ocular Examination of the School Children)

To determine the refractive error of the children, their eyes had to be examined by an independent and qualified optometrist registered with the Health Professions Council of South Africa. Children whose parents/guardians agreed to take part in the study were given information leaflets (see Appendix 7) which explained all aspects of the research and assessment forms, after which they were requested to complete the assent forms themselves (see Appendices 10 and 11). After all questionnaires had been completed by the parents/ guardians, the children were examined by the optometrist (the researcher) on days allocated for school health services by the Limpopo Province Department of Education. Approximately 20 school children were assessed per day, and each school was visited 4 or 5 times.

The visual acuity test, which is a measure of the eye's ability to differentiate shapes and details of objects at a certain distance, was taken monocularly at a distance of 6 (six) metres (m) using the Snellen acuity chart (Marsden *et al*., 2014). However, children who wore corrective lenses were allowed to wear them during the test. Pin-hole visual acuity was taken monocularly, especially for the children who failed to read the 6/6 line. Refraction is a procedure performed to determine the degree of optical correction that is needed to acquire the best possible vision for the patient. The procedure enabled the researcher to determine the refractive status of the school children (Gantz, Schrader, Ruben and Zivotofsky, 2015). The procedure further informs on whether the child is emmetropic (no refractive error) or ametropic (myopic, hyperopic of astigmatic). In order to conduct subjective refraction, the practitioner first performed retinoscopy to objectively determine the child's refractive error, and then followed with the subjective refraction, which entails the use of a trial case to refine the retinoscopy findings. Direct ophthalmoscopy, which is a procedure used to examine the anterior and posterior segments of the globe and the fine abnormalities of visual fixation, was then performed on all children without room illumination (Mackay, Garza, Bruce, Newman and Biousse, 2015). On completion of the eye examination, all children with substantial refractive error and other ocular conditions were referred to the nearby healthcare facilities for thorough assessment and management of the prognostic measures.

4.8 Validity and Reliability of the Research Instruments

Validity

In quantitative research, validity refers to the extent to which one can draw meaningful and useful statistical inferences from scores generated using particular instruments (Creswell, 2013). The validity of the research instruments (questionnaire and ocular examination form) were ensured with the pre-testing of the questionnaire and assessment form on 10% of the sampled participants (children and guardians/parents) at a primary school within Mopani Municipality District. This particular school did not form part of the final sampled schools. The pretesting of the instruments provided the researcher with an opportunity to uncover possible problems, such as misleading questions, incompetent response categories or grammatical errors and spellings; thus ensuring that gaps/problems related to the instruments were identified and eliminated in time (Wildemuth, 2016). Peer debriefing was also utilised as a mechanism to ensure validity. In this regard, the final research questionnaire was checked by the supervisors for quality assurance (Gale, Heath, Cameron, Rashid and Redwood, 2013). Experts in the field of eye care were also requested to provide input with regards to the questionnaire and ocular examination form, and their inputs were used to modify both the questionnaire and the ocular examination form (which and how examination procedures should be performed) used.

Reliability

Reliability refers to the internal consistency of the test scores on the preferred research instrument (i.e., the extent to which the item responses were consistent (not deviant) across all variables or constructs (Creswell, 2013:206). Reliability also extends to the stability and accuracy of the data results over time (test-retest correlations), and whether there was consistency in test administration and scoring environments (Holloway and Galvin, 2017:309). Reliability was established by means of conducting a pilot study and also checking the veracity of both the preliminary and final findings with the participants and respondents in order to ensure that their perspectives and input were represented both correctly and accurately. In addition, Cronbach's alpha was used to measure internal consistency. As such, the reliability coefficient of the instruments (questionnaire) was r = 0.81, and the reliability coefficient of the ocular examination form was r = 0.79, showing that the questionnaire that was completed by the parents/guardians and ocular examination form were reliable, thus justifiable to be used to collect data from both the children and the parents for the purpose of this study (Creswell, 2013).

4.9 Data Management and Analysis

Data management relates to the systematic treatment or handling of the collected data in its raw or original state in order to preserve it and prevent it from contamination or destruction (Bryman, 2016; Kumar, 2014). Most fundamentally, the management of the collected data was aimed at providing the quality assurance framework necessary for the attainment of valid, reliable and credible findings (Polit and Beck, 2017:531).

The quantitative analysis of the data accruing from the 327 parents/guardians that was obtained through questionnaires, together with the ocular examination results of the children that were recorded in the ocular examination sheets were thoroughly screened. Accordingly, incorrect, incomplete and redundant data for 8 participants was not entered. The two sets of data were then captured into the Statistical Package for Social Science (SPSS) Version 24. SPSS analysed at 95% Confidence Interval and at 5% significance. Where possible, 10% significance was used to depict weak evidence. The researcher ensured that the data was cleaned after capturing it into the SPSS. The analysis starts with the descriptive analysis to produce frequency tables and graphs where appropriate, followed by the Chi-square test used to determine the association between refractive error and its associated risk factors, and lastly multiple linear regression models to test if the independent variables had an influence on refractive error.

Chi Square tests

The Chi-square (X2) test refers to a nonparametric statistical test which is used to determine whether two or more categories of the samples are dependent or independent (McHugh, 2013). Nevertheless, there is need to emphasise that the formation of any association using the chi-square may not inevitably denote any form of causal relationship for the compared attributes, however, it suggests that such an association warrants further investigation by the researcher (Franke, Ho and Christie, 2012). The application of the Chi-square test would not be possible on continuous data. As such, the Chi-square was used on qualitative data that was either classified into categories or labelled by means of a nominally scaled variable (Sharpe, 2015). Hence all continuos data was recoded to categorical e.g. age to age groups. The p-value was used in the interpretation of the findings. A p-value refers to a measure or degree of the probability that the difference observed might have happened by a random chance (Franke, Ho and Christie, 2012; Ying, Maguire, Glynn and Rosner, 2018). Lower p-value indicated that there is a stronger statistical significance of the observed difference. Therefore, a *p*-value which was less than 0.05 (typically ≤ 0.05) showed evidence of statistical significance which further showed evidence against the null hypothesis. This was because the probability that the null might be correct would have been less than 5% (Everitt, 2021). As a result, the null hypothesis was rejected, and the alternative hypothesis was accepted.

Multiple linear regression

This study used a multiple regression (Marill, 2004; Uyanık and Güler, 2013; Petrie and Sabin, 2019) model for assessing the relationship between the dependent variable (diagnosis or pathology) and a set of explanatory variables (demographics, family history, parents' education and age etc). The variable to predict is referred to as the dependent or outcome variable, whereas the variables that were used to predict the dependent variable' value were referred to as the independent, explanatory, regressor or predictor variables (Uyanık and Güler, 2013; Petrie and Sabin, 2019). This regression can mathematically be represented as;

$$Y(\text{Diagnosis}) = \alpha + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6 + \ldots\ldots\ldots + \text{error term}$$

Where $\beta_1 - \beta_6$ are regression coefficients, usually estimated by least squares and X_1-X_6 are independent variables (school, grade, child position, family history, parents' education, employment, age, wearing spectacles, child's activities etc).

The results are interpreted also using the P-value, where if it is less than 0.05 the results are significant; the independent variable has an effect/influence on the dependent variable.

STAGE 2: QUALITATIVE STRAND

4.8 Study Population

The rationale for qualitative research includes purposefully selecting participants and/or sites to assist the researcher answer the research questions (Creswell, 2013: 239). The population of interest to the researcher were the educators of all the primary school children in the Mopani District Municipality. The researcher selected educators because they are key informants regarding the overall behaviour of children in the classroom, particularly with regards to the challenges posed by refractive error on teaching and learning in the classroom. The participants were from the same three schools where quantitative data was collected.

4.9 Sampling (Selection) of Participants

4.9.1 Sample Size

For phenomenological research, Polkinghorne (1989) suggested that interviews can be conducted from 5 to 25 participants with experience regarding the phenomenon. Creswell (2013) has found most phenomenological studies to range from 3 to 10 participants and also recommended interviews for 10 individuals. The researcher purposefully selected a sample of 10 educators. The sample size consisted of 10 educators, 4 (four) of whom were from the Foundation Phase, 3 (three) from the Intermediate Phase, and another 3 (three) were from the Senior Phase from three different primary schools in the Mopani District Municipality. Guest, Bunce and Johnson (2006) concluded that research with more homogeneity among the participants, meaningful themes and useful interpretation can be developed from about six participants. Furthermore, this study used more than one method of data collection, and as suggested by Lee, Woo and Mackenzie (2002) fewer participants were required.

Lastly, the sample size was determined on the basis of data saturation. Glaser and Strauss (1967: 61) defined saturation as a parameter for determining when sampling can be ceased which refers to the point where no more new data is found for the researcher to develop properties of the category. The researcher becomes satisfied that data is saturated when the same instances are seen repeatedly. In this study, saturation was reached during the 7^{th} interview. The researcher proceeded with sampling of the educators, however, due to similar responses that were received from the participants, sampling was ceased on the 10^{th} participant.

4.9.2 The Sampling Process (Nonprobability Sampling)

The researcher used the nonprobability sampling method to select the educators from the three schools. Nonprobability sampling intends to generalise to a population perception acquired from an individual or phenomenon. The insights of individuals are obtained by means of purposefully selecting participants and settings that provide adequate understanding of a particular phenomenon (Omona, 2013: 179), convenience sampling design which comprises individuals or groups selection depending on availability and willingness to participate in the study at the time (Omona, 2013: 180). Convenience sampling design was used to select an available total of educators who were willing to participate in the study.

Table 4.4 below shows the total number of educators from the three sampled schools, which is 48. Of the 48 educators, 13 were from School A, 18 from School B and 17 from School C. The foundation, intermediate and senior phases contributed 19,15 and 14 to the total number of educators in the three schools.

Table 0.4: Total number of educators (N=48)

Variable	**School A (n=13)**		**School B (n=18)**		**School C (n=17)**		**Total**
Phase	Male	Females	Male	Female	Male	Female	
Foundation	0	6	0	8	0	5	**19**
Intermediate	3	1	2	3	3	3	**15**
Senior	3	0	4	1	5	1	**14**
Total	6	7	6	12	8	9	48

The 10 participating educators were purposefully selected from the 3 (three) sampled schools that formed part of the study. In each school, the foundation, intermediate and senior phase educators were sampled to form part of the study. The 10 educators consisted of 7 (seven) males and 3 (three) females, each of whom was engaged in an audio-recorded one-on-one individual interview session not exceeding thirty minutes. Each interview was held at one of the three primary schools where the sampled educator worked. The pre-test of the interview provided an opportunity for the researcher to pre-determine the use of appropriate interviewing and recording skills and to establish clarity of the questions on the final interviews with the educators (Creswell, 2013).

Inclusion Criteria

Primary school educators for foundation, intermediate and senior phase who have agreed to participate in the study and signed the consent forms. The educators who were willing to volunteer enough time to the in-depth interview during the day of the appointment were included.

Exclusion Criteria

Educators who were not willing to participate in the study and/or were not available for the interview on the appointment day.

4.10 The Data Collection Process

4.10.1 The Data Collection Instrument

The data collection instrument refers to a tool used to collect data or information from the participants (Creswell, 2013). In this study, the researcher used an interview guide (Appendix 14) as an instrument to collect data from the educators in the form of unstructured in-depth interviews. In this type of interview the researcher asks the individuals unstructured open-ended questions to gain insight about the subject (Corbin and Strauss, 2008). These types of interviews usually last for 30 minutes to an hour and are conducted once (DiCicco-Bloom and Crabtree, 2006). An unstructured interview guide which is a list of questions or topics that the interviewer needs to explore (DiCicco-Bloom and Crabtree, 2006), was developed by the researcher after review of literature and consultation with experts in the field of eyecare (Appendix 14). In addition, the experience of the researcher in school health screening assisted in the development of the unstructured interviewe guide. The key (‘grand tour’) interview question premised on two fundamental issues of concern to the researcher. Firstly, the focus was on the exploration of the educators’ experiences in educating school children who manifest with ocular problems. Secondly, the interview questions focused on the assessment of the educators’ recommendations on the early detection and management of these ocular problems among primary school children.

4.10.2 Accessing Gatekeepers and Respondents

For the purpose of gaining access to the participants, the researcher visited the school premises of the three schools and engaged with the school principals. During the engagements with the school principals, the researcher presented the intention of the study. The school principals were further provided with the information leaflet that provided the information regarding the study, permission letters from the provincial departments of Health (Appendix 3) and Education (Appendix 6) and lastly the letters requesting permission for the researcher to collect data or conduct the study in the schools (see Appendix 5). The researcher made appointments with the school principals on days that were allocated for school health programs.

During the engagements with the school principals, the researcher explained that he was conducting a study regarding eye problems of primary school children and would like to interview educators from grades R to 7. The school principals assisted in arranging meetings wherein the researcher presented the intention of the study to the educators.

4.10.3. Pilot-Testing of Data Collection Tools

Pilot study can refer to feasibility studies which are small scale versions or trial runs done in preparation for the major study (Polit, Beck and Hungler, 2001:467). Furthermore, a study that is conducted for the purpose of pre-testing a certain research instrument like an interview guide or a questionnaire can also be referred to as a pilot study (Polit, Beck and Hungler, 2001:467). Therefore, it was critical for the researcher to conduct a pilot study as it provided a warning regarding the possible challenges of the major study including the methods and procedures.

For the purpose of the pilot study, the researcher used semi-structured in-depth interviews on four participants. The interviews directed the researcher to establish whether the questions would be able to elicit the required information from the participants. During the pilot study, the researcher managed to rearrange the questions, for example, the first question was "*please share with me your experience regarding children with eye problems*?". This question was rearranged to be the last question as the participants struggled with the answer. Other questions that were ambiguous were rephrased to enhance the understanding of the participants. The researcher managed to put into practice the listening skills of the interviewee and managed to probe where necessary and ensure that the participant is comfortable.

The researcher ensured that the educators felt comfortable before the commencement of data collection in the form of interviews. Rapport between the educators and the researcher was established by the researcher; that the educators provided consent to participating in the data collection of the study; and that trust between researcher and the educators existed.

Building Rapport

With qualitative research, it is important that the researcher keeps in mind that the participants try to understand the researcher and that the perception of the participants about the researcher will have an effect on the overall engagement. For the purpose of ensuring that optimal rapport with the participants is achieved, the researcher must not be intimidating and must also appear modest. In this study, the researcher also dressed in semi-formal clothes like the educators, to ensure that the researcher was presentable and at the level of the participants. Furthermore, the researcher ensured that the atmosphere was relaxed by introducing himself and then requested the educators to introduce and say something about themselves and what they loved about their work. The researcher then started the discussion about the research topic and further described what was expected from the educators. The educators were urged to engage or express themselves unreservedly.

Consent

The educators were requested to provide consent to tape record the interviews. The informed consent forms were completed by all educators that agreed to participate in the study (see Appendix 13).

Trust

The fact that the researcher was an optometrist in the local Hospital (Nkhensani Hospital) and was involved in school health programs and that the researcher was known by some of the educators, particularly the principals and the foundation phase educators, created some level of trust. In addition, continuous engagements with the school principals while collecting quantitative data and ultimately referring some of the children that experienced eye problems for further management, created trust from the educators.

4.10.4 In-depth Interviews of Educators

Ten individual in-depth interviews were conducted with the educators from foundation, intermediate and senior phase in primary schools. An individual in-depth interview refers to an interview which is conducted on one-on-one basis and makes use of the unstructured interviewing technique (De Vos *et al*., 2011: 348). Therefore, for the purpose of this study, the individual in-depth interviews were conducted for the purpose of acquiring detailed information regarding the perceptions and experiences of the educators in educating the school children that suffer from eye problems. (De Vos *et al.,* 2011).

As already explained under the qualitative research instrument, the researcher made use of the interview guide to collect the data during the interviews with the educators. The interview guide assisted the researcher to reflect thoroughly about the kind of data he anticipated to acquire and the potential obstacles that could have occurred during the process of collecting data (De Vos *et al*., 2011: 352).

4.11 Qualitative Data Trustworthiness, Credibility, Transferability, Dependability, Confirmability

Trustworthiness can be described as the quality, authenticity, and truthfulness of qualitative research findings (Schmidt and Brown, 2015). It seeks to understand whether the qualitative research findings can be trusted (Lincoln and Guba, 1985). The four qualities criteria that ensured trustworthiness in this study are credibility, transferability, dependability, and confirmability.

Credibility

Credibility determines whether the results of the study correspond to credible information that was provided by the participants and also that the data interpretation of the original views of the participants is correct (Lincoln and Guba, 1985). Researchers can utilize a variety of strategies to confirm credibility, which include prolonged engagement, persistent observation, triangulation and member check. The researcher ensured that the questions were relevant to the research questions and adequate time was allocated for the interview, and where necessary, the interviews were prolonged. Field notes and a tape recorder were utilized by the researcher during the collection of data to ensure that data is captured correctly and accurately. Furthermore, triangulation of the quantitative data and the data collected from the educators was done to ensure validity.

Transferability

According to Lincoln and Guba (1985), transferability refers to the degree to which the qualitative research findings can be generalized or transfered to a different setting with different participants. The researcher achieved transferability by using thick description. During the write up of the research, the researcher ensured that the description of the interview was rich and entailed a strong description of the situation.

Dependability

Dependability refers to the stability of the study findings over time and the researcher ensured the evaluation of findings, interpretation, and recommendations of the research by the participants and confirmed that all are reinforced by the information provided by the participants (Schmidt and Brown, 2015).

The researcher ensured that dependability was established by means of checking the veracity of both the preliminary and final findings with the participants and respondents in order to ensure that their perspectives and input were represented both correctly and accurately. Dependability was achieved by using a tape recorder, field notes and the guidance provided by the supervisor at all stages of the study.

Confirmability

The extent to which the the study results are confirmable by other investigators (Schmidt and Brown, 2015). Confirmability focuses on providing certainty that the collected data and analyses of the results are not fabrications of the interviewer's opinions but are drawn from the participants' data. The researcher verified all transcripts to ensure that there are no errors. Also, the researcher ensured that as the codes or themes emerge there is constancy throughout all data. The researcher provided information regarding the procedures for checking and rechecking the collected data, a description of data collection procedures and the sample size were provided. A data audit that focused on procedures for data collection and analysis was also conducted.

4.12. Qualitative Data Management and Analysis

4.12.1 Data Capturing

A voice recorder was used to ensure the accurate and precise capturing of the participants' narratives in their original form (Walliman, 2015). Using a voice recorder during the interview permitted the researcher to pay attention to the interview questions, the flow of the discussion, what to focus on next and how to follow up on the responses given by the educators (De Vos *et al.,* 2011: 359). Furthermore, the researcher was taking notes to ensure that the non-verbal signals like the educator's facial expressions, gestures etc. were recorded. In this regard, data was first managed prior to its analysis. However, the data management and analysis processes could still be non-sequential; that is, conducted concurrently (Brink *et al*., 2012). In that regard, for instance, data could be thematically coded (classified or categorised) while it is described and analysed simultaneously. During the data collection, the educators responded in Xitsonga language as it was the language that they were mostly comfortable with. As a result, the data was captured in Xitsonga language and with the assistance of a professional translator, the data was translated from Xitsonga to English, and again from English to Xitsonga, to ensure that the context of the data and the meaning were accurate. Therefore, the results for the qualitative data will be presented in both the original Xitsonga version in quotation and also in the translated English version.

4.12.2 Data Analysis and Interpretation

Qualitative data analysis is a process the researcher uses to understand, explain and interprete themes and patterns which arise from textual data by making use of the data analyses (Smith, 2020). In this study, thematic data analysis method was used to analyse data gathered from the educators. Thematic data analysis refers to a procedure for analysing raw data that was obtained using qualitative methods in order to categorise the needed information and patterns from the obtained data (Smith, 2020). Qualitative data analysis steps involve becoming familiar with data; coding into themes; searching for patterns and connections and then interpreting the data. The researcher became familiar with the data by listening to the recordings and translating the interviews verbatim and listening to recordings again to ensure that the data captured is accurately translated verbatim. After becoming familiar with data, coding of data was initiated. Data coding refers to the process of data analysis in grounded theory according to which statements are systematically grouped and allocated a 'code' or 'label' for ease of interpretation in the study (Streubert-Speziale, 2011:457). From the qualitative data generated, codes which are segments of meaning in a text were identified and these were identified as 1st level of codes. In addition, codes which were recurring or had the same meaning were merged and from there 2nd level of codes were identified. From the 2nd level of codes, categories were created and subcategories by grouping data associated with some thematic idea which allowed for them to be examined together. Moreover, patterns and connections were searched with the aim of looking for relatively important data and identifying relationships between themes. After the themes were identified, data was interpreted, and conclusions drawn. In addition, during interpretation of data, the participants' direct statements 'segment of meanings in a text' were used to support the theme generated.

4.13 Ethical Considerations

In this study, it was critical to ensure that ethical issues were observed. The researcher ensured that issues related to autonomy, which focusses on respecting the rights of the school children, the parents and the educators. In addition, the principle of beneficence, which relates to doing good and non-maleficence, which relates to not doing harm were observed during the study. The principle of justice, which addresses issues related to equity, were taken into consideration at all times (Brikci and Green, 2007: 5). In order to limit the anxiety and distress that may emanate from interviews and ocular examinations, the researcher ensured that the manner in which questions were asked was appropriate and also at what stage he chose to probe further (Brikci & Green, 2007: 5). Similarly, efforts were made to ensure that children were engaged in an appropriate manner during the ocular examination.

4.13.1 Ethical Clearance and Permissions

Ethical considerations are based on the moral and legal principles and protocols regulating the professional conduct of the researcher's treatment of the research subjects (Polit and Beck, 2012: 154). Additionally, the researcher was further expected to comply with ethical protocols between the researcher and the higher education institution with which the research study was registered. Accordingly, the research proposal was first submitted to the University of South Africa's Research and Publication Committee for ethical clearance. Once granted, the ethical clearance together with the approved research proposal was then submitted to the Limpopo Provincial Departments of Health for ethical clearance pertaining to the optometry aspects of the study (see Appendices 1, 2 and 3). The Limpopo Provincial Department of Education was also formally consulted for permission to access the children at schools (see Appendix 4). The written permission from the Provincial Department of Education was subsequently submitted to the Mopani District Department of Education and schools. In addition, a letter of request was written to the school principals to notify them about the research that would be conducted at their respective schools (see Appendix 5).

4.13.2 Informed Consent

All sampled educators who agreed to participate in the study were requested to sign consent forms. The participants were informed that their participation in the study was uncoerced and voluntary, and that they were free to withdraw from participation at any time should they wish to do so.

4.13.3 Privacy, Confidentiality, and Anonymity

The principles of privacy, confidentiality and anonymity imply that the identities of the participants and their personal information was protected and not shared with others; and that no form of identification was required from them at any stage of the data collection process (Kendall and Halliday, 2014: 308; Strydom, 2011: 66). Information provided by the participants was treated confidentially. Every participant was allocated a pseudonym, and a code was assigned to ensure the anonymity of their responses. The researcher kept the tape recordings of the participants. Access to tape recordings was restricted to the researcher and supervisor. All participants were not asked to disclose their names while the interview was being recorded.

STAGE 3: INTEGRATION OF QUALITATIVE AND QUANTITATIVE DATA

The research used the convergence model of triangulation design for mixed methods to collect data (Creswell, 1999). The model provided for the researcher to collect and analyse quantitative and qualitative data discreetly and then converged the two results at the interpretation stage for the purpose of comparing or validating the results. In addition, this model ensured that the quantitative and qualitative results are corroborated and conclusions about the phenomenon were made (Creswell, 1999). The data were merged when the researcher took the two data sets and explicitly brought them together or integrated them. The researcher merged the two data sets together at the discussion stage (chapter 6) of the study. In order to gain more understanding of the two data sets, the researcher opted to use ActAD framework to integrate the data.

STAGE 4: PROPOSAL OF STRATEGIES

The purpose of the study was to investigate the extent to which refractive error affects primary school children with the aim of determining its prevalence risk factors, and its associated perceptions and experiences by educators in Mopani District Municipality, Limpopo Province, in order to propose strategies that could assist in the early detection and identification of refractive error. The next section will focus on the development of strategies to enhance the early identification of refractive error among primary school children of Mopani District. The research has critically analysed the study findings, the WHO intervention strategies for refractive error in children, Mopani District school vision programme and the Integrated School Health Policy in order to apply phase 4 of the PPM. Phase 4 of the PPM focuses on strategies development, therefore, the researcher applied the DIT to propose strategies for early detection and management of refractive error. As discussed in chapter 3, the following four factors of the DIT were used to develop the strategies:

1. **Relative advantage:** refers to the extent to which the new idea is perceived as better compared to the program or idea it intends to replace.

2. **Compatibility**: can be explained as the level of consistency with the values, experiences and needs of the adopters.

3. **Triability**: refers to the degree to which the innovation can be experimented or tested prior to adoption commitment by the intended adopters.

4. **Observability**: simply answers the question, can the innovation provide quantifiable results?

The researcher has sought inputs from various experts in the field of eyecare, the departments of Education and Health and other stake holders as listed below:

1. Department of Health: District Coordinators for Optometry Services and School Health services, Allied Health Manager for Nkhensani Hospital.

2. Department of Education: District Manager for Nsami circuit
3. Private Optometrist in Giyani Town
4. Community Leader of Siyandani Village.
5. One member of the School Governing Body of School A
6. An expert in the field of Optometry from the University of Limpopo.

The inputs from the above individuals were considered by the researcher and incorporated into the final strategy document and sent back to the above individuals for final inputs. All individuals that provided inputs were engaged individually and not as a group.

4.14 Conclusion

This chapter outlined the research design and methods employed to collect, present, and analyse data as the verifiable standard of the study's evidence or findings. The interview and questionnaire methods were the main instruments of data collection. In addition, the chapter highlighted the approach to the analysis of data, which was an indispensable aspect in terms of which the evidence of the study was generated and compiled. The chapter further highlighted all ethical issues pertaining to the researcher's engagement with the participants during the process of data collection. The next chapter focuses on the presentation of the data and its analysis.

CHAPTER FIVE: RESEARCH FINDINGS

5.1 Introduction

This chapter essentially translates the research design and methods into their practical application in relation to the research problem and its related study objectives. In this regard, the chapter discusses and visually presents the findings of both quantitative and qualitative data by means of graphs, charts and tables. The chapter is demarcated into four distinct areas or sections. Firstly, the respondents' (parents or guardians) individual demographic data is presented in order to reflect on their various personal backgrounds that could have had some degree of influence on their responses to questions posed to them concerning the refractive error status of the school children (Du Plooy-Cilliers, Davis and Bezuidenhout, 2014). Secondly, the quantitative (questionnaire-based) data is presented regarding the responses or views of the participating school children's parents/ guardians in relation to their children's ocular history as obtained by the researcher's ocular examination of the school children. Thirdly, the association of the identified critical variables is presented in the context of refractive error. Fourthly, the educators' qualitative data is presented, as derived from the individual (one-on-one) in-depth interviews with the sampled educators from the selected three primary schools in the Mopani District Municipality. This qualitative section presents the respective educators' own thematically organised perspectives regarding children in Grades 5-7 who experienced ocular problems, more specifically refractive error.

The purpose of the study was to investigate the extent to which refractive error affects primary school children with the aim of determining its prevalence risk factors, and its associated perceptions and experiences by educators in Mopani District Municipality, Limpopo Province, in order to propose strategies that could assist in the early detection and identification of refractive error. Accordingly, the research specific objectives were:

i. To determine the extent of the prevalence of refractive error among the primary school children in Mopani District;
ii. To assess the risk factors of refractive error among the primary school children in Mopani District;
iii. To examine association between refractive error and socio-economic status of parents.
iv. To explore the educators' experiences in educating school children who manifest with ocular problems.
v. To propose strategies for the early detection and identification of refractive error.

STAGE 1: QUANTITATIVE RESULTS

This section provides results of the study in the form of frequency tables and graphs. The data was imported from Microsoft Excel to the Statistical Package for Social Scientist (SPSS) version 27 and analysed at 95% confidence interval and at 5% significant levels. Where applicable 10% significant levels are interpreted as weak results. The section starts with the descriptive results of the study section by section, followed by Chi-square tests of independence which test associations between the categorical variables. This is followed by a multivariate regression analysis that aims to establish if there are relationships between diagnosis results of refractive error, the independent child and family variables.

SECTION A: Parents'/ Guardians' Demographic Profiles

The critical focus of the study was on the refractive error of the primary school children, and not particularly on their parents' refractive error challenges. However, since these children were minors legally by virtue of their ages 9 (nine) to 16, grades 5 (five) to 7 (seven), their parents (on the basis of their informed consent and assent) were requested to participate on account of their direct knowledge of their children's overall health and well-being; and their historical eyesight-related profiles (see Appendices 9 and 11). In addition, one of the objectives of this study was to determine the demographic factors of the parents.

5.1. Respondents' Legal Status

A total of 327 parents/guardians (from a sample frame of 441) eventually filled-in and returned their completed questionnaires.

Table 0.1: Respondents' legal status

Variable	Category	Frequency	Percent
Questionnaire completed by	Biological mother	193	59.0
	Biological father	68	20.8
	Legal guardian	46	14.1
	Other	20	6.1

Table 5.1 indicates that regarding the respondents' legal status, more than half of those who completed the questionnaire were biological mothers (59%; n=193), a fifth (20.8%; n=68) of the questionnaire were completed by biological fathers, while a few were completed by legal guardians (14.1%; n=46) and other guardians (6.1%; n=20).

5.2. Age Profiles of Parents

Table 5.2 below represents the age profiles of both the fathers and mothers of the children. It is worth noting that even though the questionnaire was completed by one parent or guardian for each child as presented in table 5.1, the questionnaire required information for both parents (n=327: mother; n=327: father).

Table 0.2: Age profiles of parents

Age	Father		Mother	
	Frequency	Percent	Frequency	Percent
25-35 years	25	12.4	77	24.1
35-45 years	90	44.8	161	50.3
45-55 years	64	31.8	78	24.4
Above 55 years	22	10.9	4	1.3
Valid responses	201	100.0	320	100.0
Missing	126		7	
Total	327		327	

***Missing information is when the respondent did not provide an answer where required, these numbers are removed from the analysis.**

Table 5.2 indicates that there were 201 participants who responded about the age of the children's fathers. The results show that four out of every ten (44.8%; n=90) of the fathers were aged 35-45 years, three out of ten (31.8%; n=64) were aged 45-55%, a tenth was aged 25-35 years (12.4%; n=25) and above 55 years (10.9%; 22). Further results show the age groups of the mothers of the children who participated in this survey. Half of the mothers (50.3%; n=161) were aged 35-45 years; a quarter were aged 45-55 years (24.4%; n=78) and 25-35% years (24.1%; 77). There were very few parents, mostly fathers (10.9; n=22) and only 1.3% (n=4) who were aged 55 years and above. Mothers were twice as much likely to be aged 25-35 years (24.1% vs 12.4%), while fathers were aged 55 years and above (10.9% vs 1.3%).

5.3 Educational Background of Parents

The table below is reflective of the fathers' (n=327) and mothers' (n=327) educational backgrounds.

Table 0.3: Parents's education status

Parents' education				
	Father		**Mother**	
	Frequency	Percent	Frequency	Percent
None	15	7.5	27	8.4
Primary school	22	10.9	27	8.4
Secondary School	90	44.8	146	45.6
Higher education	65	32.3	116	36.3
Don't know	9	4.5	4	1.3
Valid response	201	100.0	320	100.0
Missing	126		7	
Total	327		327	

***Missing information is when the respondent did not provide an answer where required, these numbers are removed from the analysis.**

With regard to parents' education, table 5.3 above shows that four out of ten fathers (44.8%; n=90) and mothers (45.6%; n=146) had secondary school education. There were 36.3% (n=116) of mothers who had higher education and 32.3% (n=65) of fathers who had the same (higher education). One in ten (10.9%; n=22) of fathers had primary school education, 8.4% (n=27) of mothers had the same qualifications. Very few of the fathers (7.5%; n=15) and mothers (8.4%; 27) had no education.

5.4 Employment Status of Fathers

The employment status of the fathers and mothers is captured in Table 5.4 below.

Table 0.4: Employment status of parents

Is the parent currently employed	***Father***		***Mother***	
	Frequency	*Percent*	*Frequency*	*Percent*
Yes	144	73.5	188	58.4
No	50	25.5	133	41.3
Did not answer	2	1.0	1	0.3
Valid response	196	100.0	322	100.0
Missing	131		5	
Total	327		327	

Missing information is when the respondent did not provide an answer where required, these numbers are removed from the analysis.

Table 5.4 indicates that there were 196 (59.9%) fathers whose employment status was provided. Seven out of ten (73.5%) of the fathers indicated that they were employed, compared to 58.4% of mothers who were employed. A quarter (25.5%; n=50) of the fathers reported that they were not employed by the time of the survey, while 41.3% (n=133) of the mothers were not employed. Meanwhile 131 (40.1%) of the fathers' employment status was not provided by the respondents, which might be a challenge to statistical findings. However, at least six out of ten (59.9%; n=196) are evidence that justifies the validity of the finding for this variable (fathers' status) (Van der Roest, 2015).

SECTION B: FAMILY'S OCULAR HISTORY

5.6 History of General Poor Eyesight in the Family

Figure 5.1 below presents the general history of poor eyesight in the family.

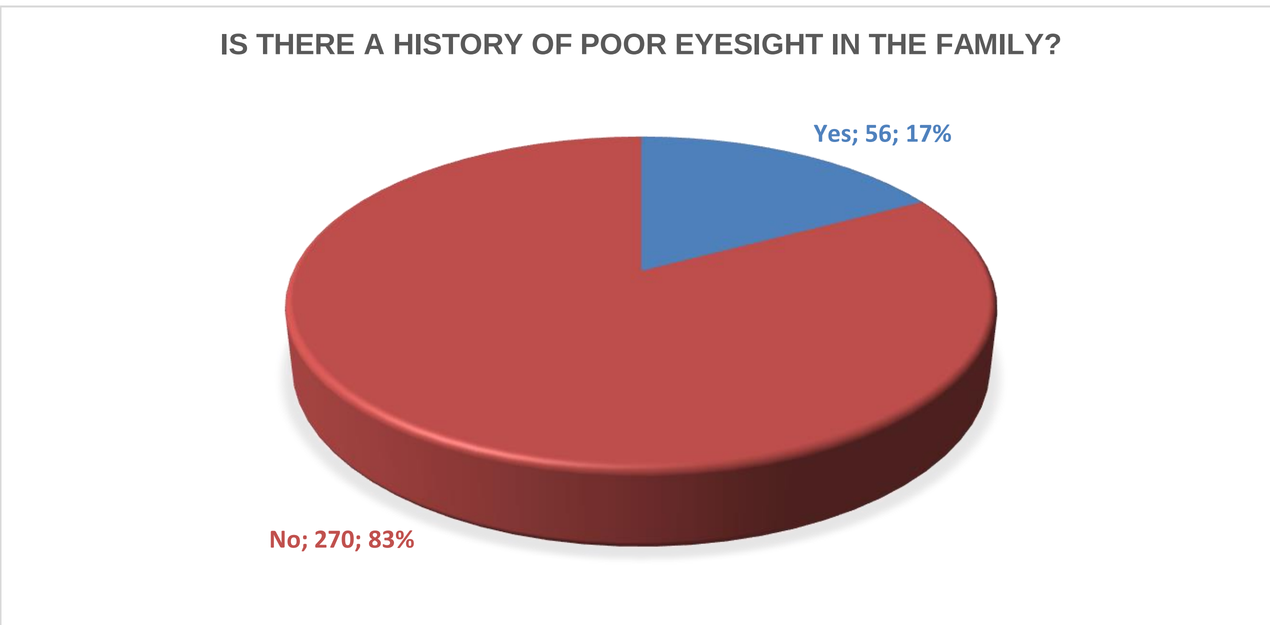

Figure 0.1: History of general poor eyesight in the family. (n=326, Missing=1)

*Missing information is when the respondent did not provide an answer where required, these numbers are removed from the analysis.

Figure 5.1 sought to know whether there was history of poor eyesight in the family. There were 56 children (17.1%) who reported family history of poor eyesight, while eight out of ten (83%; n=270) did not report any history of poor eyesight in the family.

5.7 Possible Hereditary Trace of Poor Eyesight in the Family

In addition to the history of poor eyesight in the family that was presented in figure 5.1, Table 5.5 illustrates which family members are affected in order to establish any hereditary links to poor eyesight.

Table 0.5: Possible hereditary trace of poor eyesight in the family

If yes, who is affected?	Frequency	Percent
Father/mother	25	43.1
Grand parents	15	25.9
Aunt/Uncle	12	20.7
Brother/sister	7	10.3
Valid responses	57	100.0
Not applicable	269	82.2
Total	327	

Table 5.5 indicates that four out of ten (43.1%; n=25) of the children had possible hereditary trace of poor eyesight in the family through parents, a quarter through grandparents (25%; 25.9%), a fifth through an aunt or uncle (20.7%; n=12) and a tenth through a brother or sister (10.3%; n=7).

5.8 Possible History of Blindness In The Family

Table 5.5 investigated poor eyesight problems in general in the family, whereas Table 5.6 below focused specifically on any history of blindness in the family.

Table 0.6: Possible history of blindness in the family

Is there a history of blindness in the family?	Mother		Father	
	Frequency	Percent	Frequency	Percent
Yes	12	3.8	1	0.3
No	307	96.2	325	99.7
Valid responses	319	100.0	326	100.0
Missing	8		1	
Total	327		327	
***Missing information is when the respondent did not provide an answer where required, these numbers are removed from the analysis.**				

History of blindness in the family was traced back to mothers by 3.8% (n=12) of the respondents, and only 1 out of ten whose history was traced back to their fathers (8.3%).

5.9 Parents' Status in Relation to Wearing Spectacles or Contact Lenses

Table 5.7 below essentially presents whether the participating parents wore spectacles or contact lenses. The intention of the researcher in this regard, was to establish whether any measure of correlation existed between refractive error and heredity.

Table 0.7: Parents's status in relation to wearing spectacles or contact lenses

Does the father or mother/ father wear spectacles?	Father		Mother	
	Frequency	Percent	Frequency	Percent
Yes	29	13.4	35	11.0
No	187	86.6	284	89.0
Valid responses	216	100.0	319	100.0
Not applicable/missing	111		8	
Total	327		327	

***Missing/not applicable information is when the respondent did not provide an answer where required or the child did not have a father/mother, these numbers are removed from the analysis.**

Table 5.7 indicates that at least a tenth of fathers (13.4%; n=29) and mothers (11%; n=35) wear spectacles, meaning that eight to nine out of ten do not do so.

5.10 Age at Which the Parents Wore Eye Spectacles or Contact Lenses

Table 5.7 focused on whether or not the parents wore eye spectacles or contact lenses, whereas, Table 5.8 below focuses specifically on the parents that wore spectacles and presents the age at which they started wearing eye spectacles or contact lenses.

Table 0.8: Age at which the parents wore eye spectacles or contact lenses

Parents age when they started wearing specs	Father		Mother	
	Frequency	Percent	Frequency	Percent
20-25 years	6	25.0	8	33.3
25 and above	18	75.0	16	66.7
Valid responses	24	100.0	24	100.0
Not applicable	303		303	
Total	327		327	
***Not applicable information is when the respondent was not required to provide an answer, these numbers are removed from the analysis.**				

The survey sought to know at what age did the father/mother start wearing spectacles or contact lenses. Three quarters of fathers (75%; n=18) indicated that they started wearing specs when they were 25 years or older, compared to 66% (n=16) of mothers who reported that they started wearing specs at 25 years or older. Fewer of the fathers (25%; n=6) and mothers (33%; n=8) started wearing specs when they were aged between 20 and 25 years.

5.11 Parents' Reasons for Wearing Spectacles or Contact Lenses

In addition to the age of wearing spectacles presented in Table 5.8 above, the researcher sought to know the possible reasons for spectacles wear by the parents. This would provide an understanding of the nature of eye conditions the parents had. Therefore, Table 5.9 below depicts parents' reasons for wearing spectacles.

Table 0.9: Parents' reasons for wearimg their own eye spectacles

Reasons for spectacles wears	Father		Mother	
	Frequency	Percent	Frequency	Percent
Seeing clearly at distance	7	28.0	6	20.7
For reading, working at a computer or other close work	9	36.0	13	44.8
For all of the above	8	32.0	10	34.5
Don't Know	1	4.0		0.0
Valid responses	25	100.0	29	100.0
Not applicable	302		298	
Total	**327**		**327**	
***Not applicable information is when the respondent was not required to provide an answer, these numbers are removed from the analysis.**				

Four out of ten of the mothers cited reading, working on a computer or other close work (44.8%; n=13) as reasons for wearing contact lenses, compared to 36% (n=9) of fathers who gave the same reason. At least a quarter of mothers (28%; n=7) cited seeing clearly at distance as a reason for wearing spectacles. A third of both fathers (32%; n=8) and mothers (34.5%; n=10) said they wore spectacles because of seeing in distance and for reading.

5.12 History of any Siblings Wearing Spectacles or Contact Lenses

The ocular history of siblings in the same family was considered a relevant factor for establishing whether or not any links existed between biological factors and refractive error. It is worth mentioning that “siblings” implies other children in the families than those sampled in the three primary schools. Since the parents were the respondents (on behalf of the sampled school children), they would be also conversant with the ocular history of every child in the family. In this regard, Table 5.10 below shows the number of siblings wearing spectacles in various families represented by the parents/guardians in this study.

Table 0.10: History of any siblings wearing spectacles or contact lenses

Do the siblings wear spectacles?	**Sibling 1**		**Sibling 2**	
	Frequency	**Percent**	**Frequency**	**Percent**
Yes	21	6.9	5	2.9
No	283	93.1	168	97.1
Total	304	100.0	173	100.0
Not applicable	23		154	

**Not applicable information is when the respondent was not required to provide an answer because they did not have siblings, these numbers are removed from the analysis.*

Table 5.10 shows that very few of the siblings (sibling 1: 6.9%; n=21 and sibling 2: 2.9%; n=5) wore spectacles, nine out of ten did not. These results show that there were more responses on sibling one, and very few parents provided information on sibling 2 for various reasons including families with only two children.

5.13 Possible Age at Which Sibling Wore Spectacles/Contact Lenses

As a sequel to the siblings' spectacles wear history reflected in Table 5.10, it was necessary to follow-up on the possible ages at which the siblings wore spectacles or contact lenses, as represented in Table 5.11 below.

Table 0.11: Possible age at which sibling wore spectacles or contact lenses

Age of spectacles wear	Siblings 1		Siblings 2	
	Frequency	Percent	Frequency	Percent
10-14 years	5	45.5	1	20.0
15-26 years	6	54.5	4	80.0
Total	11	100.0	5	100.0
Not applicable	315		322	

***Not applicable information is when the respondent was not required to provide an answer because they did not have siblings, these numbers are removed from the analysis.**

Of those who responded to the age question, half of them were aged 15-26 years (54.5%; n=6) when they started wearing spectacles or contact lenses, while 45.5% (n=5) were aged 10-14 years. The second siblings were also asked for their ages, 80% (n=4) were aged 15-26 years and 20% (1) were aged 10-14 years when they started wearing spectacles or contact lenses.

5.14 Possible Reasons for Siblings Wearing Spectacles or Contact Lenses

Table 5.12 below represents possible reasons for the siblings wearing spectacles or contact lenses.

Table 0.12: Possible reasons for siblings wearing spectacles or contact lenses

Reasons for spectacles wear	Sibling1		Sibling 2	
	Frequency	Percent	Frequency	Percent
Seeing clearly in distance	-	-	-	-
For reading, working at a computer or other close work	8	88.9	3	50
For all of the above	1	11.1	3	50
Total	9	100	6	100

Table 5.12 provides results on reasons for wearing spectacles. Reasons cited for wearing spectacles were reading, working at a computer or other close work by the majority of siblings 1 (88.9%; n=8) and half (50%; n=3) of siblings 2. Whereas only one (11.1%) cited both seeing at distance and reading, working on the computer or other close work for siblings 1 and half (50%; n=3) for siblings 2.

SECTION C: CHILDREN'S DEMOGRAPHIC INFORMATION

5.15 Biological positions of the children in their families

Figure 5.2 below represents the biological position of each child in their respective families as reported by the parents. This data was important for the study for the purpose of establishing whether or not the prevalence of reflective error affected children based on their biological position in the family.

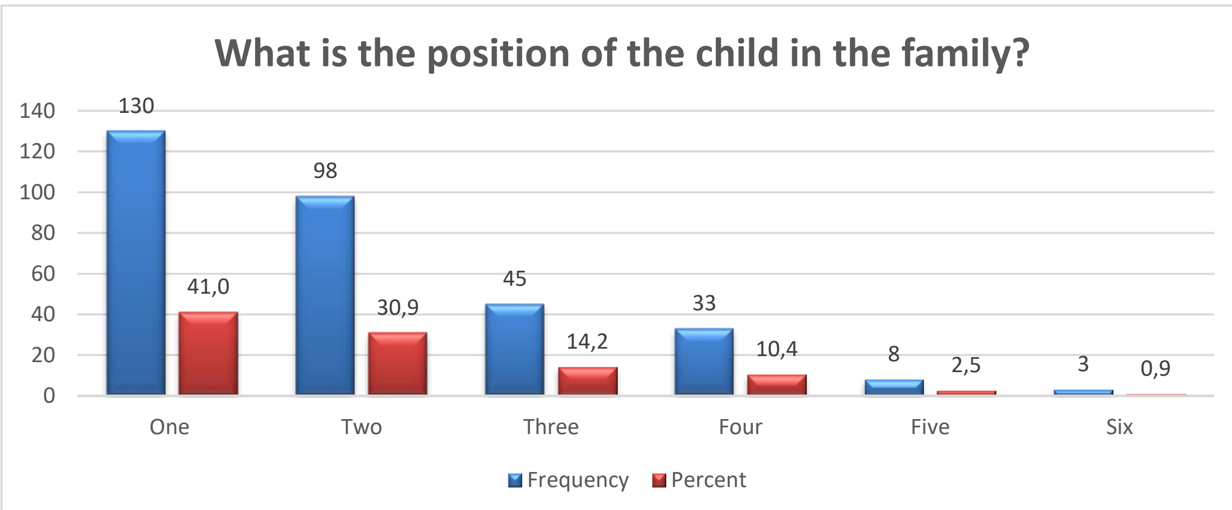

Figure 0.2: Biological positions of children in their families

Figure 5.2 shows that four out of ten (41%; n=130) of the children were position 1 (first born) in their families, three out of ten (30.9%, n=98) were position two in their families. A tenth were position 3 (14.2%; n=45) and position 4 (10.4%; 33). Very few were position 5 (2.5%; n=8) and 6 (0.9; n=3).

5.16 Children's Gender, Age and School Profiles

Table 5.13 below reflects the gender, age and school profiles of the participating parents/guardians.

Table 0.13: Children's age, gender and school profiles

School	**Age**		**Gender**					
			female		Male		Total	
			Freq	Perc	Freq	Perc	Freq	Perc
School A	**Age group**	10 years and below	6	3.4	9	6.1	15	4.6
		11-16 years	42	23.5	32	21.6	74	22.6
	Total		48	26.8	41	27.7	89	27.2
School B	**Age group**	10 years and below	15	8.4	12	8.1	27	8.3
		11-16 years	42	23.5	40	27	82	25.1
	Total		57	31.8	52	35.1	109	33.3
School C	**Age group**	10 years and below	9	5	3	2	12	3.7
		11-16 years	65	36.3	52	35.1	117	35.8
	Total		74	41.3	55	37.2	129	39.4
Total	**Age group**	10 years and below	30	16.8	24	16.2	54	16.5
		11-16 years	149	83.2	124	83.8	273	83.5
	Total		179	100	148	100	327	100

Table 5.13 indicates that there were 327 participants in this survey, of which 54.7% (n=179) were male and 45.3% were female. Eight out of ten of them (83.5%) were aged 11-16 years, with a few who were aged 10 years and less (16.5%). The children who participated in the study were from three schools; 39.4% were from School C (Urban Public), a third (33.3%) were from School B (Rural Public) and fewer were from School A

(Private School) (27.2%). In terms of education, a third were in primary school (32.7%), a third from secondary schools (33.3%), another third was from high school.

5.17 Grade Distribution of Learners

Figure 5.3 below shows that the majority of the learners from all the three primary schools (33.9%, n=111) were in grade 7, followed by 33.3% (n=109) who were in grade 6, and the remaining 32.7% (n=107) were in grade 5. The percentage distribution in Figure 5.3 is only for the grade distribution, and not case or prevalence of refractive error per grade level.

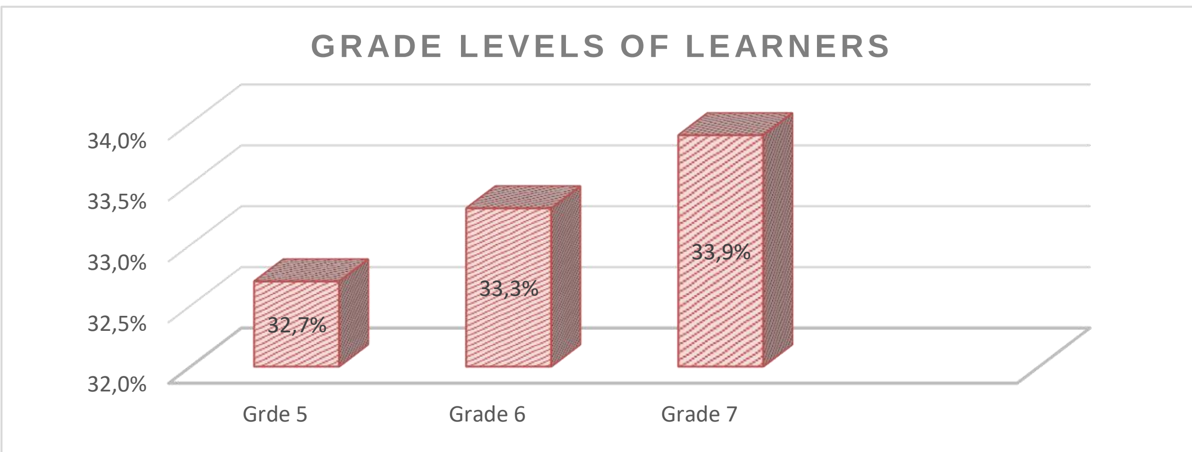

Figure 0.3: Grade distribution of learners

SECTION D: OCULAR HISTORY OF THE SCHOOL CHILDREN

Section D provides historical eye test data of the children.

5.18 Frequency of Children's Eye Testing

Figure 5.4 below is an illustration of the frequency or regularity with which eye testing has (or has not) been conducted in families. Such frequency is relevant, since it provides an account of the ocular history of each learner.

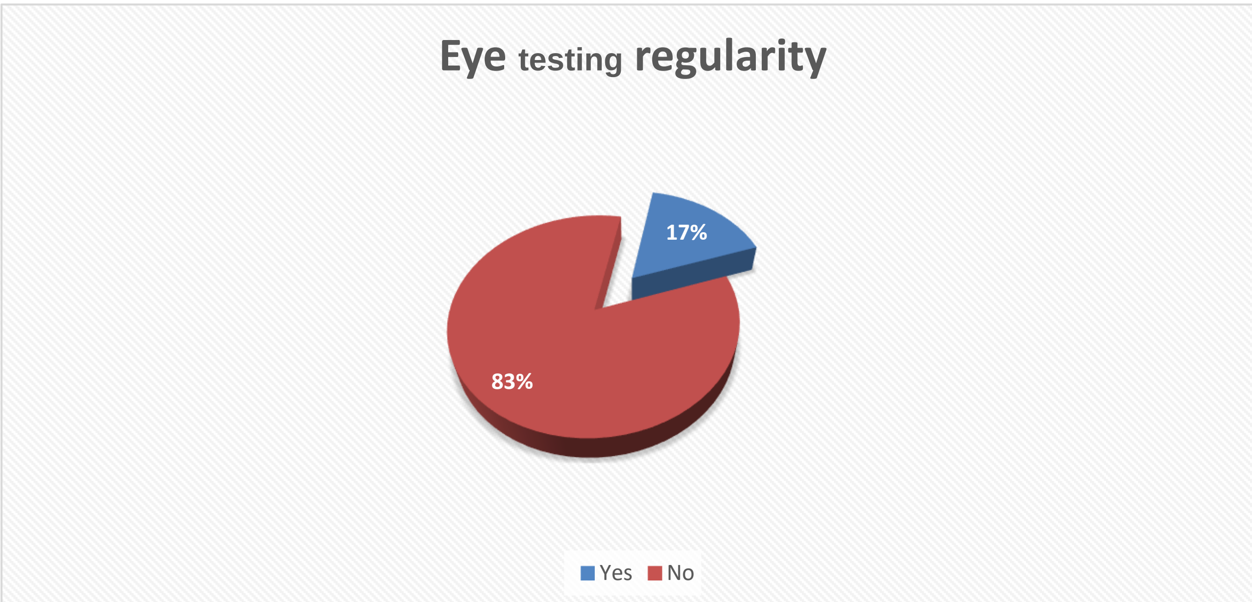

Figure 0.4: Frequency of children's eye testing

In response to the question on whether any eye testing was previously conducted, it is clear from Figure 5.8 above that the majority of 83% (n=272) responded negatively to the question corresponding to the responses given by the parents of the children who reported that their children had not undergone any eye testing. Only 17 % (n=55) of the cases have had their eyes tested.

5.19 Reasons for Children's Eye Testing

Given the astronomical irregularity of children's eye testing as shown in Figure 5.4 above, the reasons for eye testing of the children (17%, n=55) were worth exploring. Table 5.9 is an illustration of the reasons for eye testing/examination of the children presented by the parents/legal guardians.

Table 0.14: Reasons for children's eye testing

Reasons for eye testing	**Frequency**	**Percent**
General eye test or school screening	23	41.8
Painful, itchy eyes or injury	25	45.5
Poor vision	2	3.6
Missing	5	9.1
Valid responses	55	100.0
Not applicable	272	
Total	327	

**Not applicable information is when the respondent was not required to provide an answer because they did not have history of eye testing, these numbers are removed from the analysis.*

Table 5.14 indicates that four out of ten children had eye tests for reasons of general eye test or school screening (41.8%; n=23) or because of painful, itchy eyes or injury (45.5%; n=25). Very few of the children cited poor vision (3.6%; n=2) as a reason for eye testing.

5.20 Wearing of Eye Spectacles or Contact Lenses

Figure 5.5 seeks to determine the actual numbers of those wearing eye spectacles or contact lenses.

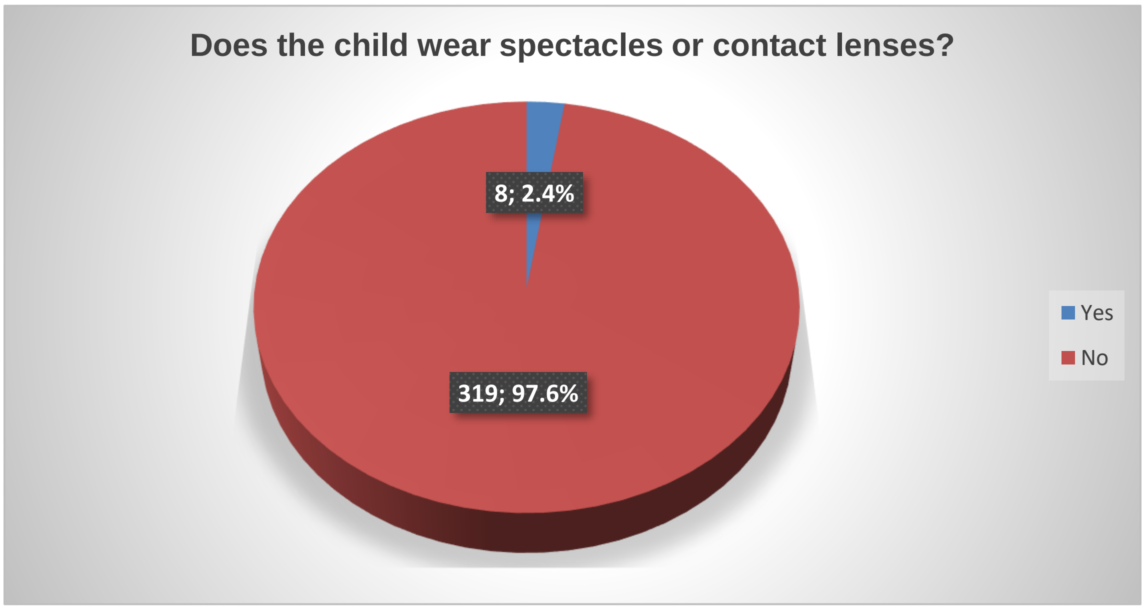

Figure 0.5: Children's spectacles wear

Figure 5.5 indicates that 8 children wore spectacles or contact lenses, representing 2.4% of the total responses. Most of the children did not wear spectacles/contact lenses.

5.21 Children’s Age of Spectacles Wear

Table 5.15 is an illustration of the reasons advanced for wearing either eye spectacles or contact lenses based on the age of the learners.

Table 0.15: Children's age of spectacles wear

If yes, at what age did the child start wearing spectacles or contact lenses?		
Age of spectacles wear	Frequency	Percent
7 years	1	12.5
8 years	1	12.5
9 years	2	25.0
10 years	2	25.0
12 years	1	12.5
13 years	1	12.5
Valid response	8	100.0
Not applicable	319	
Total	327	
***Not applicable information is when the respondent was not required to provide an answer because they did not wear spectacles, these numbers are removed from the analysis.**		

The four children who wore contact lenses started wearing lenses between 7 and 9 years (50%; n=4), while the other half (50%; n=4) started when they were 10 years, 12 years and 13 years.

5.22 Reasons for Visual Correction by those Wearing Spectacles (n=8)

Having established that "not wearing spectacles/contact lenses" is not synonymous with "not suffering from eye problems" in Table 5.14 above, it was also important for the researcher to determine or establish the extent of the parents/guardians' postexamination or corrective measures taken for the children in addition to the (pre-examination) data obtained in Table 5.14. Therefore, whereas Table 5.14 emphasised on the initial reasons and causes for eye testing, Table 5.16 particularly focuses on the various reasons advanced for the children wearing spectacles. It is in this regard that these reasons are categorised as corrective measures by the 8 learners who actually wore eye spectacles as shown in Figure 5.5. These reasons ranged from “seeing clearly from a distance” to “reading”, and “working on a computer”. These reasons are important, since they help to provide clarity on the type of refractive error being corrected by the prescribed spectacles.

Table 0.16: Reasons for visual correction for those wearing spectacles (n=8)

Reason for wearing spectacles or contact lenses	Frequency	Percent
Seeing clearly in distance	3	37.5
For reading, working at a computer or other close work	2	25.0
For all of the above	3	37.5
Valid responses	8	100.0
Not applicable	319	
Total	327	
***Not applicable information is when the respondent was not required to provide an answer because they did not wear spectacles, these numbers are removed from the analysis.**		

Table 5.16 indicates that three out of the eight children who wore lenses did so in order to see clearly in distance (37.5%; n=3), for reading, working and (25%; n=2) for both reading and seeing clearly in distance (37.5%; n=3).

SECTION D: Children's Exposure to Possible Risk Factors of Refractive Error

Now that the demographic factors have been explored, it is critical to explore the risk factors that may be associated with refractive error. In this section, the primary focus is on the extent to which children spend time on both curricular (e.g. reading and writing during school hours) and extra-curricular (e.g. watching TV and the computer) activities outside the official school hours. The factor of time spent on both curricular and extracurricular activities is of extreme importance. It helps to determine the visual demand required for ocular health, especially for those learners already suffering from eye problems (Al-Nuaimi, 2010).

5.23 Time Spent on the Computer/TV After School

Table 5.17 illustrates the time spent by the children on the computer/TV after school hours.

Table 0.17: Time spent on the TV/Computer after school

Time spent	Frequency	Percent
Less than 30 minutes	45	13.8
More than 30 minutes but less than 1hr	47	14.4
More than 1hr	69	21.1
None	166	50.8
Total	327	100.0

Table 5.17 indicates that half of the children did not spend any time on computer games or watching TV (50.8%; n=166). A fifth of them (21.1%, n=69) spent more than one hour

(21.1%; n=69), while less than 20% spent more than 30 minutes (14.4%; n=47) and others less than 30 minutes (13.8%; n=45).

5.24 Time Spent on Reading, Writing, Drawing and Coloring

Table 5.18 below specifically shows time spent on reading, writing, drawing and coloring after school hours.

Table 0.18: Time spent on reading, writing, drawing and colouring

Time spent	Frequency	Percent
Less than 30 minutes	36	11.0
More than 30 minutes but less than 1hr	109	33.3
More than 1hr	161	49.2
None	21	6.4
Total	327	100.0

Table 5.18 indicates that half of the children spent less than 30 minutes on reading. For writing, drawing and coloring (49.2%; n=161), a third of them (33.3%; n=109) spent more than one hour, while a tenth (11%; n=36) spent less than 30 minutes (14.4%) and very few never engage in this activity (6.4%; n=21).

5.25 Time Spent Engaging in Sports After School

Table 5.18 above specifically focused on time spent on homework (a direct curriculum-related activity) after official school hours, while Table 5.19 mainly focuses on time spent on extra-curricular or outdoor activities after official school hours. These activities include but are not limited to outdoor activities such as sports.

Table 0.19: Time spent engaging in sports after school

Time spent	Frequency	Percent
Less than 30 minutes	34	10.4
More than 30 minutes but less than 1hr	69	21.1
More than 1hr	204	62.4
None	20	6.1
Total	327	100.0

Table 5.19 indicates that six out of every ten of the children spent time in sports (62.4%; n=204), a fifth of them (21.1%; n=69) spent more than thirty minutes, while a tenth (10.4%; n=34) spent less than 30 minutes. Very few were not engaged in this activity (6.1%; n=20).

SECTION E: OCULAR EXAMINATION

In this section, the children's ocular examination relates to visual acuity, objective and subjective refraction, as well as ophthalmoscopy procedures that were performed by the researcher on the children. Visual acuity assessment is a procedure for quantifying how well the eye can see. Refraction procedure assesses the refractive status of the eye; that is, whether the eye is myopic, hyperopic, astigmatic or emmetropic. The ophthalmology procedure was intended for assessing the external and internal structures of the globe/

eyeball. These clinical optometry procedures were aimed at determining the refractive error status/prevalence and the general ocular health of the children. As a qualified practitioner in the sphere of eye care and health, the researcher's ocular examination focused on the visual assessment of both the left and the right eye of the school children in all three sampled primary schools.

5.26 Unaided Visual Acuity of the Left Eye and the Right Eye

Table 5.20 and figure 5.6 are an illustration of the unaided visual acuity of the right eye and the left eye.

Table 0.20: Unaided visual acuity of the left eye and the right eye

Unaided visual acuity of the left eye and the right eye				
	UVARE		**UVALE**	
	Frequency	Percent	Frequency	Percent
6/6	239	73.1	241	73.7
6/7.5	24	7.3	26	8
6/9	40	12.2	38	11.6
6/10	11	3.4	7	2.1
6/12	5	1.5	8	2.4
6/15	2	0.6	1	0.3
6/18	4	1.2	5	1.5
6/21	2	0.6	1	0.3
Total	327	100	327	100

The results on unaided visual acuity of the right eye (73.1%; n=239) and left (73.7%; n=241) values indicate that similar proportions of the children had normal sight (6/6). Those who had 6/7.5 consisted of 7.3% (left eye; n=24) and 8% (right eye; n=26). The rest of the cases were mild visual impairment, less than 20% for both eyes. In addition, figure 5.6 below further shows the distribution of the unaided visual acuity for both eyes

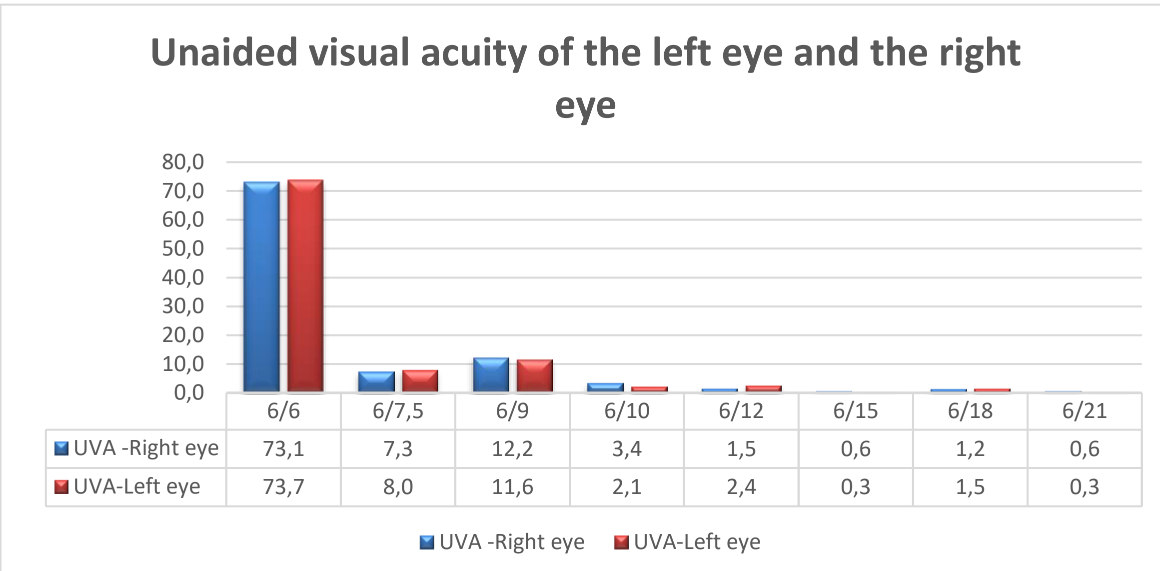

Figure 0.6: Unaided visual acuity of the left eye and the right eye

Note that as seen in figure 5.6 above, the visual acuity data is skewed towards normal vision (80-811%), and 19-20% had mild visual impairment. There was no severe visual impairment (6/60), profound visual impairment (counting fingers (CF) 6m- CF2m), near blind (CF1m-Light perception (LP), or blind (NLP) cases in this sample.

5.27 Refractive Error Status of School Children

Table 5.21 illustrates the outcomes of the diagnosis of refraction among the sampled learners from the three primary schools.

Table 0.21: Refractive error status of school children

Diagnosis	Frequency	Percent	95% Confidence Interval
No refractive error	210	64,2	58.8-69.3
Myopia	53	16,2	12.6-20.6
Hyperopia	33	10,1	7.3-13.9
Astigmatism	31	9,5	6.7-13.2
Total	327	100,0	

Table 5.21 above shows that the majority (64.2%, n=210) of the children did not have refractive error, while the minority (35.8%, n=117) had presented with various forms of refractive error. From this minority category, the refractive error presented in the form of myopia (16.2%, n=53); followed by hyperopia (10.1%, n=33) and astigmatism at 9.5% (n=31).

5.28 Other Ocular Conditions

Figure 5.7 presents the pathology conditions that were detected during the ocular examination of the children.

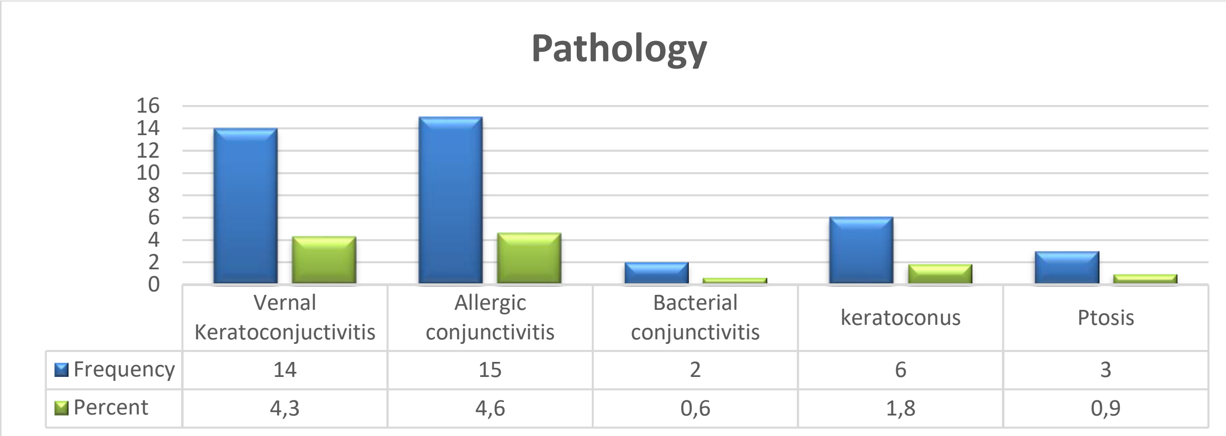

Figure 0.7: Other ocular conditions

In addition to refractive error, other ocular conditions accounted for 12,2% (n=40) of which 37.5% (n=15) of the cases were allergic conjunctivitis, which was the most occurring condition followed by vernal kerato-conjunctivitis at 35% (n=14). Furthermore, keratoconus was next at 15.0% (n=6), while ptosis conjunctivitis followed at 7.5% (n=3), and bacterial conjunctivitis was the least occurring condition at 5% (n=2).

SECTION F: CHI Square Tests of Independence and Multivariate Regression

Having presented the respondents' (parents/guardians and the children) demographic profiles, the ocular history and the ocular examination findings of the school children, the current section (Section F) presents a correlational perspective of both the parents and school children's salient aspects and variables relating to refractive error. For the parents/guardians, these correlated variables include their various levels of education and employment. For the school children the associated variables include their age, gender, grade level, history of eye testing and spectacles/contact lens wear, as well as time spent on both curricular and extra-curricular activities after school hours. An assessment of the association between refractive error and the child's demographic factors, the child's own ocular history, the family's ocular history and the time spent by the children on both curricular and extra-curricular activities will assist the researcher in determining the risk factors of refractive error among the school children of Mopani district.

The Chi-square test, which is a nonparametric statistical test, was used to assess whether the categories of the samples were dependent on each other or not (McHugh, 2013). Additionally, the Chi-Square test may not inevitably denote any form of a causal relationship, but only assesses the associations between the variables. The section further shows the confidence intervals (CI) at 95%.

5.29 Association of Refractive Error and Parent's Level of Education

Table 5.22 below presents the association of the children's refractive error and parental level of education.

Table 0.22: Association of refractive error and parent's level of education

Father's Education	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
none	12	80; (52.8-93.5)	2	13.3; (3.3-40.8)	0	-	1	6.7; (0.9-35.6)	0.051
primary school	19	86.4; (65.0-95.6)	1	4.5; (0.6-26.5)	2	9.1; (2.3-30.2)	0	-	
secondary school	62	68.9; (58.5-77.6)	14	15.6; (9.4-24.7)	9	10; (5.3-18.2)	5	5.6; (2.3-12.7)	
higher education	34	52.3; (40.2-64.2)	8	12.3; (6.2-22.8)	12	18.5; (10.7-29.9)	11	16.9; (9.6-28.1)	
don't know	8	88.9; (49.6-98.5)	0	-	1	11.1; ()1.5-50.4	0	-	
Total	135	67.2; (60.3-73.4)	25	12.4; (8.5-17.8)	24	11.9; (8.1-17.2)	17	8.5; (5.3-13.2)	
Monther's education									
none	21	77.8; (58.4-89.7)	3	11.1; (3.6-29.5)	1	3.7; (0.5-22.3)	2	7.4; (1.8-25.4)	0.636
primary school	21	77.8; (58.4-89.7)	3	11.1; (3.6-29.5)	2	7.4; (1.8-25.4)	1	3.7; (0.5-22.3)	
secondary school	91	62.3; (54.2-69.8)	26	17.8(12.4-24.9)	15	10.3; (6.3-16.4)	14	9.6; (5.7-15.6)	
higher education	67	57.8; (48.6-66.4)	20	17.2(11.4-25.3)	15	12.9; (7.9-20.4)	14	12.1; (7.3-19.4)	

	don't know	4	100.0	0	-	0	-	0	-	
	Total	204	63.8(59.0-69.5)	52	16.3(12.5-20.5)	33	10.3 (7.4-13.8)	31	9.7; (6.6-13.1)	

Table 5.22 indicates that the p-value is greater than the significance level (α = 0.1), however, the null hypothesis at 10% level was not rejected. More accurately, it is concluded that there is evidence, though weak, to imply an association between the fathers' level of education and the diagnosis. Among the children whose fathers had higher education, 52.3% (n=34) did not have refractive error, which implies that the remainder, 47.7% (n=31), had refractive error. This was followed by the children whose fathers had secondary school, where 68.9% (n=62) did not have refractive error, which implies that the remainder, 31.1% (n=28) had refractive error. The majority of the children 86.4% (n=19), 88.9% (n=8) and 80% (n=12), whose fathers had primary school education, no education and unknown education respectively, did not have refractive error. Therefore, refractive error prevalence was highest among children whose fathers had higher education followed by secondary school whereas the occurrence of refractive error was lowest among unknown level of education.

Regarding myopia, those with secondary education (15.6%; n=14), followed by those with higher education (12.3%; n=8) had higher chances of myopia, while those with primary education (4.5%; n=1) had three times less chances of experiencing myopia. Those with no schooling had higher chances of having myopia, compared to fathers with primary education. The occurrence of hyperopia (18.5%; n=12) and astigmatism (16.9%; n=11) was highest among children whose fathers had a higher level of education. There were no associations found between the mother’s education and having refractive error, meaning that the mother’s level of education had nothing to do with refractive error in this sample.

5.30 Association of Refractive Error and Parent’s Employment

Table 5.23 provides very strong evidence of association between the father’s employment status and refractive error ($p<0.05$). Fathers who were not employed were more likely to have no refractive error (76%; n=38), which implies that the remainder (24%; n=12) had refractive error. For the employed fathers 63.2 % (n=91) had no refractive error and the remainder, 36.8% (n=53) had refractive error. Therefore, the refractive error occurrence was higher among the children of the employed fathers. Further results indicate that the children of the fathers who were not employed were more likely to experience myopia (16%; n=8) vs 11% (n=16) compared to those who were employed. Children of the employed fathers were 3 times more likely to experience hyperopia (15.3%; n=22) compared to 4% (n=2) who were not employed. Lastly, astigmatism was twice as much more likely to be prevalent in children of the employed fathers (10.4%; n=15), compared to those who were not employed (4%; n=2).

Table 0.23: Association of refractive error and parent's employment

Employment		No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
		Freq	%; CI	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Father	yes	91	63.2; (49.2-74.2)	16	11.1; (5.1-22.7)	22	15.3; (11.9-20.8)	15	10.4; (6.8-15.0)	0.015
	no	38	76; (65.3-81.7)	8	16; (12.6-20.6)	2	4; (0.7-27.4)	2	4; (0.7-27.4)	
Total		129	65.8; (59.9-69.9)	26	13.3; (12.0-19.5)	24	12.2 (8.2-17.1)	17	8.7; (6.1-12.1)	
Mother	yes	127	67.6; (60.0-71.1)	22	11.7; (5.6-22.9)	20	10.6(6.4-15.3)	19	10.1; (6.1-14.2)	0.059
	no	78	58.2; (43.1-61.5)	31	23.1; (16.5-31.9)	13	9.7; (7.0-13.6)	12	9; (6.3-13.1)	
Total		205	63.7; (59.1-69.6)	53	16.6; (12.6-20.6)	33	10.4; (7.3-13.9)	31	9.6; (6.7-13.2)	

With regard to mothers’ employment, there was weak evidence of association between their employment status and refractive error, results were significant at 10% level. The results indicate that mothers who were employed were more likely not to experience refractive error (67.6%; n=127), which means that the prevalence of refractive error was 32.4% (n=61). While (58.2%; n=78) children of the unemployed did not have refractive error, 41.8% (n=56). Myopia was 2 times less likely to be prevalent among unemployed mothers (11.7%; n=22), compared to those who were employed (23.1%; n=31). There were significant differences in the prevalence of hyperopia (10.6%; n=20 vs 9.7%; n=13) and astigmatism (10.1%; n=19 vs 9%; n=12) among the employed and the unemployed, implying employment status among mothers had nothing to do with hyperopia and astigmatism. Notably, the results provide strong evidence that refractive error was more prevalent among employed fathers, and weak evidence among employed mothers. Unlike mothers, where employment status was not a significant predictor of hyperopia and astigmatism, the father's employment status was a predictor of hyperopia and astigmatism.

5.31 Association of Refractive Error and History of Poor Eyesight In the Family

The association between refractive error and history of poor eyesight in the family is as presented in table 5.24 below.

Table 0.24: Presents the association between refractive error and history of poor eyesight in the family

History of:		No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
		Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
poor eyesight	yes	35	62.5(49.2-74.2)	11	19.6(11.2-32.2)	3	5.4(1.7-15.4)	7	12.5(6.1-24.1)	0.472
	no	175	64.8(58.9-70.3)	42	15.6(1.7-20.4)	29	10.7(7.6-15.1)	24	8.9(6.0-12.9)	
Total		210	64.4 (59.0-69.5)	53	16.3(12.6-20.7)	32	9.8(7.0-13.6)	31	9.5(6.8-13.2)	
blindness?	yes	11	91.7 (78.9-97.6)	0	-	1	8.3(6.7-11.7)	0	-	0.197
	no	195	63.5(51.2-72.3	53	17.3	29	9.4(7.1-13.8)	30	9.8(7.9-12.8)	
Total		206	64.6(59.1-69.6)	53	16.6(12.7-20.9)	30	9.4(7.1-13.9)	30	9.4(7.1-13.9)	

Table 5.24 indicates that there was no evidence of any association between history of poor eyesight in the family and refractive error. Although the results are not significant, the clinical relevance of the results is that children with history of poor eyesight in their families could seem to have astigmatism (12.5%; n=7) compared to those without such a history (8.9%; n=24). The results also provide another insight that those who had family history of blindness could be more likely to have hyperopia (5.4%; n=3) compared to those without history (10.7%; n=29).

5.32 Association of Refractive Error and Father's Spectacles Wear.

Table 5.25 below presents the association between refractive error and the father's spectacles wear.

Table 0.25: Association of refractive error and father's spectacles wear

Does the father wear spectacles?	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%(CI)	Freq	% (CI)	Freq	%(CI)	Freq	%(CI)	
Yes	16	55.2(37.1-72.0)	3	10.3(3.3-27.8)	5	17.2(7.3-35.5)	5	17.2(7.3-35.5)	0.139
No	125	66.8(59.7-73.3)	31	16.6 (11.9-22.7)	17	9.1(5.7-14.2)	14	7.5(4.5-12.3)	
Total	141	65.3(58.6-71.4)	34	15.7(11.4-21.3)	22	10.2(6.8-15.0)	19	8.8(5.7-13.4)	

The results between fathers' wearing of spectacles and refractive error of the children were not significant at 5% level, hence no evidence of any associations between the two. Insights are provided, that the children whose fathers wore spectacles with a prevalence of no refractive error of 55.2% and a prevalence of refractive error of 44.8% (n=13) could have been more likely to experience refractive error compared to those whose fathers did not wear spectacles at a prevalence of no refractive error of 66.8% (n=125) and a prevalence of refractive error of 33.2%; (n=62). Other insights are that myopia was less likely to be prevalent among children whose fathers were spectacle wearers (10.3%; n=3 vs 16.6%; n=31), and hyperopia could be more likely to be prevalent among those whose fathers wore spectacles (17.2%; n=5 vs 9.1%; n=17) and astigmatism was more observable among children whose fathers wore spectacles (17.2%; n=5 vs 7.5%; n=14). These nonsignificant results could be of clinical relevance.

5.33 Association between Refractive Error and the Fathers' Reasons for Spectacles Wear

Table 5.26 below presents the association between refractive error and the reasons for wearing spectacles by the fathers.

Table 0.26: Refractive error and the father's reasons for spectacle wear

Reasons for spectacles wear	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%(CI)	Freq	%(CI)	Freq	%(CI)	Freq	%(CI)	
seeing clearly in distance	3	42.9(35.5-63.1)	1	14.3(2.7-19.4)	2	28.6(13.4-46.8)	1	14.3(2.7-19.4)	0.922
reading, working on a computer or other close work	5	55.6(39.2-70.8)	1	11.1 (1.6-17.7)	2	22.2(3.3-76.4)	1	11.1(1.6-17.7)	
all of the above	5	62.5(49.2-76.2)	1	12.5(1.7-18.9)	0	-	2	25.0	
don't know	1	100	0	-	0	-	0	-	
Total	14	56(37.2-68.7)	3	12.0(1.6-17.1)	4	16.0(7.2-31.1)	4	16.0(7.2-31.1)	

Table 5.26 indicates that reasons provided for father's wearing of glasses were not significant (p>0.05), hence no evidence of associations between refractive error and the

reasons was provided. Although this question was answered by very few fathers (n=25), the results provide clinically relevant insights that reading or working on a computer or other close work could be slightly associated with no refractive error of the children (55.6%). Hyperopia (28.6% vs 22.2%), myopia (14%.3; n=1 vs 11%; n=1) and astigmatism (14.3%; n=1 vs 11%; n=1) seemed to be slightly linked to children whose fathers wore glasses for seeing clearly at a distance more than those who wore glasses for reading, working on the computer or other close work.

5.35 Association of Refractive Error and Mothers' Spectacles Wear.

Table 5.27 below presents the association between refractive error and the mothers' spectacles wear.

Table 0.27: Association of refractive error and mothers' spectacles wear

Does the mother wear spectacles?	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Yes	23	65.7(48.7-79.5)	2	5.7(1.4-20.3)	5	14.3(7.3-35.5)	5	14.3(7.3-35.5)	0.269
No	182	64.1(58.3-69.5)	48	16.9(11.9-22.7)	28	9.9(5.7-14.2)	26	9.2(4.5-12.3)	
Total	205	64.3(58.8-69.4)	50	15.7(11.4-21.3)	33	10.3(6.8-15.0)	31	9.7(5.7-13.4)	

The results between mothers' wearing of spectacles and refractive error were not significant at 5% level, hence no evidence of any associations between the two. Insights are provided though, that the children whose mothers wore spectacles could have been slightly 2 times less likely to experience myopia (5.7%; n=2) compared to those that did not wear spectacles (16.9%; n=48). There is potential that children whose mothers wore spectacles could have slightly more chances of hyperopia (14.3%; n=5 vs 9.9%; n=28) and astigmatism (14.3%; n=5 vs 9.2%; n=26).

5.36 Association of Refractive Error and Mothers' Reasons for Spectacles Wear

Table 5.28 below is a representation of the association between refractive error and mothers' reasons for spectacles wear.

Table 0.28: Association of refractive error and mothers' reasons for spectacles wear

Reason for wearing spectacles	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%(CI)	Freq	%; (CI)	
seeing clearly in distance	5	83.3; (23.6-96.7)	1	16.7; (12.6-20.6)	0	-	0	-	0.392
For reading. working on a computer or other close work	8	61.5; (19.9-90.1)	0	-	3	23.1; (3.3-76.4)	2	15.4; (10.9-22.0)	
For all of the above	5	50; (30.9-69.1)	1	10; (3.8-23.9)	1	10; (3.8-23.9)	3	30; (15.6-44.5)	
Total	18	62.1; (46.7-76.0)	2	6.9; (3.7-11.6)	4	13.8; (8.1-18.5)	5	17.2; (8.5-32.5)	

Table 5.28 indicates that reasons provided for mothers' wearing of glasses were not significant (p>0.05), hence no evidence of associations between refractive error and the reasons was provided. Although this question was answered by very few fathers (n=29), the results could provide clinically relevant insights, that seeing clearly in the distance could be slightly associated with no refractive error in the children (83.3%; n=5), while myopia could be prevalent in children whose mothers wear spectacles for seeing clearly in the distance. These nonsignificant results could be of clinical relevance.

5.37 Association of Refractive Error and Siblings' Spectacles Wear

Table 5.29 below is a representation of the association between refractive error and siblings' reasons for spectacles wear.

Table 0.29: Association of refractive error and siblings' spectacles wear

Do any of the siblings wear spectacles or contact lenses?		No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
		Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
	Yes	14	66.7; (44.5-83.3)	3	14.3; (4.6-36.3)	3	14.3; (4.6-36.3)	1	4.8; (0.7-27.4)	0.800
	No	181	64.0; (58.2-69.4)	49	17.3; (13.3-22.2)	27	9.5; (6.6-13.6)	26	9.2; (6.3-13.2)	
	Total	195	64.1; (58.6-69.4)	52	17.1; (13.3-21.8)	30	9.9; (7.0-13.8)	27	8.9; (6.1-12.7)	

There was no evidence of associations between refractive error and wearing of spectacles or contact lenses by siblings ($p>0.05$). However, the results provide some insights, that there is potential that hyperopia could occur among the children whose siblings wore spectacles (14.3%; n=3 vs 9.5%; n=27). Astigmatism seems to have the potential to occur in those children whose siblings did not wear spectacles, again these results could be of clinical relevance. Very few survey participants responded to this question, hence it is not possible to attach any statistical inferences.

5.38 Association of Refractive Error and Position of the Child In the Family

In Table 5.30 below, the relationship between refractive error and the position of the child in the family is presented.

Table 0.30: Association of refractive error and the biological position of the child.

Position Child	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
1st	79	60.8; (52.1-68.8)	30	23.1; (16.6-31.1)	11	8.5; (4.7-14.7)	10	7.7; (4.2-13.7)	0.020
2nd	67	68.4; (58.5-76.8)	8	8.2; (4.1-15.5)	8	8.2; (4.1-15.5)	15	15.3; (9.4-23.9)	
3rd	30	66.7; (51.7-78.9)	7	15.6; (7.6-29.3)	5	11.1; (4.7-24.1)	3	6.7; (2.2-18.8)	
4th	17	51.5; (34.8-67.9)	5	15.2; (6.4-31.7)	9	27.3; (14.8-44.8)	2	6.1; (1.5-21.4)	
5th	4	50.0; (19.9-80.1)	3	37.5; (12.5-71.7)	0	-	1	12.5; (1.7-54.0)	
6th	3	100.0	0	-	0	-	0	-	
Total	200	63.1; (57.6-68.3)	53	16.7; (13.0-21.3)	33	10.4; (7.5-14.3)	31	9.8; (6.9-13.6)	

Table 5.30 indicates that there was strong evidence of association between child position and refractive error. While (60.8%; n=79) children who were first position had no refractive error, the remainder (39.2%; n=51) were diagnosed with refractive error. Similarly, children (66.7%; n=30) in the second and third (68.4%; n=67) positions did not have refractive error, the remainder had refractive error. Therefore, the prevalence of refractive error was highest amongst first position children (39.2%; n=51), followed by the second and third positions at 33.3% (n=15) and 31.6% (n=31) respectively. Those at position 4 and 5 had less chances of having refractive error (they had greater chances of not experiencing refractive error). The results suggest that the lower the order or position of the child the greater the chances of refractive error. However, myopia was more prevalent in children who were at the fifth position (37.5%; n=3) followed by the first position (n=30). Compared to these, myopia was 4 times less prevalent among second position children, and 2 times less prevalent among children at third position (15.6%; n=7). Hyperopia was

less prevalent among lower position children, first (8.5%; n=11) and second (8.2%; n=8), compared to higher order children, third (11.1%; n=5) and fourth (27.3%; n=9). There was no clear pattern between astigmatism and child position, notably children at first position (7.7%; n=10) were twice less likely to experience astigmatism, compared to children at second position (15.3%; n=15); children at third (6.7%; n=3) and fourth (6.1%; n=2) positions were also less likely to experience astigmatism, compared to those at position 5 (27.5%)-the higher the child order in the family the more likely they were to experience astigmatism.

5.39 Association of Refractive Error, Age and Gender.

Table 5.31 is a representation of the relationship between refractive error, age and gender of the sampled children.

Table 0.31: Association of refractive error, age and gender of the children

Gender	NO RE		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Male	99	66.9	21	14.4;	10	6.8;	18	11.9	0.111
Female	111	62	32	17.9	23	12.8	13	7.3	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.5; (6.7-13.2)	
AGE									
9–11 years	91	69.5; (60.7-76.6)	23	17.6; (12.0-25.3)	7	5.3; (2.6-10.9)	10	7.6; (4.2-13.7)	0.325
12-13 years	107	59.1; (51.8-66.1)	29	16; (11.3-22.1)	25	13.8; (9.5-19.7)	20	11.1; (7.2-16.5)	
14 years and above	12	80; (55.1-93.9)	1	6.7; (0.9-33.8)	1	6.7; (0.9-33.8)	1	6.7; (0.9-33.8)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.5; (6.7-13.2)	

As presented in Table 5.31 above, there is no statistical significance between refractive error and gender (chi-square P-value=0.111). This implies that any differences observed may have been the result of chance variance. Myopia was the most prevalent type of refractive error in both genders, but higher among the females at 17.9%, (n=32) than among the males (14.4%, n=21). Hyperopia was the second prevalent refractive error at 12.8% (n=23) among females, followed by astigmatism at 7.3% (n=13) in the same gender group. Astigmatism was the second common refractive error among males (11.9%, n=18), followed by hyperopia at 6.8% (n=10) among the same gender cohort.

There was no statistical significance between refractive error and the children's age since the chi-square P-value was 0.325. However, the prevalence of myopia was also noticed to decrease with an increase in age. For instance, there was more concentrated association in the 9-11 years age group (17.6%, n=23), followed by the 12-13 years age cohort (16%, n=29), and the 14 years and above age group at 6.7% (n=1). Hyperopia (13.8%, n=25) and astigmatism (11.1%, n=20) were more concentrated in the 12-13 years cohort compared to the 9-11 years and 14 years and above cohort.

5.40 Association of Refractive Error, School and Grade Level

Table 5.32 below shows the association of refractive error, school and grade level.

Table 0.32: Association of refractive error, school and grade level

	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
School	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	0.000
School A	49	55.1; (46.5-64.8)	14	15.7; (10.1-23.3)	14	15.7; (10.1-23.3)	12	13.5; (7.1-20.2)	
School B	67	61.4; (51.7-70.2	27	24.8; (15.4-36.1)	3	2.8; (0.7-4.3)	12	11; (6.4-18.5)	
School C	94	72.9; (62.6-80.2)	12	9.3; (4.8-17.1)	16	12.4; (6.9-19.9)	7	5.4; (2.1-10.2)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	
GRADE									
Grade 5	80	74.8; (65.6-82.1)	11	10.3; (5.8-17.7)	4	3.7; (1.4-9.6)	12	11.2; (6.5-18.8)	0.023
Grade 6	68	62.4; (52.9-71.0)	20	18.3; (12.1-26.8)	11	10.1; (5.7-17.4)	10	9.2; (5.0-16.3)	
Grade 7	58	54.2; (46.5-64.8)	22	20.6; (13.4-28.3)	18	16.8; (10.4-24.3)	9	8.4; (4.3-14.9)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

As presented in Table 5.32 above, there is very strong association between refractive error and the sampled schools, with the chi-square P-value of 0.000. School C had the highest chances of not having refractive error (72.9%; n=94) as compared to School B (rural public school) (61.4%; n=27) and School A (private school) (55.1%; n=49). This implies that School A had the highest refractive error prevalence (44.9%; n=40) followed by School B (38.6%; n=42) and School C (urban public school) with the least prevalence of 27.1% (n=35). In this context, myopia was highest (24.8%, n=27), at School B, followed by School A at 15.7% (n=14). It was noted that myopia was highest at a rural public school as compared to the other two schools. Additionally, Table 5.15 further illustrates that, as opposed to the previous prevalence pattern, it was noted that astigmatism was highest at 13.5% (n=12) for School A, followed by 11% (n=12) for School B. It was also interesting to note that School A also had the highest hyperopia prevalence (15.7%, n=14), as opposed to School B and School C.

The study also shows a strong association between refractive error and school grade of the children (P-Value=0,023). Most of the children in grade 5 (74.8%; n=80) did not have refractive error, while 25.2% (n=27) were diagnosed with refractive error. In the sixth grade, 62.4% (n=68) had no refractive error, therefore the remainder, 37.6% (n=41) had refractive error. Similarly, 54.2% (n=58) children in grade 7 were without refractive error, while the remainder (45.8%; n=49) suffered from refractive error. Therefore, the prevalence of refractive error was highest in grade 7 (37.6% (n=41), followed by grade 6 (62.4% (n=68) and grade 5 had the lowest occurrence of refractive error (74.8%; n=80). Therefore, refractive error prevalence increased with an increase with the school grade. Similarly, myopia prevalence was highest in grade 7 (20.6%; n=22), followed by grades 6 (18.3%; n=20) and 5 (10.3%; 11). Grade 7 children were twice more likely to have refractive error than grade 5 children. Hyperopia also followed the same pattern of distribution, wherein the prevalence was 16.8% (n=9); 10.1% (11) and 3.7% (4) for grades 7, 6 and 5 respectively. Lastly, as opposed to myopia and hyperopia, astigmatism prevalence increased with the decrease in grade, wherein the highest occurrence was in grade 5 (11.2%; n=12), grade 6 (9.4%; n=10) and grade 7 (8.4%; n=9).

5.41 Association of Refractive Error, History of Eye Test and Spectacles/Contact Lens Wear of the Child

Table 5.33 below illustrates the relationship between refractive error and history of eye test and spectacles or contact lenses wear of the child.

Table 0.33: Association of refractive error, history of eye test and spectacles/contact lenses wear of the child

	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
Eye test	Freq	%; (*CI*)	Freq	%; (*CI*)	Freq	%; (*CI*)	Freq	%; (*CI*)	0.817
Yes	33	60; (45.7-71.5)	11	20; (11.6-33.2)	6	10.9; (5.1-22.7)	5	9.1; (3.9-20.5)	
No	177	65%; (59.3-70.8)	42	15.4; (11.9-20.8)	27	9.9; (6.4-13.6)	26	9.5; (.4-13.6)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	
Spectacles wear									
Yes	2	25; (7.5-50.3)	4	50; (17.6-75.0)	1	12.5; (5.6-58.1)	1	12.5; (5.6-58.1)	0.009
No	208	65; (60.3-70.8)	49	15.3; (11.8-19.8)	32	10; (6.9-13.6)	30	9.4; (6.4-12.8)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	
Period for eye examination									
past/current year	8	42.1; (12.1-65.2)	7	36.8; (9.2-59.1)	2	10.5; (1.7-16.2)	2	10.5; (1.7-16.2)	0,510
in the last 2 years	19	63.3; (47.2-79.9)	3	10; (2.4-18.6)	5	16.7	3	10; (2.4-18.6)	
in the last 5 years	3	75; (55.3-90)	1	25; (9.5-41.0)	0	-	0	-	
over 5 years	2	100	0	-	0	-	0	-	
Total	32	58.2: (44.2-72.2)	11	20; (5.7-31.2)	7	12.7; (3.1-17.1)	5	9.1; (1.9-17.3)	
Reason for eye examination									

General eye test or school screening	12	52.2; (41.4-69.2)	5	21.7; (6.6-32.3)	3	13; (4.4-18.1)	3	13; (4.4-18.1)	0,192
painful, itchy eyes or injury	17	68; (51.6-72.1)	4	16; (5.0-19.9)	2	8; (2.1=13.6)	2	8; (2.1=13.6)	
poor vision	0	-	2	100	0	-	0	-	
Total	29	58; (44.1-69.5)	11	22; (6.8-33.0)	5	10; (2.4-18.6)	5	10; (2.4-18.6)	

The table above shows that there was no statistical significance between refractive error and the child's history of eye testing (chi-square P-value=0.817). While 60% (n=33) of the 55 children with a history of eye testing did not have refractive error, myopia mostly occurred among the children with history 20% (n=11) of eye testing compared to those without a history 15.4% (n=42). The chances of hyperopia occurrence were higher among children with a history of eye test compared to those without history (10.9%; n=6 vs 9.4%; n=26)) and lastly astigmatism was slightly lower by 0.2% among children that had a history of eye examination (9.1%, n=5) than children that did not present with any history of eye testing, 9.3% (n=25) had astigmatism.

In addition, there was weak association between refractive error and the children's spectacle/contact lenses wear (chi-square P-value=0.009) at 10%. However, these findings might be of clinical relevance. From the 8 (2.4%) children who wore spectacles only 2 (25%) did not have refractive error, whereas the majority (75%; n=6), had refractive error compared to the 65% (n=208) without refractive error among the children that did not wear spectacles. Myopia was three times associated with children that wore spectacles (50%; n=4 vs 15.3%; n=49) than those without spectacles.

The association between refractive error and the period from the last eye examination was non-significant (p value = 0.510). The non-significant finding could be of clinical relevance as it shows that the occurrence of myopia was mostly among the children that had an eye examination in the past/current year (36.8%; n=7) than those that consulted in the past 2 years (10%; n=3) and the past 5 years (25%; n=1). In this context, myopia was three times more likely to occur among children who had eye examinations in the past/current year than those that consulted in the past two years. The occurrence of hyperopia was common among those that consulted in the past 2 years (16.7%; n=5) than those that consulted in the current/past year (10.5%; n=2). There was not much of a difference in the occurrence of astigmatism between those that consulted in the current year (10.5%; n=2) and those that did in the past 2 years (10%; n=3).

Similarly, the study findings showed that the association between refractive error and the reasons for eye testing/examination was non-significant. However, it was noted that the occurrence of myopia was highest among children that cited poor vision (100%; n=2) than general eye test or school screening (21.7%; n=5) and painful, itchy or injured eyes (16%; n=4). None of the children with hyperopia and astigmatism cited poor vision as a reason for consultations. However, the majority of the children with hyperopia (13%; n=3) and astigmatism (13%; n=3) cited general eye test or screening as a reason for eye examination than painful, itchy or injured eyes (8%; n=2 for each).

5.42 Association of Refractive Error and Time Spent on the Computer/TV After School

Table 5.34 below is a representation of the association between refractive error and the time spent on the computer/TV after school.

Table 0.34: Association of refractive error and time spent on the computer/TV after school

	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
Time spent	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Less than 30 minutes	26	57.8; (43.0-71.3)	9	20.0; (10.7-34.3)	6	13.3; (6.1-26.7)	4	8.9; (3.4-21.5)	0.141
30 minutes to 1 hour	30	63.8; (49.2-76.2)	4	8.5; (3.2-20.7)	9	19.1; (10.2-33.0)	4	8.5; (3.2-20.7)	
above 1 hour	38	55.1; (43.2-66.4)	14	20.3; (12.4-31.5)	7	10.1; (4.9-19.9)	10	14.5; (8.0-25.0)	
None	116	69.9; (62.4-76.4)	26	15.7; (10.9-22.0)	11	6.6; (3.7-11.6)	13	7.8; (4.6-13.1)	

Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

Table 5.34 indicates that there were no significant associations between time spent by the child on the computer/TV and refractive error. The results provide insights that myopia could occur more in children who spent less than 30 minutes on the computer/TV after school (20%; n=9 vs 8.5%; 4) while astigmatism could occur more in children who spent more than 1 hour (14.5%; n=10 vs 8.9%; n=4). Hyperopia had the potential to be experienced by children who spent > 30 mins on the computer after school, compared to those who spent 1 hour.

5.43 Association between Refractive Error and Time Spent on After-School Reading, Writing, Drawing And Coloring.

Table 5.35 depicts the association between refractive error and time spent on after-school reading, writing, drawing and coloring.

Table 0.35: Refractive error and time spent on after school reading, writing, drawing and coloringl

Time spent	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Less than 30 minutes	20	55.6; (39.2-70.8)	4	11.1; (4.2-26.2)	10	27.8; (15.6-44.5)	2	5.6; (1.4-19.8)	0.002
30 minutes to 1 hour	81	74.3; (65.3-81.7)	10	9.2;(5.0-16.3)	10	9.2; (5.0-16.3)	8	7.3; (3.7-14.0)	
above 1 hour	94	58.4; (50.6-65.8)	35	21.7; (16.0-28.8)	12	7.5; (4.3-12.7)	20	12.4; (8.1-18.5)	
None	15	71.4; (49.1-86.6)	4	19; (7.3-41.3)	1	4.8; (0.7-27.4)	1	4.8; (0.7-27.4)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

Strong evidence is shown in Table 5.35, that time spent on reading, writing, drawing and coloring after school was significantly associated with refractive error ($p<0.05$). Of the children who spent less than 30 minutes reading, writing, drawing and coloring after school, 55.6% (n=20) did not have refractive error, whereas refractive error was recorded for 44.4% (n=16) of the children. When compared to those who spent more than 30 minutes (74.3%; n=81) on the same activity without refractive error, the prevalence of refractive error was 24.7% (n=28). In other words, those who spent less than 30 minutes on this activity were more likely to have refractive error. However, myopia was almost 2 times more likely among children who spent more than 1 hour on this exercise (21.7%; n=35), compared to those who spent between 30 minutes to 1 hour (9.2%; n=10) and those who spent less than 30 minutes (11.1%; n=4). Hyperopia was 2-3 times more likely to occur among those who spent less than an hour reading, writing etc. after school (27.8%; n=10), compared to those who spent between 30 minutes-1 hour (9.2%; n=10) and those who spent more than 1 hour (7.5%; n=12). Astigmatism was 2 times more likely to be prevalent among those who spent more than one hour on these school activities (12.4%; n=20) compared to those who spent less than 30 minutes (5.6%; n=2).

5.44 Association of Refractive Error and Time Spent On After-School Sports

Table 5.36 below is a depiction of refractive error and time spent on after-school sports.

Table 0.36: Association of refractive error and time spent on after school sports

	No refractive error		**Myopia**		**Hyperopia**		Astigmatism		Asymptotic Significance (2-sided)
Time spent	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
Less than 30 minutes	21	61.8; (44.6-76.4)	5	14.7;(6.2-30.9)	5	14.7; (6.2-30.9)	3	8.8; (2.9-24.2)	0.083
30 minutes to 1 hour	53	76.8; (65.4-85.3)	5	7.2; (3.0-16.3)	7	10.1; (4.9-19.9)	4	5.8; (2.2-14.5)	
above 1 hour	122	59.8; (52.9-66.3)	42	20.6; (15.6-26.7)	17	8.3; (5.2-13.0)	23	11.3; (7.6-16.4)	
None	14	70; (47.2-85.9)	1	5.0; (0.7-28.4)	4	20 (.7-42.9)	1	5 (0.7-28.4)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

Weak evidence of associations between time spent playing other sports after school and refractive error is shown in Table 5.36, results are significant at 10% level. Children who spent less than 30 minutes to 1 hour on these activities were less likely to have refractive error (76.8%; n=53) compared to children who spent more than 1 hour (59.8%; n=122). Other weak evidence shows that myopia was more likely to occur in those that spent 1 hour or more in playing other sports after school (20.6%; n=42), compared to those who spent less than 30 minutes (14.7%; n=5) and those who spent between 30-60 minutes. Further results indicate that those who did not participate in these activities were more likely to have hyperopia (20%; n=4), the same applies to those who spent less than 30 minutes (14.7%; n=5) compared to those who spent more than 30 minutes (10.1%; 7) or those who spent more than an hour (8.3%; n=17). Lastly, astigmatism was more likely to occur among children who spent more than 1 hour (11%; n=23 vs 8.8%; n=3-less than 30 minutes).

5.45 Association of Refractive Error and Unaided Visual Acuity

Table 5.37 represents the association between refractive error and unaided visual acuity of the right eye.

Table 0.37: Association of refractive error and unaided visual acuity of the right eye

UVARE	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%	Freq	%	Freq	%	Freq	%	
6/6	204	85.4; (80.3-89.3)	6	2.5; (1.1-5.5)	21	8.8; (5.8-13.1)	8	3.3; (1.7-6.6)	0.000
6/7,5	2	8.3; (2.1-28.0)	12	50; (30.9-69.1)	8	33.3; (17.6-54.0)	2	8.3; (2.1-28.0)	
6/9	4	10; (3.8-23.9)	25	62.5; (46.7-76.0)	4	10; (3.8-23.9)	7	17.5; (8.5-32.5)	
6/10	0	-	5	45.5; (20.2-73.3)	0	-	6	54.5; (26.7-79.8)	
6/12	0	-	3	60; (19.9-90.1)	0	-	2	40; (9.9-80.1)	
6/15	0	-	0	-	0	-	2	100	
6/18	0	-	1	25; (3.3-76.4)	0	-	3	75; (23.6-96.7)	
6/21	0	-	1	50; (5.8-94.2)	0	-	1	50; (5.8-94.2)	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

Table 5.37 provides very strong evidence of associations between refractive error and unaided visual acuity ($p<0.05$). Notably, those with normal vision (>6/6) were 8 times more likely not to have refractive error (85.4%; n=204) compared to those with mild visual impairment (6/9-6/18). Further results indicate that those with normal vision (6/6) were less likely to experience myopia (2.5%; n=6), compared to those who had mild visual impairment (62.5%; n=25) and those who had moderate visual impairment (6/21) (50%; n=1). Hyperopia was less likely to occur among those with 6/6 visual acuity (8.8%; n=21),

compared to those with unaided visual acuity of 6/7.5 (33.3%; n=8) or 6/9 (mild visual impairment). Astigmatism was lowest among survey participants who had normal 6\6 UVA, (3.3%; n=8), higher among those with normal UVA of 6/7.5 (8.3%; 2) and became higher as UVA increased; 6/9 (17.5%; n=7), 6/10 (54.5%; n=6), or 6/12 (40%; n=2).

5.46 Association of Refractive Error and Unaided Visual Acuity for the Left Eye.

Table 5.38 represents the association between refractive error and unaided visual acuity for both the right and the left eye.

Table 0.38: Association of refractive and unaided visual acuity

UVALE	No refractive error		Myopia		Hyperopia		Astigmatism		Asymptotic Significance (2-sided)
	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	
6/6	205	85.1; (80.0-89.0)	5	2.1; (0.9-4.9)	22	9.1; (6.1-13.5)	9	3.7; (1.9-7.0)	0.000
6/7,5	3	11.5; (3.7-30.4)	11	42.3; (25.1-61.6)	7	26.9; (13.4-46.8)	5	19.2; (8.2-38.8)	
6/9	2	5.3; (1.3-18.9)	27	71.1; (54.8-83.2)	3	7.9; (2.6-21.9)	6	15.8; (7.2-31.1)	
6/10	0	-	3	42.9; (14.3-77.2)	1	14.3; (1.9-58.3)	3	42.9; (14.3-77.2)	
6/12	0	-	5	62.5; (28.3-87.5)	0	-	3	37.5; (12.5-71.7)	
6/18	0	-	1	100	0	-	0	-	
6/21	0	-	1	20; (2.7-69.4)	0	-	4	80; (30.6-97.3)	
6/120	0	-	0	-	0	-	1	100	
Total	210	64.2; (58.8-69.3)	53	16.2; (12.6-20.6)	33	10.1; (7.3-13.9)	31	9.4; (6.7-13.2)	

Table 5.38 provides very strong evidence of associations between refractive error and unaided visual acuity of the left eye ($p<0.05$). Notably, those with normal vision (>6/6) were 16-17 times more likely not to have refractive error (85.1%; n=205) compared to those with mild visual impairment (6/9-6/18) (5.3%; n=2). Further results indicate that those with normal vision (6/6) were less likely to experience myopia (2.1%; n=5),

compared to those who had mild visual impairment, 6/9 (71.1%; n=27), 6/10 (42.9%; n=3) and 6/12 (62.5%; n=5). Hyperopia was less likely to occur among those with normal vision (9.1%; n=22), compared to those with mild unaided visual acuity of 6/7.5 (26.9%; n=7) or 6/10 (mild visual impairment). Astigmatism was lowest among survey participants who had normal UVA, (6/6, 3.7%; n=9), higher among those with normal UVA of 6/7.5 (19.2%; n=5) and became higher as the UVA increased; 6/10 (42.9%; n=3), 6/12 (37.5%; n=3).

5.47 Association of Unaided Visual Acuity for the Right And Left Eye and other Conditions

The table below presents the association of unaided visual acuity for the right and left eye with other conditions which include allergic, bacterial and vernal keratoconjunctivitis, keratoconus and ptosis. Although these conditions, were not the focus of the study, they were diagnosed during the visual examination of the children by the researcher.

Table 0.39: Association of unaided visual acuity of the right eye and other conditions

UVA		Vernal Keratoconjuctivitis		Allergic conjunctivitis		Bacterial conjunctivitis		Keratoconus		Ptosis		Asymptotic Significance (2-sided)
		Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	Freq	%; (CI)	0.003
UVARE	6/6	10	41.7; (9.9-80.1)	8	33.3; (17.6-54.0)	2	8.3; (2.1-28.0)	4	16.7; (7.2-31.1)	0	-	
	6/7.5	1	33.3; (17.6-54.0)	2	66.7; (28.3-87.5)	0	-	0	-	0	-	
	6/9	0	-	2	40; (14.3-77.2)	0	-	0	-	3	60; (19.9-90.1)	
	6/10	0	-	3	100	0	-	0	-	0	-	
	6/15	0	-	0	-	0	-	1	100	0	-	
	6/18	3	100	0	-	0	-	0	-	0	-	
	6/21	0	-	0	-	0	-	1	100	0	-	
	Pearson Correlation = -0,007 Sig. (2-tailed) = 0,966											
UVALE	6/6	10	37; (12.5-71.7)	8	29.6; (13.4-46.8)	2	7.4; (1.7-27.1)	4	14.8; (6.9-30.0)	3	11.1; (3.2-29.9)	0.352
	6/7.5	1	50; (30.9-69.1)	1	50; (30.9-69.1)	0	-	0	-	0	-	
	6/9	0	-	3	100	0	-	0	-	0	-	
	6/10	0	-	3	100	0	-	0	-	0	-	
	6/21	3	75; (23.6-96.7)	0	-	0	-	1	25; (3.3-76.4)	0	-	
	6/120	0	-	0	-	0	-	1	100	0	-	
Total		14	35; (18.7-56.3)	15	37; (12.5-71.7)	2	5	6	15; (7.0-30.1)	3	7.5; (1.8-27.2)	
		Pearson Correlation = 0,114 Sig. (2-tailed) = 0,485										

Table 5.39 shows a strong association (P-Value=0.003) between unaided visual acuity of the right eye and other conditions among the children. However, the Pearson Correlation (-0.007; p=0.966) showed that the relationship was not statistically significant. The prevalence of vernal conjunctivitis (41.7%; n=10), allergic conjunctivitis (33.3%; n=8), keratoconus (16.7%; n=4) and bacterial conjunctivitis (8.3%; n=2) were mostly associated with the 6/6 visual acuity. However, there was 1 case of keratoconus that was associated with the 1/15 visual acuity, 3 cases of vernal conjunctivitis that were associated with the 6/18 visual acuity and 1 case of keratoconus which was associated with the 6/21 visual acuity. However, there was no statistically significant association between unaided visual acuity of the left eye and pathological conditions (P-Value=0.352). Nonetheless, a similar pattern of distribution was noted between the right and the left eye, however, there was 1 case of keratoconus that was associated with the 6/21 visual acuity and another case that was associated with the 6/120 visual acuity of the left eye.

5.48. Multivariate Regression

In this multivariate regression the dependent variable is diagnosis, which was recorded 0=no refractive error and 1=some refractive error. β is the beta coefficient and α is the alpha value.

5.48.1 Model 1: Relationship Between Refractive Error and the Parents' Demographic Factors

The table below presents the relationship between refractive error and the parents' demographical factors. In the first model, the predictors are employment mother, age father, employment father, education father, age mother, education mother. This can mathematically be written as: Y(Diagnosis)=α + β (employment mother) + β (employment father) + β (education father) + β (education mother) + error term.

Table 0.40: Showing the relationship between refractive error and the parents's demographics

Unstandardized Co-efficients		Standardized Co-efficients			
Constant	Beta	Std. Error	Beta	t	Sig.
	1.563	0.584		2.676	0.008
Age Father	0.069	0.105	0.055	0.652	0.515
Age Mother	0.115	0.130	0.077	0.883	0.379
Education Father	0.310	0.125	0.275	2.477	*0.014
Education Mother	-0.205	0.125	-0.189	-1.637	0.103
Employment Father	-0.432	0.177	-0.186	-2.440	*0.016
Employment Mother	-0.090	0.163	-0.044	-0.551	0.582
R Square=0.67 F=2.472 Sig=0.025					

The multivariate regression shows that the model is fit (p-value=0.25), with an explanatory power of 67%; the independent variables explain variations in diagnosis 67% of the times. The results show that there is a positive relationship between fathers' education and refractive error ($\beta=0.31$, $p<0.05$), indicating refractive error increased as education increased, and vice versa. Further results show that there was a negative relationship between the fathers' employment status and refractive error ($\beta=-0.43$, $p<0.05$), results suggesting that those who were not employed had higher chances of not having some refractive error. Mothers' education and employment and the parents' age were not predictors of refractive error in this sample.

5.48.2 Model 2: Relationship Between Refractive Error, School and Grade

Table 5.41 below shows the relationship between refractive error, school and grade of the children. In the second model, the predictors are school and grade. Mathematically this can be explained as: Y (refractive error) =α + β (school) + β (grade) + error term

Table 0.41: Showing the relationship between refractive error, school and grade

Unstandardized Coefficients			**Standardized Coefficients**		
	B	Std. Error	Beta	T	Sig.
(Constant)	1.826	0.226		8.080	0.000
School	-0.178	0.068	-0.144	-2.627	*0.009
Grade	0.101	0.066	0.085	1.542	0.124

a. **R Square=0.59 F=3.210 Sig=0.023**

b. **Dependent Variable: Diagnosis**

c. **Predictors: (Constant), legal status, School, Grade**

The results show that there is a negative relationship between the school where the child was and retractive error (β=-0.18, p<0.009), indicating that the schools had a negative impact on refractive error, practically this means that children from School A (private) had higher chances of having refractive error than the other schools, while myopia had the highest chance of occurrence among children from school B (rural). There was no relationship between refractive error and grade (p=0.12).

5.48.3 Model 3: Relationship Between Refractive Error and UVARE and UVALE

Table 5.42 below shows the relationship between refractive error and unaided visual acuity for the right and left eyes. In this third model, the predictors are unaided visual acuity of the right and left eye. Mathematically this can be explained as: Y (refractive error) =α + β (UVALE) + β (UVARE) + error term

Table 0.42: Showing the relationship between refractive error UVARE and UVALE

Unstandardized Coefficients			Standardized Coefficients		
Constant	B	Std. Error	Beta	T	Sig.
	1.067	0.260		4.099	0.000
UVARE	0.318	0.080	0.403	3.978	*0.000
UVALE	0.138	0.078	0.197	1.769	**0.078
PHVARE	0.291	0.182	0.119	1.598	0.111
PHVALE	-0.344	0.191	-0.150	-1.803	0.072

a. **R Square=0.78 F=22.4 Sig=0.000**
b. **Dependent Variable: Diagnosis**
c. **Predictors: (Constant), PHVALE, UVARE, PHVARE, UVALE**

The results show that there are positive relationships between Unaided Visual Acuity of the right (β=0.32, p=0.000) and UVA of the left eye (β=0.138, 0.078). Those whose UVA was normal were more likely to have positive effects on refractive error, they had less chances of having it.

5.48.4 Model 4: Relationship Between Refractive Error and the Time Spent on Activities After School.

Table 5.43 below shows the relationship between refractive error and the time spent on the computer/TV; reading, writing, drawing and coloring; and playing sports after school.

Mathematically this is explained as: Y (Diagnosis)=α + β (activities-computer) + β (activity-reading) + β (activity-watching TV) + error term.

Table 0.43: Showing the relationship between refractive error and time spent on activties after school

Unstandardized Coefficients			Standardized Coefficients		
(Constant)	B	Std. Error	Beta	T	Sig.
	1.766	0.270		6.540	0.000
Reading, writing and coloring	-0.092	0.052	-0.100	-1.777	0.076
Computer/TV	-0.018	0.074	-0.014	-0.250	0.803
Playing sports	0.081	0.078	0.060	1.033	0.302

a. **R Square=0.78 F=1.2 Sig=0.303**

b. **Dependent Variable: Diagnosis**

c. **Predictors: (Constant), Watching TV, Sports, Computer, Reading, writing and colouring.**

The results show that there are positive relationships between reading, writing and colouring and retractive error (β=-0.09 p=0.076), weak results significant at 10% level, suggest that being indulged in reading, writing and colouring after school had a negative effect on retractive error; such children were bound to have refractive error. This implies that children who spent more than 1 hour on the activity were more likely to have myopia than those that spent lesser time. However, there was no relationship between time spent on other activities after school and retractive error.

5.48.5 Model 5: Relationship Between Refractive Error and the Child's Biological Position

Table 5.44 below shows the relationship between refractive error and the position of the child in the family. In this fifth model, the predictor is the child's position. Mathematically this is explained as: Y(Diagnosis)=α + β (Child position) + error term.

Table 0.44: Showing the relationship between refractive error and the child position

Unstandardized Coefficients			**Standardized Coefficients**		
(Constant)	B	Std. Error	Beta	T	Sig
	1,613	0,141		11,412	0,000
Child position	-0.430	0.167	-0.189	-2.445	*0.017

R Square=0.69 F=2.476 Sig=0.027

a. **Dependent Variable: Diagnosis**
b. **Predictor: (Constant), Child position**

The table above shows a negative relationship between the child's position and refractive error (β=-0.430; p=0.017). This implies that the prevalence of refractive error increased with a decrease in the position of the child. Therefore, first born children were more likely to experience refractive error, particularly myopia, than the children in the other positions.

STAGE 2: QUALITATIVE FINDINGS

SECTION G: Educators' Experiences of Learners' Refractive Error

The qualitative research strategy captures meanings and/or experiences described in the research participants' own words. This approach, therefore, in this section focused specifically on examining experiences of the recruited research participants. It was imperative to generate data as voiced by the research participants. For example, obtaining information as expressed in the words used by the research participants on the meaning or the experiences related to eye problems among school children.

The qualitative aspect of the study's data collection involved key informant interviews of 10 educators as research participants, 7 (seven) of whom were female and 3 (three) were male teachers. The educators' ages ranged from 20-25 years, and above 50 years, with the majority 50% (n=5) falling within the 41-45 years age cohort. There were four (4) Foundation Phase teachers, 3 (three) Intermediate Phase teachers, and 3 (three) Senior Phase teachers. Three (3) of the teachers were from School A, another 3 (three) from School C, and 4 (four) were from School B. The majority of the participants (50%, n=5) had teaching experience of 11-20 years, followed by 30%, n=3) who had 1-10 years teaching experience, and (20%, n=2) who had taught for 21-30 years. The highest qualification for the educators was an Honours degree (1/one educator), followed by diploma (6/six educators). The other 3 (three) had a degree.

Table 0.45: Demographic information of the educators

Demographic information of the respondents		Total (N)= 10	
		Freq	%
Gender	Male	3	30
	Female	7	70
Age	20-25 years	1	10
	26-30 yaers	1	10
	31-35 years	1	20
	41-45 years	5	50
	Above 50 years	2	20
School	School A	3	30
	School B	4	40
	School C	3	30
Education Phase	Foundation Phase	4	40
	Intermediate phase	3	30
	Senior Phase	3	30
Years of experience	1-10 years	3	30
	11-20 years	5	50
	21- 30 years	2	20
Highest qualification	Diploma	6	60
	Degree	3	30
	Honours	1	10

Thematic data analysis was used to analyse data, in terms of which the narrative (interview-based) statements of the participants have been categorised into themes, categories and sub-categories emanating from the frequently emerging responses of the educators (Brink *et al*., 2012; Bryman, 2016). It is to be noted that the key statements cited below, generally encapsulate the views and perspectives of all the sampled ten teachers. The responses of educators to the interview questions were analysed and Table 5.46 below shows the different themes, categories and sub-categories that emerged from the responses of the educators regarding their experience and attitude in teaching children with eye problems. The quotations of the educators' responses were presented in both Xitsonga and English, wherein the Xitsonga version was presented in bold and the English one in italics.

Table 0.46: The experiences of educators in teaching children with eye problems

Theme	Category	Subcategory
1. **Teachers' knowledge of eye problems**	1.1. Refractive error	
2. **Manifestation of eye problems**	2.1. Reading, Writing and Arithmetic	2.1.1. Reading/copying from chalkboard
		2.1.2. Reading/copying from textbook
		2.1.3. Orientation of text on learners' book (above lines, underlining)
	2.2. Allergies, rubbing and redness of eyes	
3. **Teacher Observations**	3.1. In Classroom	3.1.3. Failure to complete the tasks

	3.2. Outside Classroom	3.2.1. Interaction with other children
	3.3. Notification from Parents	
4. **Actions Taken by Teachers, mitigation factors**	4.1. Seating arrangement	
	4.2. Notifying kids to notify parents	
5. **Challenges**	5.1. Follow-up with Parents post-screening	
	5.2. Early Childhood Development vs Foundation Phase vs Intermediate Phase	5.2.1. The DoH only screens ECD & Foundation: Neglection of Intermediate & Snr Phase
6. **Recommendations**	6.1. Screening	6.1.1. Screening by Health educators
		6.1.2. Screening by health professionals
	6.2. Treatment of poor eyesight	6.2.1. Preference of medication over spectacles.
	6.3. Prevention of poor eyesight	

5.49. Theme 1: Knowledge of Refractive Error

This theme emanated when the educators were asked about the term refractive error.

Category 1.1: Refractive Error

The teachers' knowledge and awareness on refractive error was of particular interest to the researcher. It was because of factors such as knowledge and awareness that reasonably dependable information could be obtained concerning the school children's eye problems. The teachers were asked to say whether they knew of, understood or have heard about the term "refractive error". All the teachers had no idea (did not know, understand, or heard about) the term "refractive error", even though they could notice children presenting with signs of refractive error. The following statements confirm the teachers' assertions in this regard. *"…Its … its ... its according to me, I can say it is something that was supposed to happen, but could not happen up to the level it was supposed to reach...(Educator 9)*

"…No, I do not know…" [she giggled] (Educator 10)

When the researcher probed further, the educator tried to explain the type of eye conditions that she knew as they were common among the elderly population.

> *"…I have never heard of it [refractive error]. With the eyes, I hear of glaucoma and the likes as they are more related to the elderly who suffer from diabetes, but with children, I don't know anything…" (Educators 10)*.

5.49.1 Theme 2: Manifestation of Eye Problems

The educators described their experiences regarding eye problems of the school children, which included reading, writing and arithmetic in the classroom. In addition, the educators indicated the high occurrence of allergies, rubbing and redness of eyes among the children. This theme (manifestation of eye problems) emerged when the educators were asked about the occurrence of eye problems among children. Most teachers mentioned that their learners experienced eye problems in the classroom. The educators explained that children do experience eye problems which is a major problem for the children. The quotation below confirms the educators' assertions in this regard.

> *"…Yes, they [eye problems] are there, just like when a child is looking at the chalkboard and he/she looks at it as if he/she is struggling, and one can see that the child even closes his/her eyes (squeezing/squinting) he/she is exposed to the sun rays, as they he/she tries to see clearly..."* ***(Educator 5)***

Category 2.1. Reading, Writing and Arithmetic

In relation to the finding above, the educators mostly referred to the tasks that included reading, writing and arithmetic when relating to the children's eye problems. These tasks may be linked to the core functions within the classroom, and thus most of the activities in the classroom revolve around reading, writing and arithmetic. In this manner, the educators can instill knowledge and skills to the learners. However, all these tasks require vision, and as a result, poor vision has a direct impact on the accomplishment of the educator's goal. The educators mentioned reading and copying from the chalkboard and textbook and orientation of lines, as the most occurring problems that result from eye conditions as discussed below. In this context, it is imperative to highlight that children with binocular anomalies as well, often experience difficulties with reading and writing (Dusek, Pierscionek and McClelland, 2010: 1).

Subcategory 2.1.1. Reading and Copying from the Chalkboard

Further to the above findings, the educators reported how leaners struggle to rewrite work copied from the chalkboard in their own books. This type of task is usually given by teachers to assess or instill replication of texts and to monitor writing capabilities such as cursive writing. Most educators explained the challenges encountered when a child reads and copies from the chalkboard. This then leads to academic problems as they use the wrongly written information as correct. As explained by Educator 1 below, who gave an example of teaching a child how to write an "*a*", it is well demonstrated that children with clear vision may find it easy to grasp the lesson than those with poor vision. The educator also explained that the one that does not see clearly may not know where the line for the alphabet "*a*" is written since the demonstration was not clearly visible to him/her. By those that do not see clearly, the researcher assumes that the educator was referring to children that suffer from myopia or astigmatism as the two conditions affect distance vision. The explanation by the educator tells the researcher that educators may need to pay special attention to children with visual problems and explain the same concept separately, or some teachers who fail to identify the problem may assume that the child fails to understand the lesson, which may not be the case. This may make it difficult for the child to enjoy the lesson and may then withdraw or focus on other things during the lesson. Educator 10 as well, explained that children with eye problems copy incorrectly from the chalkboard. This tells the researcher that poor vision is a serious learning barrier in the classroom and makes it difficult for the educator and the learner to achieve their ultimate goals. This is unsurprising as the need for clear vision in performing academic tasks is critical (Raiyn, 2016: 115). The following statements confirm the teachers' assertions in this regard.

> *"… It's when the child does not copy correctly, then you can see that what he/she copied is not what I wrote on the chalkboard…" (Educator 7)*

Other educators further demonstrated how difficulty in reading or copying from the chalkboard for children with eye problems affects the academic performance and activities as confirmed by the following statement.

> *"…Yes, academic performance gets affected because if the child cannot see clearly, he/she will not know…you can teach them an "a" and he/she does not see that it is an "a" …and it has a line. Weather it [the line] is drawn on the left or on the right of the circle. But the one who sees clearly, when you write on the chalkboard, he/she immediately sees that this is an "a", it*

is written like this. So, the other one [with poor vision] will only realise it later…" (Educator 1)

Subcategory 2.1.2. Reading and Copying from the Textbook

Having discussed the challenges caused by reading and copying from the book, other educators mentioned that they could identify eye problems with reading and copying from the textbook. Although the two challenges experienced by the children maybe related as they both refer to reading and copying, they are different because of the reading distance. Most of the school activities and tasks are found in textbooks, wherein learners are taught to read. Educators have reported that children with poor vision struggle to execute tasks from the textbook. With regards to reading, educator 6 in the quote below explained that these learners do not read the words correctly and as such, the educator could easily associate the reading problem with poor vision.

"We see it when, maybe when you give them a passage to read, you find that when they read, they don't read some of the things correctly. Sometimes you will find that they struggle to read a word, then you easily see it that this child cannot see" (Educator 6)

The seriousness of this problem was further elaborated by educator 7, who explained that these children go to an extent of not writing the tasks because they cannot see clearly. It is critical for the educator to assess the knowledge of the learners by giving them tasks, however, the researcher had noted that when there are vision problems like these, that affect execution of tasks by the learners, it may be difficult for the educator to assess the level of knowledge for the learner, which may again, be a barrier for both the educator and the learner. The following statement confirms the assertion of the educators in this regard.

"…It affects them and it's not minor, it does affect the children. How can I put it? You find that…sometimes you can see that this child needs to write a task from the textbook…or there is an activity that they have to do…or

they need to write. You find that sometimes the child just seats and not write…when you ask him/her why he/she is not writing, he/she will say that he/she does not understand the task. You will find that as a teacher, you remember that ooooh, it's that child with an eye problem…" (Educator 7)

Subcategory 2.1.3. Orientation of the Lines

Another finding that was reported by the educators was that, some of the learners experienced difficulties with orientation of lines while writing in their books. These leaners struggle to keep the texts within the lines in the book, as a result, the text overlaps. This may result in untidy schoolwork which the learner and the educator may struggle to follow. Also, these learners have high chances of struggling with repeating lines in textbooks while reading without using their fingers to trace the lines. This may ultimately affect their reading skills. The following statement confirms the educators' assertion.

"…Sometimes when they write, they write and you find that, the text is not within the lines…" (Educator 10).

Category 2.2. Allergies, Rubbing and Redness of Eyes

Other major eye problems that were reported by the educators were allergies, rubbing and redness of eyes. These were described as major problems and based on the description of the eye problems by the educators, the researcher could note that the conditions were easily identifiable among the children. Educator 8 emphasised that the most common eye problem is the one that subsides by itself when a child grows, wherein the child's eyes change in colour and are itchy. The educator explained that even on the day of the interview, he had just identified another child with the same condition.

During the interviews, the researcher noticed that most of the educators that described eye conditions that were associated with tearing, rash, redness and itchiness of the eyes, showed so much confidence in their description of the conditions. This further showed the researcher that the educators have since gained experience in identifying this type of eye condition. It is therefore safe to assume that these eye problems might be common among the school children and easily identifiable by the educators. Children that suffer from these conditions may find it difficult to focus in the classroom due to tearing and continuous rubbing of eyes or itchiness. In some cases, especially where there might be infections, these conditions may be associated with pain and blurred vision. Although some of these symptoms may be associated with infections and allergies, they may also be the symptoms of refractive error and binocular vision anomalies. The following assertions confirm these findings.

> *"…There is a certain child, it seems like her eyes are itchy. It is said that this condition becomes better by itself [self-limiting] …and the eye color changes a little bit. I don't know what it is called. It is the one that I usually see. It is an eye condition that troubles a lot of children, even today I saw another child with the same condition…" (Educator 8)*

In addition, another educator explained that these conditions mostly occur in lower grades, and that the conditions present with tearing, rash and redness as confirmed by the assertion below.

> "…*There are children, more especially in lower levels, most of which are having teary eyes. Others have very red eyes. With others having things like little rash on the sides" (Education 9)*

The majority of the educators emphasised that this type of eye condition was the most common among the children. This might because the condition is generally easily noticeable by the educators. This finding was confirmed by the educator with the following statement.

> *"…Yes, it's the one that takes a lead …" (Educator 8)*

5.49.2 Theme 3: Teacher's Observations

This theme emanated when educators were asked how they identified the eye problems. Most of the educators' response showed that observation, both inside and outside the classroom, remained a key element in identifying eye problems. Although the educators did not receive any formal training on the common signs and symptoms of ocular conditions, their general knowledge on the eye conditions played a very crucial role in the detection of the eye problems. The symptoms as reported by the educators showed evidence of the the existence of refractive error among the children (Al-Nuaimi, Salama and Elijack 2010: 42; Chua, 2014).

Category 3.1: In the Classroom

Observation in the classroom by the educators was found to be the most common manner is which most educators identified common eye problems. These observations were usually done during lessons and when learners were given tasks. Some children would squeeze their eyes or even change positions by themselves to clearly see on the chalkboard. Some learners struggled to complete tasks given by the educators. As a result, educators could easily identify the eye problems through observations. However, most classroom activities may require keen vision, and as a result, poor vision may have a direct impact on the accomplishment of the educator's goal (Ambika and Nisha, 2013; 6

Subcategory 3.1.1: Failure to Complete Tasks

Another way in which the educators identify children with eye problems is with failure to complete tasks or complete long after the other children have finished. The following statement confirms the assertion by the educator.

> *"…I notice it when the child does not finish writing. Children with eye problems, since they cannot see clearly especially on the chalkboard, you will find that they don't complete their tasks. The others will have finished*

long time ago, with him/her…. maybe she/he will just seat and not write. Some children are fair enough to tell if they cannot see…" (Educator 1)

Category 3.2. Outside the Classroom.

The role of observing children by the educators as presented above, does not only end in the classroom, but some educators also reported that children with eye problems were observed outside the classroom as they interacted with other children.

Subcategory 3.2.1 Interaction with Other Children.

Even though the educators observe these children outside the classroom, they also explained the difficulty of observing challenges related to vision problems outside the classroom, as the activities that children do while they are playing outside (e.g. running) do not require keen vision. The statement below confirms the educators' assertion in this regard.

> *"Eeh, I have never observed the child's interaction with other children. I have not observed it in that fashion as to how does it affect the child. Because when they play, eeh, they use they use things which are not necessarily small. They just play by walking around, and they don't play by writing but running around and doing things with their hands. Things that involve handling/holding do not really show if the child might be having eye problems" (Educator 5)*

The above findings show that currently the educators can only detect severe visual impairment by observing children while playing or performing other tasks outside the classroom as indicated below by educator 10.

> *"…like the one I was referring to, who was subsequently refered to Rivoni [Special School for visually impaired children] because his case was severe. The condition was at a point wherein he had to be held by hand, especially*

while climbing the stairs. He could only see very close objects and could not see anything from far…" (Educator 10)

Subcategory 3.2.2. Notification from Parents.

Further to the above finding of the educators' observations, some educators have reported that there are instances wherein parents inform the school or the educators regarding the eye condition of the child. This notification from the parents helps the educator in further assisting the child during lessons and ensuring that the child complies with the recommendation from the health care practitioners or follows up on appointments. In addition, this may further provide an opportunity for both the parent and the educator to discuss the effects of the eye problem on the learner's academic work and propose possible solutions. For example, if a child with refractive error had to use spectacles in the classroom, the educator would ensure that the child wears the spectacles at all times and that the spectacles are safe from breakage. The statement below by educator 8 confirms the educator's assertion.

…"Sometimes parents come by themselves and report that the child has an eye problem"…(Educator 8).

5.49.3 Theme 4: Actions Taken by Teachers

The above findings described how the educators identify children with eye problems, further to which they were asked about the measures they take to address the problem. This theme describes the measures employed by the educators to mitigate the children's eye problems. These measures included seating arrangement and notification of parents as discussed below.

Category 4.1. Seating Arrangement.

In addressing the vision problems, all the teachers agreed that children with poor vision should be allowed to sit in front so that they can see better on the board. The researcher has noted that the rationale behind this seating arrangement is to ensure that the distance between the child and the chalkboard is reduced to increase the clarity of the texts on the chalkboard. In this regard, children who struggle with reading from the chalkboard are allowed to move closer to the chalkboard to increase the visibility of the text. Although this arrangement may not be a permanent solution to the child's vision problem, the researcher has noted that it has worked and is used by almost all the educators and the school children to address the vision problems experienced by the learners in the classroom. These manoeuvres are attempts to resolve the vision problem caused by refractive error that the child experiences, as children may not know themselves that they have vision problems (Shukla *et al.,* 2018: 937). The quotation below confirms the assertions of the educators.

> *"…And we end up positioning them where they can see a little better. So normally this child you will find that when they look on the chalkboard, and when they copy, they don't copy correctly sometimes, just copying. Which shows that they have a problem with their eyes…" (Educator 10)*

While the educators take the initiative to reposition the children that struggle with distance vision, some educators indicated that children themselves, also take the same initiative and move closer to the board during lessons without being informed by the educators to do so. This eventually makes the educator aware of the child's vision problem. This finding was confirmed by the educator's statement below.

> *"…If a child is seated and then moves closer to the board, we will then realise that this child cannot see [what is on the chalkboard] …" (Educator 4)*

Category 4.2. Notifying Parents

In addition to the seating arrangement discussed above, one of the actions taken by educators after identifying a child with eye problems, is reporting the matter to the school management in order to notify parents of the child's problem through a letter. Some educators invite the parents to school to discuss the child's problem. Educator 10 went further to demonstrate how one child with very poor vision was eventually referred to Rivoni School for the Blind. This tells the researcher that educators do not only identify the children but ensure that the child receives appropriate management or intervention. Also, that the involvement of parents is key in ensuring that the identified children with vision problems receive treatment. This was further emphasised by educator 5 who stated that the parents are advised by the educators to take the children with eye problems to the hospital. The researcher sees this as a form of a referral to the health institutions that is used by the educators to ensure that the children receive appropriate treatment, and also shows the importance of parents' involvement in addressing refractive error of children in schools. As discussed above (subcategory 3.2.2), parents also notify educators should a child experience eye conditions, and here educators are reported to notify the parents about the eye conditions. This finding shows that there is a two-way communication between the parents and the educators, where the parents and the educators inform each other about the eye condition of the child. This form of referral is also consistent with the recommendation by Shukla *et al*. (2018: 938), who indicated that all children that are identified by the educators to be experiencing vision problems should be referred to the healthcare facilities for further management or treatment. The statements below confirm the assertion of the educators.

> *"…As a school we usually report to the school management, that we have this kind of a child with eye problems. Then a letter is written to the parents trying to find out whether the parent is aware of the child's problem, since some don't report. So, from there he/she will have to be checked …" (Educator 10).*

Other educators discuss the problem with the parents directly, without the involvement of the school management as confirmed by the assertion hereunder.

> *"…Another thing, with other children, as I have observed for the years that I have been working with children, if we see that the problem is worse, we*

are able to call the parents and discuss with them. We then advise them to take the child to the Hospital…" (Educator 5)

5.49.4 Theme 5: Challenges

Looking at all the presented educators' experiences above, the teachers try to seek collaboration with parents in order to ensure that the eye condition of the child is resolved and thus improving learning. However, the educators have reported the challenges they experienced in their endeavor to involve parents. In addition, further challenges with regards to the school health program were reported. Therefore, all these challenges are discussed in detail below.

Category 5.1: Follow up with Parents

Most educators have expressed themselves regarding the unsatisfactory responsiveness of the parents when requested to play their role in ensuring that the children with eye problems receive appropriate treatment or are at least thoroughly examined by the healthcare practitioners. The educators have explained that regardless of endless follow ups, some parents are just never available to attend to the children's eye problems. This challenge seemed very serious and the researcher has noted that the educators were very worried about it. Educator 6 emphasised the non-responsiveness of the parents by indicating that some parents can be called to come to school for more than 5 times without any response, while the educator can see that the child has a problem. This shows that without the involvement of the parent, the educator and the child will continue to experience the same barrier to education due to eye problems for a long time, which may affect the performance of the child. Other educators also suggested that in order to address the issue of non-responsiveness of the parents, meetings should be held with the parents and they be informed of the dangers of not ensuring that follow ups regarding the child are made. The finding regarding unavailability of parents in this study was supported by the case study of The Healthy School Programme in South Africa, wherein the involvement of parents in issues relating to school activities were inadequate. (WHO/AFRO, 2013).

> *"…Ehh … when we are at school and call parent, it's not helping much because it happens that you call a parent 5 times and they don't come. But you can see that the child has a problem. But what is better is when you eyecare practitioner], who work with these things, visit us here, and find them [children with eye problems]. It is better because you [eyecare practitioner] can write them letters [to take the child to an eyecare facility] … we [teachers] will make follow ups ... Even when they [parents] return from Nkhensani [Hospital], they must show me a letter to show that they went. So, I feel that if you [researcher] visit the schools its better. Most parents ignore a lot, when you call them concerning issues relating to their children, they don't come to school…" (Educator 6)*

One of the educators further referred to the lack of response from parents that happened when the children were referred to the hospital for further dental examination or treatment, which confirmed the non-responsiveness of some of the parents. Educator 3 also explained that if the educators cannot reach the parents, they are unable to proceed with resolving the problem. This further shows the concern of the educators and the impact it has on their work. Yasmini, Minto and Chan (2015: 14) also emphasised that the involvement of parents/guardians is a key factor in ensuring the success of the school health vision programme. The following statements confirm the assertions of the educators in this regard. Below is the statement of one of the educators.

> *"… Imm, there is still a problem of the parents like I said. I remember previously the Department once came. In grade 1 there are parents whose children had problems. Whether it was teeth problems or what? Eeh, they left us notes. We make several follow ups only to find that parents cannot be found. These are the barriers that we encounter because if we can't find the parents, we can't move forward*..." (Educator 3)

Category 5.2 Phases in Primary School and School Health Screening Programme.

Another challenge that was raised by the educators was related to the School Health Screening Program. The educators reported that the primary school phases include the foundation phase, which is grade R-3, intermediate phase include grades 4-6, and senior phase which includes grade 7. However, the School Health Vision Programme does not cover all the grades, as a result, the intermediate and senior phases are excluded in the program as discussed below. In addition, one of the educators confirmed that school vision screening had never been conducted in the school, which may simply imply that the current school health program does not reach all the schools.

Subcategory 5.2.1. Exclusion of Intermediate & Senior Phase.

Further to the finding above, some of the educators have touched base on the Department of Health screening programs, which only focused on foundation phase, particularly grades R and 1. Educator 7 explained that the clinic which is near the school ensures that grade R learners are examined. While it is an advantage that the DoH prioritises the entry levels, the failure to screen the intermediate and senior phases does not do justice to the children in these phases. Educator 7, who is from senior phase has confirmed that screenings were only provided to foundation phase. However, educators from intermediate and senior phases had observed children with eye problems in their classes. Although this challenge might be due to the lack of sufficient resources in the form of healthcare practitioners (Shung-Kingi, Orgilli and Slemming, 2014: 67), the need for screening in these intermediate and senior phases cannot be underestimated.

> *"… It's only when the clinic staff visit the school to examine grade R children, and they provide letters to those that were identified to have problems, so that they go to the clinic. So, we give the letters to the parents…" (Educator 7)*

When the researcher probed further regarding the response of the parents to the referral of the children for further treatment, the educator explained that only grade R children benefit from these screening services, and not the other grades as confirmed by the following assertion.

> *"… With that one I will not have an answer because they only check grade R. If maybe you can give me time to go and ask, that's if it's not urgent, I would ask and give you a call and tell you how it goes. But I see others responding, they come and take children to the clinics. But since I'm not there…" (Educator 7)*

The above finding was corroborated by educator 5, who indicated the advantage of having a clinic facility near the school, however, emphasized that only grade R learners receive the services from the clinic.

> *"… When they are still in grade R, the clinic works together with the school since it is nearby. When they are in grade R every time they come and check different conditions. Those found with certain conditions, they write letters to the parents of the child so that they go to the Hospital, and then the child starts getting help from there. If there is a need to constantly visit the Hospital, or constantly visit the clinic, they must constantly go…" (Educator 5)*

5.49.6 Theme 6: The Educators' Recommendations

Based on the described eye problems, the identification of the children with eye problems and the challenges described above, the educators were asked to provide recommendations for the early identification, referral and treatment of the eye problems. The educators recommended screening as a method of identifying children with eye problems and showed preference of medication over spectacles as a method of treating refractive error or vision problems as discussed below.

Category 6.1: Screening

The educators have emphasised the importance of early detection of the eye conditions among the children. They all preferred screening as the method of identifying children that are affected by eye conditions, wherein some educators referred to screening that can be conducted by the educators themselves. However, the majority of the educators recommended that screening should be performed by the health professionals. School vision screening is critical in ensuring the early detection and management of refractive error (Thiago *et al.,* 2019: 37).

Subcategory 6.1.1. Screening by Educators.

One of the educators explained how educators can ensure that children with vision problems are identified in the classroom. His explanation could be related to the actual vision screening, wherein he would ask the learner to point at a number on the chalkboard, to ensure that when a child says the number, for example the number 3, indeed he/she knows how it looks like. Although the educator may not have the knowledge for visual acuity screening procedures, his method could be modified, with appropriate training and equipment, to vision screening. This shows the researcher that the educator has the ambition and potential to perform some form of visual assessment on the children, which might be prompted by the observation he made in the classroom. The screening of children by educators was also seen in Peru, where educators successfully performed vision screening on the school children after receiving training (Latorre-Arteaga *et al*, 2016: 652).

> *"…Eeh, mmm, for them to be detected early, I can say teachers must see to it that children that are reading numbers…they must read these numbers while the teacher is pointing at the numbers. Example, when a child says 3, they should point 3, but if the child can read out number 3, but does not know how it is written…Because it is possible that the reason for not knowing the number might be related to vision and the child may not have*

seen the number before. If it [the number] is on the chalkboard they [children] see it from far and they might not understand whether it is a 3 or 2. But when we can make sure that the child goes to the board and point, or maybe we mix the numbers, until them to point at the number 3. We will see whether they can see clearly. If we try two or three times but they cannot point at the number 3, then we will see they do not know it and they might not have seen it before…" (Educator 5)

Subcategory 6.1.2: Screening by Healthcare Professionals.

According to the teachers, the best way of identifying cases of eye problems is through screening by eye care professionals. This was strongly recommended by all teachers from all the three primary schools. Ideally, this could be the most recommended approach (Sabherwal, Sood, Siddiqui, DasGupta, Ganesh and Basset (2020: 449), however, factors related to availability of health practitioners remain a major constrain. Amongst other reasons for the recommendation of screening by Healthcare Professionals, the educators highlighted that health care professionals have the necessary skills and equipment to detect vision problems at an early stage and ensure that appropriate treatment is provided on time as some of the problems may not be treatable when left unattended for a considerable number of years. It was also indicated that parents would respond better to the referral letter from a healthcare practitioner than the school letter, and thus improve the response rate for further management. Some teachers alluded that their suggestions for parents to take their children for assessment at a health care facility (based on their observations in class), are sometimes misunderstood by parents who then think their children are disliked by teachers. Consequently, the parents adopt uncooperative attitudes. It is for this reason that teachers strongly recommended that referral letters for further eye tests should be sent by health professionals. The following statements further attest to the teachers' efforts in assisting school children with eye problems.

> *"What I see is that in the beginning of the year children should be examined, especially this side of Grade R, Grade 1 because they are coming from somewhere else. Eeh, when they arrive here and get examined, it will be known right from the start … that they have a problem of this kind" (Educator 8)*

While another educator described the efforts that could be used by educators to test the eyes, the majority of the educators were adamant that vision screening should be conducted by health professionals as the educator's knowledge regarding eye conditions and methods of identifying children with eye problems may be limited to noticing signs of poor vision. The educators would ultimately leave out most of the children with vision problems undetected. The statement below confirms the educators' assertion in this regard.

> *"But what I think should be done is, there should be a time where the clinic staff or nurses from the clinic visit the children. To come and check the children for us using their skills. In such a way that those children would be assisted because us as teachers, would only rely on poor vision as the only sign. But maybe they would be able to see other signs that…that even before the problem becomes manifest…since they can check for redness of the eyes maybe or other things, which show that the eyes have a problem, then conditions would be detected early" (Educator 5)*

Category 6.2. Treatment of Poor Eyesight

In addition to the detection of children with eye problems, particularly in relation to poor eyesight, the educators voiced their views with regards to the desired treatment method. The majority of the educators showed lack of interest in prescription of spectacles to children.

Subcategory 6.2.1 Preference of Medication Over Spectacles

The majority of the educators were adamant that when children that suffer from vision problems visit health care practitioners for further management, their mostly preferred and appropriate method of treatment would be medication or injection and not spectacles. It was very clear from the explanation of the educators that spectacles were not the recommended manner of treatment for the children. Some of the reasons that were raised by the educators included the risk of breakage of spectacles. Educator 3's statement below confirms the educators' recommendations.

> "…*Eeh, so if there can be medication and they get treated, haaaa, that would be good'…" (Educator 3)*

The above statement emphasises the educators' preference of medication over glasses. However, the recommendation by the educators shows that there is still a gap in knowledge of refractive error treatment which is not surprising as the educators may not have received any training on refractive error, as seen by their limited knowledge of the term "refractive error" above. The statements below further confirm the assertion by the educators regarding their non preference of spectacles.

> *"…With the issue of treatment, I would say, for these young children, if there was enough medication in the Hospital, these small children when they go to the Hospital, they should have eye drops instilled and eye ointments applied. According to how they see it. I think if there can be medication in the hospital, it can be better than gl……. According to me actually, I mostly prefer medication than glasses. You can see that they are still young, they will always break each others'glasses. There can always be cases of broken glasses. You see..." (Educator 3).*

Subcategory 6.3. Prevention of Poor Eyesight.

In addition to treatment of the children by medication, a minority of the educators had suggested the use of injections to prevent the occurrence of poor vision, of which the educators were referring to vaccination of the children. Below is the statement that confirms the educators ‘assertion in this regard.

> *“What I can say is, while they are still in foundation phase, there should be a checkup that should take place, that will be checking the children ‘eyes. Eeh… eeh… if they are able to prevent it would be noticed earlier so that they can inject them…” (Educator 2).*

5.50. Conclusion

This chapter presented both the quantitative (questionnaire-based) and qualitative (interview-based) findings of the study by means of tables, charts, graphs, and narrative statements. In both the quantitative and qualitative phases of data analysis, refractive error was interstitially embedded into the thematic mold of the ultimate outcomes of the investigation from the perspective of the biological parents/legal guardians. The responses from the questionnaires were thematically analysed and converted into meaningful statements as the evidence or findings of the study from parents/legal guardians responding on behalf of the school children whose age did not allow for their direct participation as respondents. In the case of the interviews, the educators’ knowledge of, and responses to the concept, “refractive error” was pivotally linked to the final analysis regarding their perspectives. This chapter also presented an overview of the associations between different variables related to “refractive error”. Such cross-referencing of variables is intended to present the findings of the study as a product of both a logically undertaken and coherently structured process (Walliman, 2015).

As such, the quantitative data of the study has shown a prevalence of refractive error of (35.8%, n=117) which was associated with risk factors like parental education and employment, private school, grade of the school, time spent on near work and sports activities. Refractive error was the cause of visual impairment in the majority of the children. The qualitative findings of this study have shown evidence of the existence of refractive error and other eye problems among the children, and also described the challenges experienced by both the educators and learners at school due to these eye problems. The following chapter presents the data synthesis, discussion and justification for contribution to the body of knowledge of the study.

CHAPTER SIX: DISCUSSION

6.1 Introduction

This chapter presents the integration or synthesis of study findings obtained from the analysis of data, beginning by discussing the extent of refractive error, its effects on learning and risk factors. This is followed by the educators' experiences in relation to their methods of detecting refractive error, mitigating strategies of the detected problems, challenges, recommendations, and the school health vision screening program. In addition, the chapter describes the application of the conceptual framework and findings in relation to study objectives.

6.2 The Extent of Refractive Error

The research objectives of this study yielded adequate data both quantitatively and qualitatively to suggest the occurrence of refractive error, although it was evident that other eye problems existed among the children. The quantitative study findings (figure 5.7) showed that the prevalence of refractive error was high among the school children (35.8%; n=117), which was corroborated by the educators' observations of learners with refractive error or eye problems in Theme 2: "the manifestation of eye problems". In this context, the educators confirmed the occurrence of refractive error or eyesight problems. The extent of refractive error in this study was consistent with the study conducted in Hong Kong where the refractive error occurrence was reported among 36.71% of school children (Fan et al., 2004). However, the findings of this study were lower than the prevalence of refractive error of 46.8% in India (Ravi Sekhar Rao, Krishna and Vasantha, 2016: 21), 57.98% in Malawi (Kawuma and Mayeku, 2002: 69), 86.6% in Onitsha, Nigeria (Ezinne and Mashige, 2018: a455) and 66.9% in Assiut District, Egypt (Mohamed *et al.,* 2014: 101). Similarly, the prevalence of refractive error in this study was lower than in the rural communities of Motherwell Township, Eastern Cape Province of South Africa, which was 43.9% (Akuta, 2015). It was further observed that the prevalence of refractive error in this study was higher than the findings of 17.36% in West Ulttar Pradesh, India (Singh *et al.,* 2017: 500), 21% in Gujranwala, Parkistan (Mehboob, Nisar and Khan, 2018: 701), 8% in Abia State of Nigeria (Atowa, Munsamy and Wajuihian, 2017: a369), 2.4% in the rural areas of Malawi (Msiska, Njuguna and Kariuki, 2020) and 20.8% in the Malamulele community of Limpopo Province, South Africa (Baloyi, Akinsola and Mabunda, 2018: 142). The difference in the extent of refractive error in the current study and the other studies might have been due to environmental factors (Hasemi *et al.,* 2018: 3), inconstancy in the definition of myopia, hyperopia and astigmatism and the data collection methods (Atowa, Munsamy and Wajuihian, 2017: a369). However, as opposed to most of the above studies, the strength of the current study was in the use of qualitative and quantitative data and the inclusion of private, public and rural schools to provide in-depth understanding of the phenomenon. As such, this approach has provided the researcher with an opportunity to assess the problem from different angles.

6.2.1 Visual Impairment

The above finding on the extent of refractive error was further corroborated by the quantitative data, which showed statistical significance (P-value=0.00) between refractive error and unaided visual acuity in this study. As a result, the prevalence of refractive error seemed to increase with a decrease in unaided visual acuity. These findings imply that refractive error was more likely to be the cause of visual impairment (Chuah, 2014). This finding is consistent with most studies, wherein the major cause of visual impairment among the school children was refractive error. For example, visual impairment among 32.50% of the children in Amanat Eye Hospital of Rawalphindi, Pakistan (Amir *et al*., 2017: 251) was caused by refractive error and in India, wherein refractive error was the major cause of visual impairment in 2.77% of the reported cases (Kemmanu *et al*., 2018: 1590). The prevalence of refractive error, which seemed to be considerably high in the District of Mopani, creates a serious gap for learning and teaching. The rate of refractive error among the 117 school children is worrisome, as this evidence suggests that there might be a possibility that several school children struggle due to refractive error, particularly myopia, which affects distance vision. In turn, this may ultimately affect the children's school performance.

In addition, the qualitative data provided evidence of the existence of severe visual impairment among the children. For example, subcategory 3.2.1: “Interaction with other children”, provided the educators’ experiences on visual impairment. In this context, the educators reported that there was one child who had severe visual impairment, to an extent that he depended on his friends to hold him by hand when he had to climb stairs. This child was only identified by the educators at a later stage, and the only solution was to refer to a special school for visually impaired children. This condition may have possibly affected the quality of life, wellbeing and the future of the child. This evidence was enough to suggest the existence of severe visual impairment in schools, which remain unidentified, possibly due to the shortcomings of the school vision program. The researcher can therefore argue that, had this child’s condition been detected timeously and managed earlier, the likelihood for a much better outcome might have been a possibility. In the worst-case scenario, the visual impairment could have been inevitable, appropriate arrangements for referral to a special school would have been made, and thus, to a certain extent, improving his copying mechanism with the condition. As such, this finding provided practical evidence of the enormous lasting effects of visual impairment on the quality of life of children, as they must live their entire lives with blindness or visual impairment, which will impact negatively on their emotional, social and economic state (Heijthuijsen, Beunders, Jiawan, de Mesquita-Voigt, Pawiroredjo, Mourits, Tanck, Verhoeff and Saeed, 2013: 812). In addition, this may have significantly affected the child’s learning ability, personality, and adjustment in the classroom as supported by (Ambika and Nisha, 2013: 6). Furthermore, a significantly high percentage (90%) of children with visual impairment, particularly in low-income countries, are deprived of education because of factors such as unavailability of suitable infrastructure, affordable health care, suitable and accessible school resources and adequately trained personnel (Vision 2020).

6.2.2 The Distribution of Refractive Error

The study found that the distribution of myopia, hyperopia and astigmatism were found to be 16.2% (n=53); 10.1% (n=33) and 9.5% (n=31) respectively, which further highlighted the reasons for learners to struggle with distance vision. The educators explained that most learners had difficulty reading and copying from the chalkboard. These findings were comparable with the study conducted by Gupta *et al.,* (2009:133) in Shimla, North India. The evidence provided by the educators seeks to suggest that the learners might be affected by myopia, and as a result, their distance vision is affected and easily identifiable by the educators during lessons (Chua, 2014). As such, one of the reasons cited by the children for wearing spectacles in the study conducted by Shukla *et al.* (2018: 937) was seeing clearly on the chalkboard. Even though some educators identified children with poor near vision in the form of difficulty copying from the textbook and avoidance of textbook tasks, the prevalence of hyperopia, which affects near vision; and the occurrence of astigmatism, which affects both near and distant vision, were significant in this study. The distribution of the refractive error type as seen in this study was consistent with the study in Karachi, Pakistan, which showed that myopia was the most prevalent type of refractive error with 77%, followed by hyperopia at 23% and astigmatism at 10% (Qureshi and Ahmed, 2016). Similarly, in Onitsha, Nigeria, myopia (46.4%) was the most prevalent type of refractive error, followed by astigmatism (36.1%) and lastly hyperopia (17.5%) (Ezinne and Mashige, 2018: a455). A similar pattern was also observed in studies conducted among primary schools in Limpopo Province (Raliavhegwa and Oduntan (2000: 54); Baloyi, Akinsola and Mabunda, 2018: 142). Other studies have also reported myopia as the most common type of refractive error among school children (Shrestha and Shrestha, 2017: 49; Popović-Beganović *et al.*, 2018: 858). In contrast, astigmatism was the most common type of refractive error in the Eastern Cape Province of South Africa, followed by hyperopia, while myopia was the least occurring refractive error type. The distribution of refractive error in this study further contrasted the findings by Mabaso, Oduntan and Mpolokeng (2006: 132), in the same District of Mopani, where hyperopia was the most occurring type of refractive error among rural children, and myopia came last. The observed difference might be attributed to the difference in the sample participants, as this study sampled children from private, urban public schools and rural public clusters, while the former study only focused on rural public schools. Another reason could be the two studies were conducted about 11 years apart, therefore, the environmental and socio-economic factors may have changed, which may have possibly affected the study findings. For example, accessibility to gadgets like computer games was not as common among the children then compared to the present time.

Although hyperopic children may not usually struggle with distance vision, they usually experience difficulties with near-work activities like prolonged exposure to reading or writing. Therefore, the children with hyperopia experience symptoms such as headaches, tearing, redness of eyes, and eye strains and if left uncorrected, hyperopia may result in amblyopia and difficulties at school (Jonas, Xu, Wang, Bi, Wu, Jiang, Nangia, Sinha, Zhu, Tao, Guo, You, Wu, Tao, Guo, Ohno-Matsui and Jonas, 2016: e0154554; Saxena *et al*., 2015: 2). Furthermore, children diagnosed with refractive error see images as distorted, and experience eye strains and squinting (Emerole *et al*., 2013). Astigmatism also affects the children’s school performance, which can be seen in cases when children mistake alphabets such as “D” for an “O”, or a number such as 9 (nine) for “8” (eight).

6.2.3 Other Eye Conditions

The use of quantitative data and qualitative data provided evidence of the occurrence of pathological conditions among the children. The strength of this study was drawn from ensuring that data relating to these conditions was assessed from different angles and by different methods. The study findings show that the occurrence of ocular conditions like vernal kerato-conjunctivitis, allergic conjunctivitis, bacterial conjunctivitis, and ptosis were detected in 12.2% (n=40) of the children. Similarly, in Pakistan, the occurrence of vernal kerato-conjunctivitis and conjunctivitis among children was reported (Soni, Durrani and Jadoon, 2015: 262). In this study, the prevalence of pathological conditions was strongly associated (P-Value=0.003) with unaided visual acuity of the right eye and not of the left eye (P-Value=0.352).

The prevalence of vernal conjunctivitis (41.7%; n=10), allergic conjunctivitis (33.3%; n=8), keratoconus (16.7%; n=4) and bacterial conjunctivitis (8.3%; n=2) were mostly associated with the 6/6 unaided visual acuity of the right eye. Therefore, these conditions may not have been the major cause of visual impairment in children. However, there were few pathological cases that were associated with visual impairment or poor visual acuity of the right eye as supported by other studies (Magakwe, Xulu-Kasaba and Hansraj, 2020: a551; Naidoo *et al*., 2020:1658). In this study, an example would be one case of keratoconus that was associated with the 1/15 visual acuity, 3 cases of vernal conjunctivitis that were associated with the 6/18 visual acuity and one case of keratoconus which was associated with the 6/21 visual acuity. In the qualitative data, the category 2.2: “allergies, rubbing and redness of eyes”, to a certain extent, supported the occurrence of vernal conjunctivitis, allergic conjunctivitis and bacterial conjunctivitis.

The above finding was further corroborated by the reasons for consultations for the children as cited by the respondents (Table 5.14). In this regard, 45.5% (n=25) of the children consulted due to painful eyes, itchiness and redness of eyes. Although these conditions mostly presented with symptoms like itchiness and redness, which may not have permanent effects on the eyes of the children, these symptoms can be disturbing and intolerable during lessons and therefore necessitate appropriate management, good hygiene, and prevention of spread (Soni, Durrani and Jadoon, 2015: 262). These findings would support the initiative of appropriate eyecare awareness or health education to the learners, educators and the parents to improve the detection, prevention and management of some of these ocular conditions like bacterial conjunctivitis (Mohamed *et al*., 2014: 101).

6.3 Refractive Error and Learning.

According to Raiyn (2016: 115), approximately 75% of learning in the classroom is achieved through vision, wherein educators make use of various formats to transmit information to school children. These formats may include images, graphs, posters, videos, etc. This type of learning, which is referred to as visual learning, is easily understood by the learners and further assists in the development of visual thinking (Raiyn, 2016: 115). However, the educators' experiences provided evidence which showed that refractive error may lead to reading and writing difficulties, which may affect the core functions of teaching and learning in the classrooms. In addition, most of the activities in the classroom revolve around reading and writing which is used by the educators to instill knowledge and skills to the learners. However, all these activities may require keen vision, and as a result, poor vision may have a direct impact on the accomplishment of the educator's goal (Ambika and Nisha, 2013; 6). The strength of using quantitative data to determine the extent of refractive error and the qualitative data ensured an in-depth understanding of the barriers to learning as a result of refractive error.

6.3.1 Reading/Copying from the Chalk Board

The educators, as presented under subcategory 2.1.1: "reading/copying from chalkboard", reported how learners with refractive error struggled to copy tasks from the chalkboard to their own books. The findings are suggestive that the possible cause of symptoms relating to poor vision while looking at the chalkboard might be due to prevalence of myopia 16.2% (n=53) or astigmatism 10.1% (n=33) as the two conditions have the potential to affect distance vision (Chua, 2014).

6.3.2 Reading/Copying from the Textbook

Some of the activities in the classroom may include copying from the textbook to the learner's book, which was noted as a challenge for children with refractive error. The subcategories 2.1.2: "reading/copying from the textbook" confirms this finding. Children affected by refractive error, may find it challenging to execute tasks that involve reading and copying from the textbook. Reading difficulties maybe caused by refractive error, particularly hyperopia and astigmatism with the prevalence of 10.1% (n=33) and 9.5% (n=31) respectively, as confirmed by the quantitative data of this study. In this context, it is imperative to highlight that children with binocular anomalies as well, often experience difficulties with reading and writing (Dusek, Pierscionek and McClelland, 2010: 1). Therefore, this may further suggest the occurrence of binocular vision anomalies. The findings of this study were supported by a study that was conducted in California, USA, which reported that children with hyperopia had poor academic performance compared to those with myopia, as good near vision was critical in ensuring that school children's academic performance was optimal (Castellanos, Davey and Remick-Waltman, 2019: 5836).

6.3.3 Orientation of Lines on Learner's Book

In addition to the above, subcategory 2.2.1: "Orientation of text on learners' book", showed that one of the challenges experienced by children with eye problems included failure to keep text within lines in the books. In this study, the educators associated refractive error and the orientation of lines in the learners' book, in contrast, the educators in North India were not aware of symptoms related to orientation of lines (Gupta *et al.,* (2009:133). This study provided evidence that suggests that children with refractive error might struggle with keeping texts within the lines in the book while writing, as a result, the text happens to overlap. In addition to refractive error, this finding may also suggest the importance of assessing binocular vision in children to rule out heterophoria, vergence and accommodation anomalies, as they might have the potential to affect the child's ability to follow written texts or lines in the book, and result in poor writing and reading ability (Dusek, Pierscionek and McClelland, 2010: 1).

6.3.4 Failure to Complete Academic Tasks

One of the major findings of this study was presented under subcategory 3.1.1: "failure to complete tasks". This finding demonstrated that children with refractive error or who cannot see clearly in class either neglect academic tasks completely or take a considerable amount of time to do the tasks, and as such, they do not complete. The study findings provided evidence that children with poor eyesight who do not write their tasks usually report that they do not understand the task, however, the educators reported that the reason was usually due to poor vision. Evidently, children with refractive error might take time to execute academic tasks as extra effort is directed on vision by squeezing the eyes or moving the texts closer to the face, than the actual academic task. This is unsurprising as the need for clear vision in performing academic tasks has been emphasised in the above sections (Raiyn, 2016: 115). This finding further supports the possible effects of poor distance and near vision as confirmed by the high prevalence of refractive error (35.8% (n=117) in Mopani District.

6.5 Risk Factors of Refractive Error

6.5.1 Association of Refractive Error, Parents' Level of Education and Employment

The study showed that the p-value (0.0051) for the association of refractive error and the father's education level is greater than the significance level ($\alpha = 0.1$), we do not reject the null hypothesis at 10% level. Rather, the finding shows weak evidence to suggest an association between the fathers' levels of education and the diagnosis. In addition, the results for the regression model showed that there is a positive relationship between the fathers' education statuses and refractive error ($\beta=0.31$, $p<0.05$), indicating refractive error increased as education increased, and vice versa. The refractive error prevalence was highest among children whose fathers had higher education 47.7% (n=31), followed by secondary school 31.1% (n=28), whereas the occurrence of refractive error was lowest among those with an unknown level of education. With regards myopia, those with secondary education (15.6%; n=14), followed by those with higher education (12.3%; n=8) had higher chances of myopia, while those with primary education (4.5%; n=1) had three times less chances of experiencing myopia. Although the evidence of association was weak, the findings of this study were consistent with most studies, particularly myopia, which was found to be associated with the economic educational status of the parents and increase with higher levels of education (Wong *et al., 2000: 2486*; Mutti *et al.,* 2002: 633; Goh et al., 2005: 678). In contrast to the fathers' findings and the above studies, the association between refractive error and the mothers' level of education was non-significant (chi-square P- value= 0.636).

Furthermore, the association between refractive error and parental employment status was statistically significant for the fathers, with the chi squared P-value of 0.015. As such, the regression model showed that there was a negative relationship between the fathers' employment status and refractive error (β=-0.43, $p<0.05$), these results suggested that those who were not employed had higher chances of not having some retractive error. In addition, astigmatism was mostly associated with the employed fathers. In contrast, the findings in Southern California showed a degree of correlation between higher income of the parents and the prevalence of myopia (Theophanous *et al*., 2016: 1581). With regard to the mothers' employment status, there was weak evidence of associations between their employment status and refractive error (P-value=0.059), results were significant at 10% level. However, the regression model could not provide any evidence of a relationship between the two variables. However, the clinical relevance of this finding provided evidence that myopia was 2 times less likely to be prevalent among children of unemployed mothers (11.7%; n=22), compared to those who are employed (23.1%; n=31). These findings were consistent with most studies (Wong *et al.,* 2000: 2486; Mutti *et al.*, 2002*:* 633; Goh et al., 2005: 678), which showed that the occurrence of myopia among children from high income families was higher than low income families. Notably, the results provide strong evidence that refractive error was more prevalent among employed fathers, and weak evidence among employed mothers.

6.5.2 Association of Refractive Error and Family History of Spectacle Wear

There was no statistical significance between refractive error and family history of spectacle or contact lenses wear, the chi-square was P-value 0.139 (fathers) 0.269 (mothers). Other insights are that myopia was less likely to be prevalent among children whose fathers (10.3%; n=3 vs 16.6%; n=31) and mothers (5.7%; n=2 vs 16.9%; n=48) were spectacle wearers. This was contrary to most studies, which showed an association between family history of wearing spectacles and refractive error myopia (Mutti *et al.,* 2002: 633; Ayub et al., 2007: 96; Yingyong, 2010: 1288). In addition, among Asian children, the early onset of myopia was associated with children whose parents were both myopic, as such, genes were reported as a contributing factor to the early onset of myopia in children (Chua *et al.,* 2015: 8101). The difference between the above studies and the current study, could be induced by the fact that in Mopani district, parents might not have access to eyecare services mainly due to affordability. Although most of the parents (fathers: 73.5%; n=144 and mothers: 58.4%; 188) reported that they were employed, there were no findings to suggest their affordability level of eyecare services. This is because the District of Mopani is still affected by poverty and most of these parents might not afford eyecare services (South African Child Review, 2013; Mabaso, Oduntan.and Mpolokeng, 2006: 132). Therefore, parents (and their children) may not be wearing eye spectacles or contact lenses simply because the condition has not been detected yet or due to issues of affordability. As such, the prevalence of spectacles wear among the parents was 13.4% (n=29) and 11% (n=35) among the fathers and the mothers respectively. However, when considering the age of the parents, about 31.8% (n=64) fathers and 24.4% (n=78) mothers fall within the 45-55 years age cohort and 10.9% (22) mothers and 1.3% (n=4) fathers are above 55 years of age. These age groups of parents, and obviously a reasonable number from the 35-45 years cohort, might be presbyopic and requiring spectacles for near vision. Therefore, the above prevalence of spectacles wear for the parents (fathers: 13.4% (n=29) and mothers: 11% (n=35)) may be considered low for this community. In addition, the study conducted at Nkhensani hospital showed a high prevalence of visual impairment for participants aged 6-92 years, refractive error, cataract and glaucoma were reported as the leading causes of visual impairment (Maake and Oduntan, 2015:5). This confirms that the low prevalence of spectacles wear among the parents does not imply low prevalence of refractive error, rather the high rate of undetected or uncorrected refractive error.

6.5.3 Association of Refractive Error, History of Eye Test and Spectacles/Contact Lens Wear of the Child

There was no statistical significance between refractive error and the child's history of eye test (chi-square P-value=0.817). However, it is important to note that the findings of this study showed that only 17% (n=55) of the children had a history of eye examination or testing, which is quite worrisome as screening was recommended as the method of identifying uncorrected refractive error among school children (Latorre-Arteaga *et al*, 2016: 652). This was also recommended by Mabaso, Oduntan.and Mpolokeng (2006: 132), particularly for Mopani District. Of the 55 children that had a history of eye examination, only two (3.7%) children cited poor vision as reason for consultation, meanwhile the occurrence of refractive error as discussed in 6.2, particularly myopia, was high. These non-significant association findings of this study might be of clinical relevance as they showed that myopia mostly occurred among the children with history 20% (n=11) of eye testing compared to those without history 15.4% (n=42). The chances of hyperopia occurrence were higher among children with a history of eye test compared to those without a history (10.9%; n=6 vs 9.4%; n=26).

This study found that there was weak association between refractive error and the children's spectacle/contact lenses wear (chi-square P-value=0.009) at 10%. However, these findings might be of clinical relevance. From the 8 (2.4%) of the children who wore spectacles only 2 (25%) did not have refractive error, whereas the majority (75%; n=6), had refractive error compared to the 65% (n=208) without refractive error among the children that did not wear spectacles. Myopia was three times associated with children that wore spectacles (50%; n=4 vs 15.3%; n=49) than those without spectacles. In addition, myopia was the most common refractive error type at 50% (n=4). The reason for having myopia as the most prevalent refractive error among the children who wore spectacles could be that myopia causes poor distance vision, and children were able to report to their parents. Another reason could be that it is easily noticed by teachers in class, as demonstrated by most educators in this study, especially where vision is significantly affected. The study has shown that among the 310 (97%) of the children who did not wear spectacles/contact lenses (table 5.33), 15.8% (n=49) were myopic, 10% (n=31) were hyperopic, and 9.1% (n=21) were astigmatic. These learners could benefit from the use of eye spectacles, which they did not have. The low prevalence of spectacle wear found in this study is comparable to the findings (4.6%) in Markos District, Northwest Ethiopia (Sewunet, Aredo and Gedefew, 2014: 5). This was also supported by the findings of a study conducted in Aba, Nigeria, where less than a quarter of the children with refractive error had spectacles (Saxena *et al*., 2015: 2). Similar findings were seen in Delhi, Shangai and Combodia (He *et al*., 2014; Gao *et al*., 2012). However, the finding of this study was higher than the study conducted in Mopani District, where none of the children that required spectacles had them (Mabaso, Oduntan.and Mpolokeng, 2006: 132).

The non-significant finding (p value = 0.510) between refractive error and the period for the last eye examination showed that the occurrence of myopia was mostly among the children that had an eye examination in the past/current year (36.8%; n=7) than those that consulted in the past 2 years (10%; n=3) and the past 5 years (25%; n=1). In this context, myopia was three times more likely to occur among children who had eye examinations in the past/current year than those that consulted in the past two years. However, these children who had eye examinations in the past/current year (36.8%) with myopia should have been provided with spectacles during this consultation and they should still have them as the consultation took place in the last 12 months. However, taking the spectacle wear rate into account (2.4%; n=8), of which only 4 children (50%) were found to be myopic in this study, one can safely conclude that the majority of the children that consulted did not receive spectacles from the health practitioner although the study provides evidence that they required them. On the other hand, the association between refractive error and the reasons for eye testing/examination was non-significant. However, it was noted that the occurrence of myopia was highest among children that cited poor vision (100%; n=2) than general eye test or school screening (21.7%; n=5) and painful, itchy or injured eyes (16%; n=4). This shows that there had been some efforts of detection of refractive error by the parents, however, this finding suggests that the actual correction of the refractive error was not satisfactorily provided to the affected children, considering the low rate of spectacles wear in the overall sample. The qualitative findings also corroborated with this finding, wherein educators confirmed that parents were able to inform the educators of the children's problems. This seeks to suggest the important role played by the parents in the detection of eye conditions, particularly refractive error, however, a proper referral system that will ensure the actual correction of these conditions needs to be strengthened (Rasesemola, Matshoge and Ramukumba2019: a1912).

Other factors that seemed to have contributed to the above low rate of spectacles wear were both the economic status of the parents and the low percentage of children who had prior eye examination as discussed above. It is evident that factors such as affordability and availability of eyecare services have a direct impact on the high prevalence of spectacles non-wear (Ntsoane and Oduntan 2010:183; Dandona and Dandona, 2001). The communities around the investigated research sites depend largely on government screening programmes, which are not sufficient to cater for the whole community; therefore, refractive error remains undetected and uncorrected among school children. Mabaso, Oduntan and Mpolokeng (2006: 132) also stated that poor knowledge of visual challenges and the cost of refractive lenses were regarded as some of the major causes of spectacle non-wear. The wearing of spectacles is not only beneficial to the child, but to the educators as well because of the challenges associated with educating visually impaired children (Kodjebacheva *et al*, 2014: 29). Yasmini, Minto and Chan (2015: 14) emphasised the importance of financial support for provision of optical correction from the government to ensure the success of the school health vision programme.

In addition to the above, the perception of educators about treatment of refractive error preferred injections and medication over the use of spectacles, which may be a contributing factor to the low prevalence of spectacle wear. One of the reasons for such a recommendation was that children may break spectacles, which was also the case in the study conducted by Shukla *et al.* (2018: 937), where 13 children who were provided with spectacles accidentally broke or lost them. Although the study did not assess the perception of the parents regarding the treatment of refractive error, the findings about preference of medication or injection over spectacles as a form of treatment for refractive error is worrisome and is consistent with the findings among the educators in rural China, who assumed that the utilization of spectacles should be avoided since they may cause harm or reduce uncorrected vision (Wang *et al*., 2019: 179). This perception might have a direct impact on the treatment of refractive error in Mopani District because the role played by the educators in influencing children to acquire and wear spectacles is paramount as children are mostly obedient to their educators than anyone else. (Shukla *et al.,* 2018: 937). This is mainly because children spend most of their time at school, and the educators have sufficient time to observe them and encourage spectacle wear compliance. As such, one of the reasons cited by the children for wearing spectacles in the study conducted by Shukla *et al.* (2018: 937) was motivation from the educators. The negative perception on spectacles by educators may be attributed to the gaps in knowledge of refractive error treatment in children among the educators, as seen in rural China (Wang *et al*., 2019: 179). However, instances where the educators supported and recommended spectacles as a form of treatment of refractive error in children were associated with the acceptance of spectacles (Wang *et al*., 2019: 179).

6.5.4 Association of Refractive Error, Age, and Gender of the Children

There was no statistical significance between refractive error and gender (chi-square P-value=0.111). This implies that any differences observed may have been the result of chance variance. Similarly, there was no association between gender and refractive error in Tetovo, Macedonia (Mahmudi *et al.,* 2013: 52), in Morocco (Anera *et al*., 2009: 191) among the younger age group in Polland (Czepita, Czepita and Safranow, 2019: 1). In contrast, in Dona, the refractive error among the children was associated with gender among school children (Al-Nuaimi, Salama and Elijack 2010: 42). Furthermore, this study showed that myopia was the most prevalent type of refractive error in both genders, but higher among the females at 17.9%, (n=32). This situation differs with the study conducted in Mexico (Garcia-Lievanos *et al.,* 2016: 53) and by Mohammad, Mohammadreza and Mohammadi (2009:174), according to which myopia was associated with male children than their female counterparts.

There was no statistical significance between refractive error and the children’s age since the chi-square P-value was 0.325. In contrast, in Sydney, Australia, the study showed that there was a significant association between myopia and age, with myopia increasing with age (Junghana and Crewther, 2003: 339). Similarly, in Brazil, the study showed that there were trends towards myopia prevalence with increasing age (Lira *et al*., 2017: 29). The same was reported in Ireland where myopia and hyperopia were significantly associated with age (Theophanous *et al*., 2016: 1581). In Nigeria as well, myopia was associated with an increase in age (Isawumi, Agboola and Ayegoro, 2016: 147). As opposed to the above studies, the prevalence of myopia in this study decreased with an increase in age.

6.5.5 Association of Refractive Error and the Position of the Child in the Family.

There was strong evidence of associations (P-Value=0.020) between child position and refractive error as shown in Table 5.30. In addition, the regression model showed a negative relationship between the child's position and refractive error (β=-0.430; p=0.017). The prevalence of refractive error was highest amongst first position children (39.2%; n=51), followed by the second (33.3%; n=15) and third (31.6%; n=31) positions respectively, whereas those at fourth and fifth positions had less chances of having refractive error (they had greater chances of not experiencing refractive error). The results suggest that the lower the order or position of the child the greater the chances of refractive error. These findings agree with the study conducted in England, Scotland and Wales, and in Britain (Rudnicka *et al.*, 2008: 1392). However, in terms of percentage, myopia was more prevalent among the children who were at the fifth position, however, only 3 (37.5%) children were affected compared to the 30 (23.1%) children in the first position. This is due to the distribution of the participants among the positions, as the higher positions had fewer respondents compared to the lower positions. Furthermore, the number of participants in the study may have affected these results, as seen in the study conducted in the United Kingdom, Israel, Singapore and Australia, wherein the strong association was only seen in studies where the number of participants exceeded 4000 (Guggenheim *et al.,* 2013:375). However, the insights of this study show that, as more children with myopia were in the first position than all the other positions, there might be an association between myopia and the first-born children as opposed to the fifth born children with 37% (n=3). Morgan and Cotch, 2013: 333 suggested that associations between refractive error and child position might be due to the effects of investing more educational resources on the first-born than the children that are born later, which then predisposes the children to factors like, near work, that are associated with myopia (Morgan and Cotch, 2013: 333).

6.5.6 Association of Refractive Error, School and Grade Level

There is statistical significance between refractive error and the sampled schools, with the chi-square P-value of 0.000 (table 5.32). In addition, the regression model showed a negative relationship between the school where the child was and refractive error ($\beta=-0.18$, $p<0.009$). This was consistent with Vishnuprasad *et al.* (2017: 58)'s study among urban and rural school children in Puducherry, India, which also found a statistical difference in the prevalence of refractive error and schools. In the current study, refractive error was the highest in School A (Private School), wherein 44.9% (n=40) of the children in that school had refractive error and School C (Public Urban School) had the lowest refractive error prevalence (27.1%, n=37). Contrastingly, urban schools in Cambodia had higher prevalence of refractive error than rural schools (Gao et al, 2012). It was surprising to note that myopia was highest at the rural public school (24.8%, n=27) compared to the other two schools. These findings are contrary to those of Saxena *et al*. (2015: 2), which found myopia to be higher at a private school than at government schools. The high prevalence of myopia among rural public-school children implies that there are more children with reduced distance vision in rural government schools, and their school performance might be affected should the myopic condition remain uncorrected. Additionally, it was noticed that astigmatism was highest at 13.5% (n=12) for School A. The findings imply that a high number of children in the private school have distorted vision to astigmatism, which results in eye strains and has the potential of causing squint.

Furthermore, there was statistical significance between refractive error and grade (chi-square P-value = 0.023). However, the study could not establish a relationship between refractive error and grade (p=0.12) through the regression model. Refractive error, particularly myopia and hyperopia increased correspondingly with an increase in the school grade level. For example, in this study, Grade 7 children were twice more likely to have refractive error than grade 5 children. As such, the occurrence of myopia (20.6%; n=22) and hyperopia (16.8%; n=9) was highest in grade 7. Regarding myopia, this distribution pattern might be due to myopic shift and increased near work activities with higher grades (Hepsen *et al*., 2001). This finding was consistent with the study in Ethiopia, wherein refractive error was 4.8% more likely to occur in the higher grade level than in the lower grade. However, in this study astigmatism decreased with an increase in the grade level.

6.5.7 Association of Refractive Error and Time Spent on the Computer/TV after School

From Table 5.34 above, the chi-square P-value of 0.141 shows that there is no statistical significance between refractive error and the time spent by the child on the computer/TV after school, as opposed to most studies that showed near-work as strongly associated with myopia (Ayub *et al.,* 2007: 96; Rasheed, Khan and Khan, 2010: 125; Yingyong, 2010: 1288). Statistical non-significance implies that the differences observed might have been due to a chance variance. It is noted however, that the non-prevalence of refractive error was highest at 69.9% (n=116) among the 166 children that obviously did not spend any significant amount of time on the computer/TV after school. Such a situation could mean that the majority of the sampled school children had no access to computers/TV.

6.5.8 Association between Refractive Error and Time Spent on After-School Reading, Writing, Drawing and Colouring

A significant association between refractive error and the time spent on reading, writing, drawing and colouring after school (chi-square P-value= 0.002) was observed. In addition, there was a negative relationship between this activity and retractive error (β=-0,09 p=0.076). This is comparable to most studies. For instance, Rasheed, Khan and Khan (2010: 125) reported a strong correlation between refractive error and the time spent on playing video games, which are considered as near work activities. Similarly, the Northwest Ethiopian children that used computers regularly had an increased chance of 4.5% of being diagnosed with refractive error compared to their counterparts who were irregular or non- users (Sewunet, Aredo and Gedefew, 2014: 5). Additionally, this study showed that myopia (21.7%, n=35) was highest among the 161 (49.2%) children who spent more than an hour on reading, writing and drawing and colouring after school. This is unanimous with studies conducted by Jonas *et al.* (2016), Saxena et al. (2015: 2), Vishnuprasad *et al.* (2017: 58), and (Yingyong, 2010: 1288).

6.5.9 Association of Refractive Error and Time Spent on After-School Sports

The chi-square P-value of 0.0083 (table 5.36) showed weak evidence of associations between time spent playing other sports after school and refractive error, the results are significant at 10% level. Myopia was more likely to occur in those that spent 1 hour or more playing other sports after school (20.6%; n=42), compared to those who spent less than 30 minutes (14.7%; n=5) and those who spent between 30-60 minutes. These findings were contradictory to that of Guo, Liu, Xu, Tang, and Lv, 2013: e75260, wherein less time spent outdoors was associated with increased myopia, therefore, the study suggested that it would be beneficial for school children to spend more time on outdoor activities to prevent myopia onset.

6.6 Methods of Detecting Refractive Error by the Educators.

The study findings have determined the methods used by educators to detect eye problems among the children. These methods included:

i. **Observation in the Classroom:** The educators have observed the children during lessons. For example, the educators would suspect vision problems when they noticed symptoms like failure to read or copy form either the chalkboard or the textbooks, which are the symptoms of refractive error (Al-Nuaimi, Salama and Elijack 2010: 42; Chua, 2014).
ii. **Observation Outside the Classroom:** Although the educators have indicated the difficulties in detecting eye problems outside the classroom, as children play games that do not require keen vision, further evidence demonstrated that they

could detect severe cases of visual impairment as confirmed in sub category "Interaction with other children". Therefore, this seeks to suggest educators' capabilities to detect severe visual impairment outside the classroom.

iii. **Notification from Parents and Children:** The study findings further showed that parents notify the educators of the children's ocular problems. In some instances, children were able to alert the educators of their vision problems during lessons, which shows the capability of children to report their own problems. Therefore, this seeks to suggest the necessity of appropriate health education for both children and the parents (Departments of Health and Basic Education, 2012), which could assist in children detecting eye problems by themselves and notification of the parents or educators, or the parents detecting the eye problems and assistance from health practitioners. This in turn, would increase the eye testing rate in the area and eradicate children's avoidable visual impairments.

6.7 Educators' Strategies for Mitigating Vision Problem

Section 6.5 above discussed the methods used by educators to detect refractive error and other ocular conditions at school. This section focusses on the strategies that the educators use to mitigate the challenges posed by the detected conditions.

i. **Seating Arrangements**

Category 4.1: "seating arrangements" describes the study findings on one of the actions taken by the educators to ensure the continuity of learning for children that experience refractive error. The educators allow children that struggle to see clearly on the chalkboard to move closer to the chalkboard.

These manoeuvres are attempts to resolve the vision problem caused by refractive error that the child experiences, as children may not know themselves that they have vision problems (Shukla *et al.,* 2018: 937). The researcher has noted that the rationale behind this seating arrangement is to ensure that the distance between the child and the chalkboard is reduced to increase the clarity of the texts of the chalkboard as conditions like myopia reduce distance vision (Chuah, 2014). Although this arrangement may not be a permanent solution to the child's vision problem, the researcher has noted that it has worked and is used by almost all the educators and the school children to address the vision problems experienced by the learners in the classroom. Therefore, these findings provide enough evidence to suggest that the correction of refractive error with spectacles might not only assist the children, but might benefit educators as well by reducing the teaching and learning barrier caused by the existence of refractive error among the school children (Kodjebacheva *et al*., 2014: 29).

ii. Notification of Parents

In addition to the above, category 4.2 "notifying parents" another strategy used by the educators to mitigate the challenges of refractive error, includes informing the parents of the children's condition. In this manner, the educators attempt to ensure that the child receives the necessary intervention (Bell, Rodes and Keller, 2013: 241-2). In some instances, the educators notify the school management to communicate with parents or the educators may directly engage the parents. This form of referral is also consistent with the recommendation by Shukla *et al*. (2018: 938), who indicated that all children that are identified by the educators to be experiencing vision problems should be referred to the healthcare facilities for further management or treatment.

6.8 Challenges Experienced by Educators

Section 6.6 described the strategies implemented by the educators to ensure that children affected by refractive error receive appropriate treatment or measures are in place to ensure continuity of learning in the classroom. Despite the efforts by the educators to involve the parents in resolving the challenges posed by the eye conditions of the children, particularly in learning, the educators have explained that parents are not responsive. "Subcategory follow up with parents" described this finding. This finding shows that parents as well, might be experiencing challenges which have direct impact on their availability to support the educators' endeavors to resolve the problem. The finding regarding unavailability of parents in this study was supported by the case study of The Healthy School Programme in South Africa, wherein it was reported that the inadequate involvement of parents in issues relating to school activities that require their (parents) attention was identified as one of the major concerns (WHO/AFRO, 2013). In addition, Yasmini, Minto and Chan (2015: 14) emphasised that the involvement of parents/guardians is a key factor in ensuring the success of the school health vision programme.

6.9 Educators' Recommendations

Based on the confirmation by the educators of the existence of the refractive error problem, their methods of detecting refractive error, mitigating strategies and challenges, the educators provided the following recommendations to ensure the early detection and management of refractive error in schools.

i. School Vision Screening

Subcategory 6.1.1: "Screening by educators" demonstrated how the educators have strongly recommended screening as the key factor in identifying children with refractive error and other eye conditions. This finding was consistent with many studies (Wangtiraumnuay *et al.,* 2021: 235; Latorre-Arteaga *et al*, 2016: 652). School vision screening is critical in ensuring the early detection and management of refractive error (Thiago *et al.,* 2019: 37).

ii. Screening by Health Care Professionals

Subcategory 6.1.2: "Screening by Healthcare Professionals" described most of the educators' recommendations regarding screening. The majority of the educators recommended that screening should be performed by healthcare professionals. Although ideally, this could be the most recommended approach (Sabherwal, Sood, Siddiqui, DasGupta, Ganesh and Basset (2020: 449), factors related to inadequate human resources (Health Care Practitioners) may have a negative impact on ensuring the full coverage of school vision screening program. As such, other measures to reinforce the current program that is being run by health care practitioners are necessary.

iii. Screening by Educators

Screening by Health Care Practitioners was the most recommended method of conducting vision screening in schools, even so, subcategory “screening by educators” described how one of the educators demonstrated his vision screening technique. The educator reported that this was achieved by asking the child to read numbers on the board, which suggests to the researcher that should the educator receive formal training on assessing visual acuity, his screening results would be accurate (Marsden, Stevens, and Ebri. 2014). In this study the educators had not received any training on refractive error, its identification, causes and treatment, which was comparable with the study conducted by Ambika Nair and Nisha (2013: 8). As such, they depended on the noticeable symptoms of refractive error and general observations. This method has assisted the educators to identify refractive error in schools, and eventually involve parents in ensuring that the affected children are referred to healthcare facilities. The screening of children by educators was also seen in Peru, where educators successfully performed vision screening on the school children after receiving training (Latorre-Arteaga *et al*, 2016: 652). However, Shukla *et al.* (2018: 938) reported that performing school screening for individuals that are non-health professionals can be a challenge as they do not have the medical background. Given the current affairs and the urgency in mitigating the gaps identified in the school health program, it might be necessary for the Mopani District to explore the adoption of school vision screening by the educators or non-health care practitioners.

6.10 School Health Vision Screening Programme

Due to the public health challenges faced by developing countries, particularly in the sub-Saharan region, the evaluation of the intervention strategies in relation to their effectiveness, efficacy and impact on finances is critical for ensuring that the development of policies are rational (Deen, Von Seidlein, and Clemens (2014).South Africa, as one of the developing countries, is not an exception to the health risks posed by the global public health challenges. As such, about 50% of the children in South Africa live in disadvantaged provinces, which are also noted to be rural provinces (South African Child Review, 2013), of which Limpopo Province is part of. As such, the children in the community of Mopani District depend on government facilities to receive healthcare services. Therefore, failure for the government to provide adequate vision screening to schools may result in high numbers of undetected and uncorrected refractive error conditions among the children. The evidence provided by this study, as seen in figure 5.8 of the quantitative data, showed that a majority of 83% of the children (n=272) had not undergone any eye testing in the form of school health vision screening or consultation with a healthcare practitioner. While only 17% (n=55) of the children had a history of eye examination or testing, only 40% (n=22) of the 55 children were tested through school vision screening. Evidently, this included children as old as 16 years. Although vision screening is the most cost-effective method of early detection of refractive error (Latorre-Arteaga, *et al.,* 2016: 652), this finding suggests that most learners might remain uncovered by this appropriate initiative. This finding was consistent with the study conducted in Tshwane District, Gauteng Province, where it was concluded that most children are likely to complete school without having received any form of school health screening (Rasesemola, Matshoge and Ramukumba2019: a1912). While comparing this study with the findings in Tshwane District, it is critical to note that the infrastructural challenges in Mopani District are much more devastating as compared to Tshwane District. This study provided adequate evidence to suggest that low ocular examination rate (17%; n=55) might be a contributing factor to the low spectacle wear rate (2.4%; n=8). As such, children may not have access to corrective lenses unless they were detected. The low frequency of eye examination among the children in Mopani District was consistent with the study conducted in India (Sabherwal, Sood, Siddiqui, DasGupta, Ganesh and Basset (2020: 449). This finding was further corroborated by the qualitative findings of the current study, wherein the educators provided that only the foundation phases, particularly grade 1 receive vision screenings. Accordingly, subcategory 5.2.1: “exclusion of Intermediate & senior phase” described this limitation. In addition, the educators provided further evidence that suggested the existence of refractive error and other eye problems in the intermediate and senior phases, which were not covered by the school vision screening program in the district of Mopani. Furthermore, some of the educators confirmed that one of the schools in the district had never received any vision screening services in the recent years, this might be evidence to substantiate the very low number of children that have a history of school vision screening.

Furthermore, as the study was conducted in both public and private schools, the educators raised concerns regarding the exclusion of some schools, particularly private schools. This was consistent with the school vision programme in India (Sabherwal, *et al.,* 2020). Although the reasons for exclusions of private schools in Mopani District may not be related to the ISHP, the current school vision programme in Mopani focused mostly on public or government schools (Mopani District Department of Health, 2019). The challenges posed by the incomplete coverage of schools in the current school vision screening program therefore explains the reasons for the unidentified and uncorrected refractive error of over 32.8% and only 3% were identified and corrected. This suggests to the researcher that the current vision screening program might be incapable of covering all the children in grade 1 as prescribed by the ISHP (Departments of Health and Basic Education, 2012). Therefore, the evidence presented by this study is adequate to suggest that most of the children in Mopani District with refractive error remain undetected due to the short comings of the school vision program. This is a major challenge as children may not know that they have vision problems (Shukla *et al*., 2018: 937). In addition, literature has also shown that refractive error increases with age, for example, a study conducted in Pradesh, India between 1992 and 2000 showed that the prevalence of myopia, astigmatism, high-myopia, and anisometropia significantly increased with age (Krishnaiahi, Srinivas, Khanna and Rao, 2009: 17). As a result, older children in intermediate and senior phases would benefit from the school vision program.

The current study suggests that factors related to resources in the form of health practitioners like professional nurses and optometrists maybe contributory to the identified short comings. This was also confirmed by Shukla *et al.* (2018: 939), who explained that the major challenge of ensuring that all school children were screened country wide would be the requirement of optometrists and the provision of free spectacles for the children that need them. As such, children in intermediate and senior phases should also receive eyecare services to ensure that those with refractive error are treated timeously. Although this challenge might be due to the lack of sufficient resources in the form of healthcare practitioners (Shung-Kingi, Orgilli and Slemming, 2014: 67), the need for screening in these intermediate and senior phases cannot be underestimated. Based on the above findings, there is a great need for strategies to ensure the inclusion of all grades in the vision screening program. This study has provided evidence on the effectiveness and efficacy of the current strategies to detect and manage refractive error in children, which highlighted an urgent need for reinforcement of these strategies.

6.11 Description of the conceptual Framework Application to the Study.

The purpose of this section is to describe how the conceptual frame was applied by the researcher to ensure that the study provided an in-depth understanding of the refractive error phenomenon in Mopani District.

The study used the PPM as a framework to understand the extent of refractive error and its risk factors, however, since the model had gaps, the researcher used triangulation of frameworks to address the challenges of PPM (Green and Kreuter, 2005; Crosby and Noar, 2011: S15). The PPM was used together with ActAD framework to ensure that any shortcomings on the PPM had been addressed. The limitations included cost and time required to ensure the complete and practical application of the model in reality, and lack of detailed guidance for each step of the model, however, the authors of the model have advised that the model can be applied in parts to minimise the identified limitations (MacDonald and Mullett, 2009: 165; Sharma and Romas, 2012: 48). In addition, DIT was used to propose the strategies for early detection and management of refractive error as discussed in chapter 7. The researcher has used ActAD frame as a lens in the refractive error study, whereas this framework is commonly used in the field of Information Technology (Korpela, 2004). The applied four phases of the Precede phase of PPM and its contribution to the attainment of the study objectives are described as follows:

6.11.1 Phase 1: Social Assessment and Situation Analysis Literature Review in Chapter 2

Demographic data collection of the children and the parents in the form of a questionnaire from the parents/guardians has assisted the researcher to explore the social diagnosis in detail. In addition, qualitative data was collected from the educators. In this phase, it was critical to ensure that the information that assists in community diagnosis was acquired from multiple sources (Green and Kreuter, 2005: 31). In addition, literature review in chapter 2 explored the refractive error prevalence in Mopani, the school health programme and Integrated School Health Policy, to enhance the social assessment of the community.

6.11.2 Phase 2: Epidemiological Diagnosis

This phase included epidemiological diagnosis that focused on measurable factors that have the potential to affect the refractive status of the children and their quality of life (Sharma and Romas, 2008). Therefore, this phase together with phase 1, ensured that the extent of refractive error was assessed by the actual ocular examination, while its risk factors were assessed by determining the refractive error association with demographics, family history and children’s activities. The associations of the risk factors were presented in chapter 5. Community diagnosis was achieved through qualitative and quantitative data analysis and synthesis using The ActAD in chapter 6.

6.11.3 Phase 3: Educational Assessment

Phase 3 aimed at the identification of factors that influence the epidemiological profile that may have been identified in the second phase of the model (Green and Kreuter 2005).

Predisposing factors: A better understanding of refractive error with regards to its effect on the child, symptoms, and treatment would put the parents/guardians and the educators in a better position to identify the eye problem and seek the services of an eyecare practitioner timeously. Through quantitative data, the study provided evidence of the low frequency and reasons for eye examination and low prevalence of spectacle wear and further explored the causative factors of factors like school health vision screening programme gaps, and the educators' recommendations on treatment of refractive error, which included medication or injection.

Enabling factors: In this study, these factors included availability, accessibility and affordability of the eyecare services, which directly affect the identification and management of this condition (Ntsoane and Oduntan 2010:183). The study findings highlighted school health vision screening challenges which included incomplete coverage of the schools and children in Mopani District. This might be due to inadequate resources like optometrists, professional nurses, affordability, accessibility and availability of spectacles.

Reinforcing factors: In addition to the above, the clinical reasons that influenced the eye examination, included symptoms such as: redness of eyes, injury and poor vision. In addition, the study also explored clinical reasons for wearing spectacles which included: clear vision and near and far vision. All these were explored in chapter 5.

6.11.4 Phase 4: Administrative, Policy Assessment and Intervention Alignment

Based on the qualitative and quantitative findings in phases 1-3, in Phase 4, the focus was designing the plan to ensure the achievement of the purpose of the study and selecting intervention strategies that ensure success in attaining all objectives (Green and Kreutzer, 2005). In this context: "*the study endeavoured to gather data that will be used to develop/propose strategies that can be utilised to promote early detection and management of refractive error among Primary School Children in Mopani District of Limpopo Province."* Therefore, in this phase, the strategies were proposed in chapter 7 of the study. However, to enhance the proposal of these strategies, triangulation of theoretical frameworks was used as discussed above, where the researcher applied the DIT to propose the strategies based on the study findings (phase 1-3) and the review of literature (phase 1). Therefore, each strategy briefly described its relative advantage, compatibility, triability and observability as described in the theory.

6.11.5 Proceed Phase:

Proceed comprises of implementation and evaluation phases, and its goal is to ensure the availability, accessibility, accountability, and acceptability of the programme (Green and Kreuter, 2005: 245), however, this phase was critical in providing recommendations for future studies as discussed in chapter 7, that would implement and evaluate the strategies proposed by this study.

6.12 Attainment of the Study Objectives.

The previous section discussed the application of the conceptual framework in the study, this section describes the attainment of the objectives which was achieved through the application of the conceptual framework as discussed in chapter 3. This section will present the attainment of the purpose of the study and the study objectives.

6.12.1 Purpose of the Study:

The study endeavoured to gather data that will be used to develop/propose strategies that can be utilised to promote early detection and management of refractive error among Primary School Children in Mopani District of Limpopo Province.

One of the recommended strategies by WHO and ISHP for early detection and management of refractive error is school vision screening (WHO, 2007; Departments of Health and Basic Education, 2012). Therefore, Mopani District has implemented this strategy. However, this study has identified the challenges of the Mopani District School Vision program, which were seen to be barriers to adequate vision screening and accessibility to eyecare services. For example, the study showed that vision screening was only provided to the foundation phase, particularly grades R and 1 and the intermediate and senior phases were not covered by the program. As a result, the study has proposed strategies to enhance the early detection or identification of refractive error and its management thereof, in Mopani District in chapter 7 of the study. This justifies the attainment of objective 5: To propose strategies for the early detection and identification of refractive error.

6.12.2 Objective 1: To determine the extent of refractive error among the primary school children in Mopani District.

This study objective was achieved by collection of quantitative data from the children by means of ocular examination to determine the refractive status. The finding of this study has explored the extent of refractive error in private, urban and rural schools of Mopani district, which was further validated by qualitative data collected from the educators. As such, this study provides more rigor and recent data on refractive error, visual impairment and other visual conditions in the area. In addition, the study has provided evidence of the association of unaided visual acuity with refractive error, which was further supported by the relationship between refractive error and unaided visual acuity as described by the regression model. In addition, due to limited rigor on the spectacles wear rate, particularly in the African continent (Ezinne *et al*., 2020), this study has provided most recent evidence of spectacles wear rate among primary school children of Mopani District Municipality. The study has also explored the possible reasons for the low rate of spectacles wear in the context of Mopani District Municipality.

6.12.3 Objective 2: To assess the risk factors of refractive error among primary school children in Mopani District.

The study further showed association between refractive error and the school cluster, wherein refractive error prevalence was associated with the private school and the occurrence of myopia was associated with rural public school. This was further supported by the negative relationship that was described by the regression model. Refractive error prevalence was also associated with the school grade, wherein refractive error increased with an increase in the school grade. Myopia and hyperopia increased with higher grade levels, while astigmatism, was more associated with lower grades. Association between refractive error and near work, that is reading writing and colouring after school was observed among the children. In addition, the regression model showed a positive relationship between this activity and refractive error. The above baseline data becomes critical for the purpose of planning and prevention of refractive error. Furthermore, the study showed that the occurrence of refractive error in Mopani District Municipality was not associated with the other risk factors like gender and parental refractive error as opposed to other studies (Theophanous *et al*., 2016: 1581; Chua *et al.,* 2015: 8101). The study has also shown a weak association of child spectacles wear history and refractive error, where about half of the children that wore spectacles were myopic.

6.12.4 Objective 3: To examine the association between refractive error and the socio-economic status of parents.

The attainment of these two study objectives was through the collection of quantitative data in the form of a questionnaire that was completed by the parents or guardians of the children and the actual examination of the children's eyes. Although studies have described the risk factors of refractive error among school children, the researcher could not find published literature regarding the risk factors of refractive error in Mopani District Municipality (Lanc, Serra and Prista, 2014: 115; Sheeladevi *et al*., 2018: 495). Therefore, the study has provided baseline data on the risk factors of refractive error, which might be crucial for the purpose of health promotion, prevention and proposal of strategies in the District of Mopani. For example, regarding parental education level, the study showed a weak association between refractive error and the fathers' level of education, where refractive error was mostly associated with higher education and myopia prevalence was highest among the children whose fathers had secondary school level followed by higher education. In addition, the prevalence of refractive error was associated with the parental employment status, with a very strong association between the father's employment and refractive error and a weak association with the mothers' employment status and refractive error. However, the regression model only demonstrated a relationship between refractive error and the fathers' employment status.

The study findings further showed evidence that the prevalence of refractive error was associated with the position of the child in the family, as such, refractive error prevalence increased with lower child positions. The regression model established a strong negative relationship between refractive error and the child position in the family. Therefore, children with higher positions were less likely to experience refractive error.

6.12.5 Objective 4: To explore the educators' experiences in educating school children who manifest with ocular problems.

Furthermore, the study provided data on the effect of vision problems, particularly refractive error, on teaching and learning. These challenges included difficulties experienced by teachers in teaching children who cannot see clearly on the chalkboard, failure by some learners to complete tasks or assessments and having to increase the size of the letters of the alphabet on the chalkboard. The study further provided information relating to the strategies used by educators to ensure that teaching and learning continues despite the eye problems experienced by the learners. These strategies included seating arrangements, wherein learners with poor eyesight are encouraged to move closer to the chalkboard. The study has also shown that due to inadequate knowledge on the treatment of refractive error in children, educators preferred medication or injections as a form of refractive error treatment and prevention than spectacles. Furthermore, evidence has shown that the schools experience challenges in addressing the problems of refractive error. These challenges included lack of parental involvement and inadequate school screening services. In addition, the educators recommended possible strategies that should be utilised to address the refractive error problem. Therefore, the findings provided by the objective provided rigor on the refractive error phenomenon in the context of the teachers' experiences, in Mopani District.

6.13 Conclusion.

In this chapter the researcher integrated qualitative and quantitative data in order to draw meaningful conclusions as a pragmatic. Therefore, the study findings have shown the high prevalence of refractive error and its possible risk factors. It was noted that, despite the educators' mitigation strategies to address issues of refractive error, this condition unfortunately remains a major barrier to teaching and learning in schools. It is concerning that due to the shortcomings of the current school health vision screening, most children remain undetected and uncorrected. Therefore, there is a need for urgent strategies to address issues of refractive error among school children. The following chapter will focus on the conclusions and recommendations of the study.

CHAPTER SEVEN: PROPOSAL OF STRATEGIES

7.1 Introduction

The proposal of strategies for early detection and identification of refractive error among school children will be addressed in this chapter. These stratergies are drawn from several intuitively obvious and commonly used categorization schemes prompted by the research findings. The strength was the homogeneity within categories. As should be obvious from the above discussion, the consensus among studies and educators is that early identification of refractive error represents the single best intervention measure.

7.2 Reinforcing existing WHO infrastructure

This section will focus on the development of strategies to enhance the early identification of refractive error among primary school children of Mopani District. South Africa is now one of the World Health Organization member states. The School Health Programme as envisioned by the WHO includes eye care. Reinforcing the existing WHO infrastructure is paramount. After critical analysis of the study findings, the WHO strategies, and the Mopani District school vision programme, the researcher applied the DIT to propose strategies. As discussed in chapter 3, the following four factors were used to develop the strategies:

1. **Relative advantage:** refers to the extent to which the new idea is perceived as better compared to the program or idea it intends to replace.

2. **Compatibility**: can be explained as the level of consistency with the values, experiences and needs of the adopters.

3. **Triability**: refers to the degree to which the innovation can be experimented or tested prior to adoption commitment by the intended adopters.

4. **Observability**: simply answers the question, can the innovation provide quantifiable results?

7.2.1. Strategy number 1: Vision Screening by Non-health Care Practitioners

Studies have proven that screening for refractive error among school children by non-health care workers was effective. The rationale behind the idea being the scarcity of healthcare professionals to cater for the entire population that requires school screening, and that the procedures for detecting refractive errors can be modified to the level of the non-healthcare workers. This modification ensures that effective and comprehensive training for the non-health professionals requires a few days. The current screening programme in the district, which is carried out by the optometrists, and sometimes nurses, only caters for a small portion of the population. This was confirmed by the statistics and the findings of this study, which showed that most of the children had no history of eye examination or screening.

The recommended categories of non-professional people to be involved in school vision screening:

- Educators
- Assistant teachers
- Home Based Care Workers

Relative advantage: for this strategy is that more children will receive some form of vision assessment, thus assisting the current DoH school health program. The services will be based locally and at school level, as a result, the actual assessment, referral, and engagement with the parents/ or guardians will be more convenient.

Currently, the DoH school vision program has no mechanisms to track or follow up on screened children, which means there is no record that confirms that all children that were identified during screening, have been refracted and managed either at the hospital or private optometry practice. However, teachers, for example, would ensure that identified children with refractive error during screening, are referred to the next level of care and appropriate feedback is provided to the school. Home based carers are usually based in the same community as the children and the school and could also assist in breaking the barrier between the school and the parents, by assisting with enhancing communication where children are referred to the next level of care. Another benefit is that the home-based carers share the same beliefs, culture and social factors as the children and their families, which will bridge the gap between the community and the health practitioners and thus enhance the management of refractive error.

Compatibility: In the context of Mopani District, the use of homebased carers and their involvement in health care is not new. The population is familiar with their role, therefore, the introduction of an extra role at school level could be a better approach. Also, the educators, as seen in the findings of this study, are already involved in providing solutions to children with eye problems, which included some form of identification and referral to the health professionals in collaboration with the parents.

Triability: The main advantage of this strategy is that it focuses on the resources that are available in terms of human resources, however, this can be perceived as new or additional roles. Since there are no additional resources that require enormous budgeting for equipment, resources and staff, the strategy can be easily tested. The main requirement would be the training of the screeners by health care professionals, which does not require a considerable amount of time.

Observability: The results of implementing this strategy could be determined by the assessment of the quality and accuracy of the screening techniques. Furthermore, this could be determined by assessing the number of false positives and negative referrals.

7.2.2. Strategy number 2: Optometry Assistants Training Program

The Department of Health, Department of Higher Education and the Health Professions Council of South Africa should collaborate and decide on the training and opening of an optometry assistant register especially in the outskirts of the rural schools. Currently, the HPCSA does not have any register for optometry assistants, nor do the South African Higher Education Institutions offer programmes for optometry assistants. The optometrist assistant programme would ensure sufficient training of students on basic visual screening and refraction, particularly for the purpose of school vision screening. The optometrist assistants would be registered under the category of supervised practice with the HPCSA.

Relative advantage this strategy would not only assist in the screening of school children, but also in the refraction of children under the supervision of an optometrist.

Compatibility: The use and registration of assistants with the HPCSA and other councils has been seen among other professions like dentistry, occupational therapy, physiotherapy, nursing, and pharmacy. In the context of Mopani District as well, the community is familiar with the services of assistants in the mentioned professions. Therefore, introducing optometrist assistants for the purposes of school health care in Mopani District could be easily adopted by the community.

Triability: The strategy may require more time to implement as it may require deliberations by the relevant departments, the HPCSA and other stakeholders, however, the appropriate and quicker method of triability would be to benchmark with the professions that have already implemented the strategy.

Observability: The effectiveness of the strategy could be determined by assessing the knowledge of trained optometry assistants to perform basic optometry examination under supervision.

7.2.3. Strategy number 3: Incorporation of Refractive Error Education in the Curriculum

The study has revealed that the educator's knowledge of refractive error was not satisfactory. Therefore, incorporating refractive error lessons in the current curriculum would increase both the educators and the children' s awareness of the condition, as a result, children would be able to report, and educators identify any symptoms associated with refractive error timeously. This could be easily achieved by gathering similar journals for reference when teaching learners regarding refractive error.

Relative advantage: There will be an increase in self reporting of refractive error symptoms by the learners, and identification of refractive error by the educators in the classroom setting.

Compatibility: The current curriculum in primary schools incorporates some level of health education in certain areas like HIV/AIDS. Therefore, the educators are familiar with the method of educating learners in the classroom about health-related matters. Therefore, educators will be able to learn and then instill the knowledge about refractive error to the learners without major difficulty.

Triability: To implement or try this strategy mainly requires resources such as learning materials and time for the educator to understand the topic; therefore, no enormous budgeting may be required to implement this strategy.

Observability: The results of implementing this strategy could be evaluated by assessing the refractive error knowledge of both the learners and educators and the number of self-referred children for refraction.

7.2.4. Strategy number 4: Community Awareness.

Community awareness in the form of health education, media involvement, health talks, and other programs is essential. The community needs to understand the impact of refractive error as a learning barrier for the children. This will increase their involvement in identification and compliance in the treatment. When the parents and the entire community are aware of the condition, the risk factors and the treatment method, a positive response from the community shall be received. Community involvement in the context of Mopani District is very crucial, especially in the outskirts of the district.

Relative Advantage: This will assist parents/guardians and other family members to identify refractive error symptoms. For example, children with myopia might be seen sitting very closely to the television at home. This study showed a very low percentage of children that had a history of ocular examination. Therefore, the community awareness strategy will assist parents to further ensure that children receive regular or periodic ocular examinations, adhere to the recommendations and treatment by the healthcare practitioners and avoid possible risk factors like prolonged video games. In addition, the strategy will enhance the cooperation of parents when educators and health care practitioners engage them regarding the condition of the children's eyes. The stigma around spectacles wear will also be addressed and as a result reducing the spectacles non-wear prevalence.

Compatibility: The Mopani District currently has awareness programmes for different diseases and conditions which are coordinated by the Department of Health. These are achieved through health talks, community radio stations and distribution of education materials. Incorporating the vision school health awareness programme will not be a completely new phenomenon in the area of Mopani District, as the community is currently involved in other awareness programmes.

Triability: The strategy only requires personnel in the form of Optometrists, community Liaison officer and educational materials. These sources are currently available and can be utilised to try out the implantability of the strategy.

Observability: The results of this strategy will be seen by an increase in the number of periodic ocular examination and compliance to the recommendations of the health practitioners.

7.2.5. Strategy number 5: Mobile Optometry Clinic

As seen from the qualitative findings of the study, the educators reported that the lack of parental involvement in ensuring that children that are referred for further management after screening, go for the appointments was a major challenge. The use of a mobile optometry clinic would ensure that children that are detected to be potentially suffering from refractive error are refracted in the school premises by optometrists and optometry assistants, who will constantly visit the school to ensure that such services are rendered.

Furthermore, children that require spectacles correction will be supplied with the spectacles at school, without visiting the health facility.

Relative Advantage: This will ensure that the eyecare services are accessible to the children and the utilisation rate is increased. There will be no need for long distance travels to access the service, especially for the rural areas and poor communities.

Compatibility: In the province of Limpopo, there are Districts like Vhembe, which have utilised mobile optometry clinics for school health programs during the National Health Insurance Piloting, therefore this type of service is not new in the province. Furthermore, mobile clinics have been used for other services in the Department of Health, for example, dental mobile clinics and PHC mobile clinics responsible for management of chronic conditions like hypertension and diabetes.

Triability: The strategy requires support in terms of budget allocation to procure vehicles and equipment.

Observability: This will be observed through an increase in the number of refracted children and the dispensing of spectacles to the children or increased spectacle wear prevalence.

7.2.6. Strategy number 6: Intersectoral Collaboration

Refractive error in children is a public health issue, which requires timeous intervention. Therefore, the responsibility to ensure the elimination of visual impairment and blindness, and to improve the quality of life is not only the responsibility of the government, but all sectors. This is to ensure that all possible resources in eyecare are channelled for the achievement of this goal. As a result, this study proposes the intersectoral collaboration amongst the private sector, government departments and non-profit organisations. For example, there are private optometry companies that provide spectacles for free to children of 12 years and below. However, there is no formal collaboration that exists between the company and the department of health and education which is currently responsible for the school vision services. Intersectoral collaboration is critical to ensure the appropriate channelling of resources. For example, children in the rural areas may not access the facilities of the said company as it is mostly located in cities, however, optometrists from the private sector could perform eye examinations on children and order spectacles with the assistance of the company. In addition, local optometrists in the private sector could sign a memorandum of understanding with the DoH and DoBE to assist in the provision of eyecare services to the schools, and possibly at a lower rate. It is worth noting that as much as the program relies only on the government resources, challenges related to accessibility, availability and affordability of eye care service may continue to be barriers to the quality of life of the affected children.

Relative Advantage: To enhance the management of refractive error in schools by facilitating the sharing of resources among population groups of different socio-economic levels as supported by the National Health Insurance approach.

Compatibility: The concept of intersectoral collaboration currently exists in the healthcare system of Mopani District. For example, the medical practitioners in private practices admit private patients in government hospitals and perform surgical procedures. Similarly, there is a strong referral system between private optometrists and government eye care services, however, not in the context of refractive error in children.

Triability: The collaboration of government departments like DoH and DoBE will require proper planning in order to develop a memorandum of understanding, particularly with the local optometrists, optical laboratories, businesses and NGOs.

Observability: The success of this strategy will be observed by an increase in the number of children refracted and corrected in the private sector. Furthermore, there will be an increase in the number of resources provided by the private sector and the non-government organisations.

7.3 Conclusion

This chapter has presented the approached employed by the researcher to propose strategies for early detection and identification of refractive error among primary school children.

CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

This chapter presents, the main conclusions of the study and the study reccomendations are brought forth to address the gaps that were identified. In addition, the chapter provides the justification for the study's contribution to the body of knowledge and discusses the limitations of the thesis.

8.2. The Extent and Risk Factors of Refractive error.

In order to address visual impairment and avoidable blindness in Mopani, acquiring the epidemiological data of refractive error is a necessity. The study showed that the high prevalence of visual impairment among school children was caused by uncorrected refractive error in Mopani District Municipality, with myopia being the most occurring type of refractive error. The occurrence of allergic, vernal and bacterial conjunctivitis, which affected the children, was described as a major problem by the educators.

In addition, refractive error was significantly associated with the amount of time spent by the children on near work activities after school. There was a strong association and negative relationship between refractive error and the type of school, wherein School A (Private School) had the highest occurrence of refractive error while myopia prevalence was highest in School C (rural public school). In addition, the school grade was associated with refractive error, however, the there was no relationship between the two variables. Furthermore, the study found an association and a negative relationship between refractive error and the child's position in the family, wherein the refractive error increased with lower family positions. A weak association of child spectacles wear was also recorded, however, there was no evidence of a relationship between the two variables. The education and employment status of the parents were associated with refractive error wherein refractive error increased with an increase in the education status. These factors are critical for prevention and community awareness purposes.

8.3. School Vision Screening Program, Eye Testing and Spectacles Wear.

The recommended method for early identification and management of refractive error is vision screening, which ensures that children are referred for thorough ocular examination for the purpose of providing appropriate treatment (Wangtiraumnuay *et al.,* 2021: 235). Having noted the findings on the extent of refractive error, it was surprising to learn of the low rate of eye testing and spectacles wear among the school children. This might be due to incomplete coverage by the school vision screening programme, which showed an exclusion of senior and intermediate phases, private and some public schools. The eyecare services, including spectacles were sourced from public hospitals, as such, the children share these limited resources with the general public. Therefore, these resources, including human resources, might be inadequate to cater for all school children and the entire population in the area considering the burden of refractive error as highlighted above. In addition, the study findings showed that parents had challenges which resulted in their unavailability to address the challenges of refractive error among the children.

8.1 Effects of Refractive Error on Teaching and Learning

This study further provided evidence that the occurrence of eye conditions, particularly refractive error, had a direct effect on learning and teaching in schools, which ultimately results in failing to finish academic tasks provided by the educators, thus making it difficult for the children to learn, and for the educators to instill knowledge to the children and assess the children's knowledge. The educators' strategies to mitigate for the above refractive error challenges which included seating arrangements, where children were moved closer to the chalkboard to ensure that teaching and learning continues, might be inadequate. Therefore, the negative impact of refractive error in schools remains a major barrier to teaching and learning. Unfortunately, there is still a gap in the awareness of the refractive error condition among the educators. For example, the educators' preference of medication and injections over spectacles as treatment methods for refractive error; and the recommendation of vaccination as a form of prevention of refractive error, indicates that more still needs to be done to ensure that adequate knowledge is provided to the educators.

8.2 Conclusions

The challenges of refractive error among school children are a disconcerting public health problem, which eventually impact on young children's quality of life, academic performance and future well-being (Chisanga and Funjika, 2016: 1740). Notwithstanding that the management of refractive error through the prescription of spectacles is an effective and affordable treatment method, most children have no access to eyecare services, and consequently, spectacles. The community relies mostly on the Department of Health for eyecare screenings and provision of spectacles. However, the resources seem to be inadequate to cater for the whole community. Most families of children attending public and rural schools cannot afford the eyecare services provided for by the private sector. The study also showed the possible risk factors of refractive error. The study has also shown that most children have never undergone eye examination, which might be the reason for the low prevalence of spectacle wear, as children with refractive error remain undiagnosed. This may therefore cause the development of amblyopia and preventable blindness. Children with untreated refractive error also struggle with their schoolwork, as reported by the educators, which poses serious risks for learning and teaching. Should the refractive error of these children be left untreated, it might be unlikely that these children will progress to higher levels of education. Furthermore, their quality of life in general is compromised. The overall coverage of the current school health program in Mopani District Municipality had shortcomings and was inadequate. This, therefore, suggested urgent implementation of the strategies proposed by this study below in chapter 7, which was the major achievement of this study.

8.3 Study Relevance

This section presents the relevance of the findings of this study to the community, Departments of Health and Education, and Policy development.

8.3.1. Relevance to the Community

The study findings, particularly the associated risk factors of refractive error will assist in health education or awareness of the parents and the general public regarding these factors. For example, parents should be made aware of the effect of the time spent on near work on vision. The findings of the low rate of eye testing and spectacles wear may assist in increasing the awareness of refractive error and the treatment options and thus increasing the consultation rate, and parental involvement in the management of refractive error. This will ensure that children with refractive error are treated with spectacles and their quality of life would be improved. Lastly, refractive error as a major public health problem requires the involvement of the entire community, as such, the findings of this study proposed an intervention that enables the community home-based care workers to assist in the detection of refractive error in schools.

8.3.2. Relevance to the Department of Education

The study has shown the difficulties and challenges encountered by the educators and the children due to the occurrence of refractive error and other eye conditions. In addition, the study findings revealed that the educators' knowledge of refractive error was low. This will assist the department to implement some of the strategies proposed by this study. For example, including the refractive error in the curriculum for life orientation and for the educators and teacher's assistants to form part of the vision screening team for refractive error. Lastly, to ensure that enough resources to support the school vision programs are provided.

8.3.3. Relevance to the Department of Health

The study has shown that the current School Vision Screening Program has gaps and it excludes a majority of the learners. As a result, more children had never had an eye examination which resulted in a very low prevalence of spectacles wear. These findings will assist the DoH in considering the implementation of the strategies proposed by this study. For example, the Department would collaborate with the private sector to ensure that enough resources in terms of health workers and spectacles are provided to achieve the goal of detecting and treating refractive error. Furthermore, the DoH would ensure the provision of resources like mobile optometry clinics to enhance the accessibility of eyecare services. This would mitigate the challenges of lack of response by parents when their children are referred for further management at health facilities.

8.3.4. Relevance to Policy Development/Review.

Policies have consequences and research on their effects must be systematically undertaken. Current policy emphasises the provision of eyeglasses. It is assumed that such a policy might result in the over utilization of these devices by adults while children are overlooked. Although there is no precise data regarding this hypothesis, it is also thought that many eye care devices might be used for aesthetics, particularly in the private sector. The Integrated School Health Policy bears reference in this case because South Africa is now one of the World Health Organization member states.

The findings of this study showed that the ISHP was implemented in Mopani District, and that the School Vision Program exists. It was noted that there were issues with regards to coverage of all schools and children. The findings of this study will assist in the amendment of the policy to allow for non-health practitioners like educators to perform vision screening. In addition, that all children from all grades be eligible to receive school vision screening.

8.4. Recomendations

The recommendations of this study are based on the study findings, proposed strategies for early detection and identification of refractive error as discussed in chapter 7, and lastly the relevance of the study as discussed in 8.6 above. The above therefore form a strong base for the recommendations for improvement of current practices, which were presented in the form of a Proposed School Eyecare Service Model, and recommendations for future research.

8.4.1. Recommendation for Improment of Current Practices

The recommendations for improvement of current practices will be presented in the form of a model as seen below. The proposed strategies as discussed in chapter 7, which focused mostly on increasing the capacity for the resources for early detection of refractive error, were incorporated into the existing strategies. Therefore, the proposed school eyecare service model was presented in three levels of intervention, having considered the relevance of the study as presented in 8.6 above.

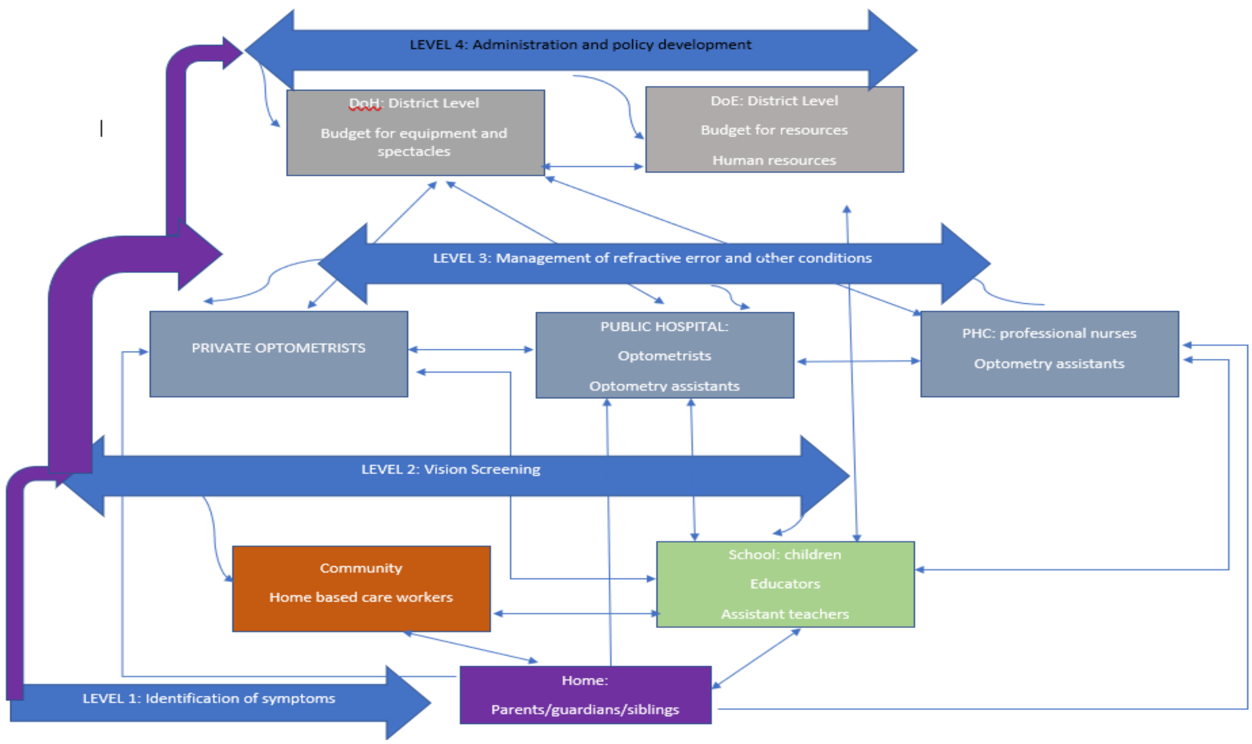

Figure 8.1: Schematic presentation of the proposed school eyecare services model

8.4.2. Level 1: Identification of Symptoms

The detection of refractive error can be achieved in level 1 of the model. This will happen at family level, where parents/guardians and other family members are able to identify the symptoms for refractive error and take appropriate action to ensure that the child receives the appropriate treatment from healthcare practitioners. In order to achieve this goal, there is a need to raise awareness about the symptoms of refractive error, its effects on the child and the possible treatment options. Therefore, strategy number 4: community awareness, would be very important in this intervention level. Furthermore, strategy number 3: Incorporation of refractive error education in the curriculum, would assist the children to notice the eye problems by themselves and report to the educators and parents.

8.4.3. Level 2: Vision Screening at School.

This level requires skills to perform basic screening techniques for vision like visual acuity and pinhole visual acuity tests. To ensure that all children receive this form of screening, formal training should be provided to the non-health professionals as discussed above. The non-health professionals may perform the simple vision screening tests to identify children that may be affected by refractive error. These tests will have to be performed at the school facilities. Furthermore, the Departments of Health and Education should ensure that there is appropriate equipment and offices for screening. All children that fail the screening tests will be booked to be examined by an optometrist, optometry assistant, or a professional nurse. Alternatively, a referral can be made to a health care facility. Therefore, strategy number 2: human resources development & management programme, would ensure the attainment of this level of intervention. In addition, strategy number 1: vision screening by non-health care practitioners, would assist in increasing the capacity for adequate vision screening in schools.

Optometrists, optometry assistants and professional nurses would provide support to the non-healthcare practitioners by visiting the schools to examine children that would have been detected by the non-healthcare practitioners. Children confirmed to be having refractive errors will be refracted in a mobile optometry clinic or referred to a healthcare facility like a hospital or private optometrists.

8.4.4 Level 3: Management of Refractive error

The treatment of refractive error will involve refraction and thorough examination of the children by the optometrists. The optometrists will prescribe and dispense optical corrections to children that will require spectacles. This will require optimal support from both the Departments of Health and Education, to ensure that adequate funds are made available for the procurement of the optical devices. Furthermore, there will be need for a strong collaboration between the Departments of Health and Education and the Private Sector Optometrists to ensure that some of the children are assessed and managed in private practices to ease the burden on the eyecare service of the Department of Health.

The optometrists will ensure that they work together with the school to monitor the compliance of spectacle wear in schools, and keep track records of the treated children.

8.4.5. Level 4: Administration and Policy Development

The support in terms of budget, resources, human resources and appropriate training and awareness will be provided and facilitated by both the Departments of Health and Education at district level. Therefore, it is critical that the two departments strengthen their relationship to ensure proper facilitation of all the eye care services at school level. Furthermore, there is a need to incorporate the 4 proposed strategies into the current policies, programs and guidelines in the context of Mopani District.

8.4.6. Recommendations for Future Research

It is recommended that future studies should focus on the implementation, monitoring and evaluation phase of the strategies developed in this study as described in PPM. Furthermore, further research could focus on determining the association of refractive error and academic performance among the children. This study has shown a high prevalence of spectacles non wear, it would also be beneficial to explore the determinants for this high prevalence, for example, the further research study focus could be the knowledge and attitude of the parents on spectacle wear among the children.

8.5. Justification to the Study's Contribution to the Body of Knowledge.

In developing countries, research in the field of Public Health, though required, is difficult (Deen, Von Seidlein, and Clemens, 2014). The researcher believes that this study has provided many benefits which include but are not limited to the in-depth understanding of the refractive error problem and the study has also proposed strategies for early detection and management of refractive error in the area. This will ensure the overall improvement on the quality of life among the children and the community. This section presented the practical, conceptual and methodological justification of the study's contribution to the body of knowledge.

8.5.1. Practical Contribution

In cross-sectional studies, one of the biggest challenges is to ensure that the sampled participants are a representative of the study population (Deen, Von Seidlein, and Clemens (2014). This study has ensured that the private, urban public and rural public-school clusters were included in the sample to provide an in-depth understanding of the extent of refractive error, and its distribution. The quantitative findings on the extent of refractive error in private, urban and rural schools were further validated by qualitative data collected from the educators. As such, this study provides more rigor and recent data on refractive error, visual impairment and other visual conditions in the area. Therefore, this justifies the study's contribution to the body of knowledge as there was limited rigor on refractive error studies among primary school children of Mopani District. In addition, the study has provided evidence of the association of unaided visual acuity with refractive error, which was further supported by the relationship between refractive error and unaided visual acuity as described by the regression model. In addition, due to limited rigor on spectacles wear rate, particularly in the African continent (Ezinne *et al*., 2020), this study has provided the most recent evidence of spectacles wear rate among primary school children of Mopani District Municipality. The study has also explored the possible factors that have the potential to influence the rate of spectacles wear in the context of Mopani District Municipality.

Risk Factors of Refractive Error

The collection of quantitative data in the form of a questionnaire that was completed by the parents or guardians of the children and the actual examination of the children's eyes offered an opportunity for the researcher to establish a possible relationship and association between refractive error and the possible risk factors. Although studies have described the risk factors of refractive error among school children, there was limited rigor in the aspect of risk factors in Mopani District (Lanc, Serra and Prista, 2014: 115; Sheeladevi *et al*., 2018: 495). Therefore, the study has provided baseline data on the risk factors of refractive error, which might be crucial for the purpose of health promotion, prevention and proposal of strategies in the District of Mopani. For example, amongst other risk factors, the prevalence of refractive error was associated with the parental employment status, with a very strong association between the father's employment, and the regression model demonstrated a relationship between the variables.

Educators' Experiences

The study has used in-depth interviews to collect qualitative data on the experiences of educators in educating children with refractive error. The qualitative findings provided evidence of the manifestation of eye problems and their effects on teaching and learning in schools. In addition, the study findings described the educators' methods of detecting refractive error, mitigation strategies to resolve the challenges posed by the detected problems, challenges experienced in implementing these strategies and recommendations to resolve the refractive error challenges. This study provided rigor on the refractive error phenomenon in the context of the teachers' experiences, in Mopani District. As such, the educators' experiences provided evidence that refractive error has the potential to affect teaching and learning in the classroom.

School Health Vision Screening.

One of the recommended strategies by WHO and ISHP for early detection and management of refractive error is school vision screening (WHO, 2007; Departments of Health and Basic Education, 2012). The qualitative data showed that there were gaps on the implementation of school health vision screening in Mopani District. These gaps included incomplete coverage of the children and schools. For example, the study showed that vision screening was only provided to the foundation phase, particularly grades R and 1 and the intermediate and senior phases were not covered by the program.

Proposal of the strategies

The proposal of cost-effective strategies to manage public health conditions like refractive error and cover a large segment, particularly in developing countries, has become the focus. This is to ensure that the limited resources benefit bigger segments of the population than less cost-effective treatment for fewer individuals (Deen, Von Seidlein, and Clemens (2014). Having considered the need for this type of research in eye care, the research findings informed the study's proposal of strategies which can enhance the early detection or identification of refractive error and its management thereof, in Mopani District.

8.5.2. Methodological Contribution

The researcher saw it critical to gain an in-depth understanding of the refractive error phenomenon. To ensure that such an understanding is achieved, data was collected from various sources (parents, educators and children) by using different techniques and methods. The researcher has acknowledged that there are a number of studies that have been conducted in different parts of the world on refractive error in primary school children, however, most of these studies used the quantitative research method to explore the phenomenon of refractive error (Beganović *et al.*, 2018: 858; Azizoglu *et al*., 2017; Magakwe, Xulu-Kasaba and Hansraj, 2020: a551). Evidently, the study's methodological contribution was demonstrated using multiple data sources and collection techniques as presented in chapter 4. In this context, the study has collected data from the parents, children and educators. Therefore, this study has adopted a different strategy of research methodology for a study in refractive error. As such, triangulation of quantitative and qualitative data was the main strength of this study using mixed methods to ensure that the limitations of each method were reduced. This has increased the credibility of the findings in this study. The use of PPM offered the researcher with an opportunity to be pragmatic and combine techniques at different phases of the Precede phase. In phase 1 to 3, the study described the refractive error phenomenon from the literature and data collected from the parents, children and educators by using a combination of questionnaires, ocular examination and in-depth interviews. The researcher has taken into consideration that with cross sectional studies, it is challenging to ensure that the sample is representative of the population being studied (Deen, Von Seidlein, and Clemens (2014). Therefore, the strength of this study was derived from ensuring that the private, rural and public clusters were included in the sample, thus providing a deeper understanding of the phenomenon in the population of interest.

8.5.3. Theoretical Contribution

The study used triangulation of frameworks to provide an in-depth understanding of the extent of refractive error and its risk factors. This was achieved using PPM as a conceptual framework, and the use of ActAD framework as a lens in the refractive error study, whereas the framework is commonly used in the field of Information Technology (Korpela, 2004). DIT was used in the development proposal of strategies to enhance the early detection and management of refractive error in schools.

8.6. Study Limitations

In this study, the identified discipline-specific and methodological limitations did not in any way attenuate both the significance and efficacy of the study. Rather, these limitations serve as a framework for improvement (Brink *et al*., 2012; Creswell, 2013).

8.6.1. Epistemological/ Discipline-Specific Limitations

The recommended methodology to determine the refractive status of the children is cycloplegic refraction, as such, the non-use of cycloplegic refraction was a limitation for this study. Therefore, there is a likelihood that refractive error findings might have probably presented differently.

During the examination of children that presented with refractive correction, the prescriptions of the lenses should have been determined with the use of a lensometre. This would have given the researcher an overview of the accuracy of the corrective lenses. It would have been very important to also assess the relationship between refractive error and the academic performance of children in different grades and learning areas. This would have provided an overview of the extent that a particular type of refractive error affects different learning areas. Regarding the time spent by the school children on activities after school, options should have included the determination of any correlation between academic performance and time spent on both curricular and extra-curricular activities after normal school hours.

Although the study managed to propose strategies for the early detection and management of refractive error in Mopani District, the implementation, monitoring and evaluation of these strategies, which are phases of the PPM as discussed in chapter 3, were not done due to issues related to the time it takes to implement some of the strategies and the financial constraints involved.

8.6.2. Empirical/ Methodological Limitations

Only 3 (three) primary schools under specific circuits were considered for involvement in the study. This may not truly reflect the distribution and generalisability of refractive error in the entirety of schools in the Mopani District Municipality.

The unavailability of parents, especially for the rural public school was a challenge beyond the researcher's control. The completion of the questionnaire was done by guardians (14%) and others (6%), as most of the parents work away from home and these extended families take care of the children. However, the extended families did not have full information of the parents. For example, the extended families may not be able to provide details regarding the use of spectacles by the 111 fathers, which may have an effect on the association of the child's refractive error and the spectacle wear of the parents. Furthermore, some sampled participants did not respond to some of the questions, which may have affected the validity and statistical significance of the findings pertaining to those questions. Such a trend could be reflective of most parents' lack of involvement in their children's education, a fact corroborated by the educators themselves. Special appointments were made for parents who were only available after the actual data collection dates, which then resulted in additional trips for data collection. The expectations of parents and educators included provision of spectacles and medication for children that had preexisting conditions that they knew of, even though they were not part of the study. In some instances, the examination of children could not be completed on the date of the appointment since the researcher was conducting the eye examinations in all three primary schools alone. Nonetheless, the schools were flexible enough to arrange for another appointment to complete the examinations, which exerted more travelling costs for the researcher.

8.7. Conclusion remarks

The conclusions articulate a relatively eclectic and broader view on some pivotal aspects of the entire research process. The challenges of refractive error among school children is a disconcerting public health problem, which eventually impacts on young children's quality of life, academic performance and future well-being (Chisanga and Funjika, 2016: 1740). Notwithstanding that the management of refractive error through the prescription of spectacles is an effective and affordable treatment method, most children have no access to eyecare services, and consequently, spectacles. The community relies mostly on the Department of Health for eyecare screenings and provision of spectacles. However, the resources seem to be inadequate to cater for the whole community. Most families of children attending public and rural schools cannot afford the eyecare services provided for by the private sector. The study also showed that near work activities and rural schools were risk factors of refractive error. Lastly, the study has proposed strategies for early identification and management of refractive error among the children in Mopani District Municipality.

LIST OF REFERENCES

Akuta, G.C. 2015. Prevalence of refractive errors among primary school children (7-14 years) in Motherwell Township, Eastern Cape, South Africa. University of Limpopo. Available from: http://ulspace.ul.ac.za/handle/10386/1751

Alomair, R., Alghnam, S. A., Alnasser, B. N., Almuhawas, H. A., Alhoshan, S. A., Altamimi, B. S., Alshaye, R. M., Almuayli, M. T., Alokiliy, M. K., Alfawaz, W. J., and Alghamdi, S. K. 2021. The prevalence and predictors of refractive error among school children in Riyadh, Saudi Arabia. *Saudi journal of ophthalmology: official journal of the Saudi Ophthalmological Society*, *34*(4), 273–277. Available from https://doi.org/10.4103/1319-4534.322621 (viewed 12 July 2021).

Al-Nuaimi, A.A., Salama, R.E. and Elijack, I.E. 2010. Study of refractive errors among school children in Doha. *World Family Medicine Journal*, 8(7): 41-48.

Ambika, K. and Nisha, P.N. 2013. A study on awareness of primary school teachers regarding refractive errors and its early identification among primary school children. *International Journal of Nursing Education*, 5(1): 6-9.

Amir, S., Khan, D.A., Asrar, A. and Jalis, M. 2017. Prevalence of refractive errors causing amblyopia in children. *Ophthalmology Update*, (15)3: 251-253.

Anera, R.G., Soler, M., de la Cruz Cardona, J., Salas, C. and Ortiz, C. 2009. Prevalence of refractive errors in school-age children in Morocco. Clinical and Experimental Ophthalmology, 37:191-6. Available from: doi:10.1111/j.1442-9071.2009.02001.x (Viewed 19 June 2021)

Arkkelin, D. 2014. *Using SPSS to understand research and data analysis.* Available from: eduhttp://scholar.valpo.edu/cgi/viewcontent.psychr (viewed 01 July 2017).

Artini, W., Riyanto, S., Hutauruk, J.A., Gondhowiardjo, T. and Kekalih, A. 2018. Predictive factors for successful high myopia treatment using high-frequency laser in-situ keratomileusis. *The Open Ophthalmology Journal*, 12: 214–225. Available from doi:10.2174/1874364101812010214 (Viewed 19 March 2017)

Artino, A.R., La Rochelle, J.S., Dezee, K.J. and Gehlbach, H. 2014. Developing questionnaires for educational research: AMEE Guide No. 87. *Medical Teacher*, 36(6):463-474. Availables from doi:10.3109/0142159X.2014.889814 (Viewed 19 August 2021)

Atowa, U.C., Munsamy, A.J. and Wajuihian, S.O. 2017. Prevalence and risk factors for myopia among school children in Aba, Nigeria. *African Vision Eye Health*, 76(1): a369. Available from https://doi.org/10.4102/ aveh.v76i1.369 (Viewed 15 June 2021)

Ayub, A., Imran, A. and Saima, A. 2007. Prevalence of undetected refractive errors among school children. *Biomedica*, 23: 96-101.

Azizoglu, S., Crewther, S.G., Serefhan, F., Barutchu, A, Goker, S. and Junghans, B.M. 2017. Evidence for the need for vision screening of school children in Turkey, *Bio Med Central Ophthalmology*, 17: 230. DOI 10.1186/s12886-017-0618-9

Baloyi, V.H.A., Akinsola, H.A. and Mabunda, J.T. 2018. Pattern of distribution of refractive error among primary school children in Malamulele community of Limpopo Province, South Africa. *African Journal for Physical Activity and Health Sciences,* 24(4): 142-152.

Barria, F., Conte, F., Muñoz, S., Leasher, J.L. Silva, J.C. 2018. Prevalence of refractive error and spectacle coverage in schoolchildren in two urban areas of Chile. *Pan American Journal of Public Health* 42: e61.

Bataineh, A.H and Khatatbeh, E.A. 2008. Prevalence of refractive errors in school children (12-17 years) of Tafila City-Bataineh. *Rawal Medical Journal* 3(4): 86-88.

Barasheh, Shakerinejad, Nouhjah and Haghighizadeh. 2017. The effect of educational program based on the precede-proceed model on improving self-care behaviors in a semi-urban population with type 2 diabetes referred to health centers of bavi, iran.

Diabetes and Metabolic Syndrome: *Clinical Research and Reviews*; Vol. 11: S759-S765

Bell, A.L., Rodes, M.E. and Keller, L.C. 2013. Childhood eye examination. *American Family Physician*, 88(4): 241-248.

Ben, K.D., Abdul-Kabir, M., Victor, O.Y. and Samuel, A. 2015. Prevalence of ocular morbidities among basic school children in the Kwabre East District of Ghana. *International Journal of Health & Allied Sciences*, 4(2): 111-114.

Benjamin, W.J. 2006. *Boriah' clinical refraction*. 2nd edition. USA: Elsevier.

Bhattacharyya, B and Bhattacharyya, D. 2009. *Textbook of visual science and clinical optometry*. 1st edition. New Delhi: Jaypee Brothers Medical Publishers.

Bodack, M.I., Chung, I. and Krumholtz, I. 2010. An analysis of vision screening data from New York City public schools. *Optometry,* 81(9): 476-84. doi: 10.1016/j.optm.2010.05.006. Epub 2010 Jul 8.

Brikci, N. and Green, J. 2007. *A guide to using qualitative research methodology*. Medecins sans Frontiers. [O] Available from: http://fieldresearch.msf.org/msf/bitstream/10144/84230/1/Qualitative%20research%20methodology.pdf. (Accessed on 2014/03/18).

Brink, H., van der Walt, C. and van Rensburg, G. 2012*. Fundamentals of research methodology for health professionals.* 3rd edition. Cape Town: Juta.

Bradfield, Y.S. 2010. Vision Screening to Detect Refractive Error, *Journal of the American Medical Association*, 304. 1114-5. 10.1001/jama.2010.1298. Bryman, A. 2016. *Social research methods*. 5th edition: New York: Oxford University Press.

Casson, R.J. 2013. Worldwide reduction in blindness: Making progress? *Lancet*, 1: e311-312.

Carlton, J. and Czoski-Murray, C. 2010. *The value of screening for amblyopia* *revisited.* In: Pediatric Ophthalmology, Neuro-Ophthalmology, Genetics: Strabismus - New Concepts in Pathophysiology, Diagnosis, and Treatment. Essentials in Ophthalmology. Springer, Berlin Heidelberg, 95-111. ISBN 978-3-540-85850-8

Carter, M.J., Lansingh, V.C., Schacht, G., Río del Amo, M., Scalamogna, M. and France T.D. 2013. Visual acuity and refraction by age for children of three different ethnic groups in Paraguay. *Arquivos Brasileiros de Oftalmologia,* 76(2): 94-97. Available from: http://dx.doi.org/10.1590/S0004-27492013000200008 (viewed 12 December 2018).

Castagno, V.D., Fassa, A.G., Carret, M.L.V., Vilela, M.A.P. and Meucci, R.D. 2014. Hyperopia: A meta-analysis of prevalence and a review of associated factors among school-aged children. *Bio Med Central Ophthalmology*, 14: 163. 1-19 Available from: https://doi.org/10.1186/1471-2415-14-163 (viewed 12 December 2018).

Castellanos, E., Davey, P.G. and Remick-Waltman, K. 2019. Can refractive error impact the academic performance? *Investigative Ophthalmology and Visual Science Journal*, 60(9):5836.

Chin, M.P., Siong, K.H., Chan, K.H., Do, C.W., Chan, H.H.L. and Cheong, A.M.Y. 2015. Prevalence of visual impairment and refractive errors among different ethnic groups in schoolchildren in Turpan, China. *Ophthalmic and Physiological Optics*, 2015: 35: 263-270. Available from: doi: 10.1111/opo.12193 (Viewed 17 Septemebr 2018)

Chisanga, K. and Funjika, M. 2016. Refractive errors in school-aged children as diagnosed at Arthur Davison Children Hospital eye clinic department. *Asian Pacific Journal of Health* Sciences/APJHS, 3(3): 173-177.

Chou, R., Dana, T. and Bougatsos, C. 2011. Screening for visual impairment in children ages 1-5 years: systematic review to update the 2004 U.S. preventive services task force recommendation. *American Academy of Pediatrics,* 127(2): 340-346; DOI: 10.1542/peds.2010-3177

Chua, S.Y.L., Ikram, M.K., Tan, C.S., Lee, Y.S., Ni, Y., Shirong, C., Gluckman, P.D., Chong, Y.S., Yap, F., Wong, T.Y. and Ngo, C.S., 2015. Relative contribution of risk factors for early-onset myopia in young Asian children. *Investigative ophthalmology and visual science*, *56*(13): 8101-8107.

Chuah, G. 2014. *A patients' guide to myopia and myopia treatment*. Singapore: Faris Digital Solutions Pty Ltd.

Chung, K.M., Mohidin, N. Yeow, P.T., Tan, L.L. and O'Leary, D. 2006. Prevalence of visual disorders in Chinese school children. *Optometry and Vision Science*, 73 (11): 695 – 700

Čiumbaraitė, R. and Liutkevičienė, R. 2017. Refractive errors characteristic of the patients at the children's ophthalmology outpatient department of Kauno Klinikos Hospital. *Acta Medica Lituanica*, 24(2): 83–9.

Congdon, N.G., Patel, N., Esteso, P., Chikwembani, F., Webber, F., Msithini, R.B. and Ratcliffe, A. 2008. The association between refractive cutoffs for spectacle provision and visual improvement among school-aged children in South Africa. Brish Journal of Ophthalmology, 92(1):13-8. Available from doi: 10.1136/bjo.2007.122028. (Viewed 17 July 2021)

Congdon, N., Zheng, M., Sharma, A., Choi, K., Song, Y., Zhang, M. Wang, M., Zhou, Z., Li, L., Liu, X. and Lam, S.C.D. 2008. Prevalence and determinants of spectacles non-wear among rural Chinese secondary school children: The Xichang pediatric refractive error study report 3. *Archives of Ophthalmology,* 126:1717-23.

Colodny, N., Miller, L. and Faralli, M. 2015. The development of a feeding, swallowing and oral care program using the PRECEDEPROCEED model in an orphanage-hospital in Guatemala, *International Journal of Speech Language and Pathology*, 17:127-37.

Corbin, J. and Strauss A. 2008. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* 3rd edition. Thousand Oaks, California: Sage Publications. [Google Scholar]

Creswell, J.W. 2007. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. International Student Edition. Thousand Oaks, California: Sage [Google Scholar]

Creswell, J.W. 2013. *Qualitative enquiry and research design: Choosing among five approaches*. 3rd edition. Washington, D.C.: Sage

Creswell, J.W. and Plano-Clark, V.L.P. 2018. *Designing mixed methods research*. Los Angeles: SAGE.

Crosby, R. and Noar, S.M. 2011. What is a planning model? An introduction to PRECEDE-PROCEED. *Journal of Public Health Dentistry*, 71: S7-S15. Available from https://doi.org/10.1111/j.1752-7325.2011.00235.x (Viewed 12 September 2021)

Czepita, D., Mojsa, A., Ustianowska, M., Czepita, M. and Lachowicz, E. 2007. Role of gender in the occurrence of refractive errors. *Annales Academiae Medicae Stetinensis*, 53(2): 53, 5-7.

Czepita, M., Czepita, D. and Safranow, K. 2019. Role of gender in the prevalence of myopia among Polish schoolchildren, *Hindawi Journal of Ophthalmology,* 1:1-4, 9748576. https://doi.org/10.1155/2019/9748576

Deen, J., Von Seidlein, L., and Clemens, J. D. 2014. Issues and Challenges of Public-Health Research in Developing Countries. *Manson's Tropical Infectious Diseases*, 40–48. e1. Available from: https://doi.org/10.1016/B978-0-7020-5101-2.00006-6 (Viewed 20 September 2021)

De Vos, A., Strydom, H., Fouche, C.B., Delport, C.S.L., 2011. *Research at grass roots: for the social sciences and human services professions*. 4th edition. Pretoria: Van Schaik.

Departments of Health and Basic Education, 2012. *Integrated school health policy*, Government Printers, Pretoria. Available from http://www.hst.org.za/sites/default/files/Integrated_School_Health_Policy.pdf

(Viewed 18 July 2021)

Dondana, L. and Dondana, R. 2006. Revision of visual impairment definitions in the international statistical classification of diseases. *Bio Med Central Medicine*, 4:7.

Donoghue, L., McClelland, J.F., Logan, N.S., Rudnicka, A.R., Owen, C.G. and Saunders, K.J. 2010. Refractive error and visual impairment in school children in Northern Ireland. *British Medical Journal,* 94(9): 1155-1159.

Du Plooy-Cilliers, F., Davis, C. and Bezuidenhout, R. 2014. *Research matters*, 1st edition. Cape Town: Juta and Company.

du Toit, R., Courtright, P. and Lewallen, S. 2017. The Use of Key Informant Method for Identifying Children with Blindness and Severe Visual Impairment in Developing Countries. Ophthalmic Epidemiol. 24(3):153-167. doi: 10.1080/09286586.2016.1259637. Epub 2017 Mar 13. PMID: 28287870.

Dusek, W., Pierscionek, B.K. and McClelland, J.F. 2010. A Survey of Visual function in an Austrian population of school-age children with reading and writing difficulties, *Bio Med Central Ophthalmology* 10:(16): 1-10

DiCicco-Bloom, B., Crabtree, B.F. 2006. The qualitative research interview. *Med Educ,* 40:314–21. [PubMed] [Google Scholar]

Edmonds, W.A. and Kennedy, T.M. 2012. *An applied reference guide to research designs: Quantitative, qualitative, and mixed methods.* Los Angeles: SAGE.

Elmajri, K.A.K. 2017. A survey of the prevalence of refractive errors among children in lower primary schools in Darnah City, Libya. *Advances in Ophthalmology and Visual System*, 7(5): 378–383. 00235. DOI: 10.15406/aovs.2017.00235

Emerole, C.G., Nneli, R.O. and Osim, E.E. 2013. Astigmatism: Prevalence, distribution and determinants in Owerri, Nigeria. *Journal of Experimental and Clinical Anatomy*, 12(2): 87-91.

Ezinne, N.E., Nnandi, C.J., Mashige, K.P. and Onoikhua, E.E. 2018. Causes of childhood blindness among children seen at the eye centre, Kaduna, Nigeria. *Journal of Ophthalmology and Clinical Research*, 5:39.

Ezinne, N.E. and Mashige, K.P. 2018. Refractive error and visual impairment in primary school children in Onitsha, Anambra State, Nigeria. African Vision Eye Health, 77(1), a455. DOI: https://doi.org/10.4102/aveh.v77i1.455

Ezinne, N.E., Mashige, K.P., Akano, O.F., Ilechie, A.A. and Ekemiri, K.K. 2020. Spectacle utilisation rate and reasons for non-compliance with wearing of spectacles amongst primary school children in Onitsha, Anambra state, Nigeria. African Vision Eye Health, 79(1): a544. Available from: https://doi.org/10.4102/aveh.v79i1.544 (Viewed 18 August 2021)

Everitt, B.S., 2021. Medical statistics from A to Z: a guide for clinicians and medical students. Cambridge University Press.

Fan, D.S., Lan, D.S., Lam, R.F., Lau, T.F., Chong, K.S., Cheung, E.Y., Lai R.Y. and Chew, S. 2004. Prevalence, incidence, progression of myopia of school children in Hong Kong. *Investigative Ophthalmology and Visual Science*, 45(4): 1071-1075.

Ferebee, A. 2004. *Childhood vision: Public challenges and opportunities – A policy brief*. Available from: http://www.healthinschools.org/wp-content/uploads/2016/10/visionfinal.pdf (viewed 09 March 2018).

Fox, W. and Bayat, M.S. 2007. *A guide to managing research*. Cape Town: Juta.

Franke, T.M., Ho, T. and Christie, C.A., 2012. The chi-square test: Often used and more often misinterpreted. *American Journal of Evaluation*, *33*(3), 448-458.

Gantz, L., Schrader, S., Ruben, R. and Zivotofsky, A.Z. 2015. Can the red-green duochrome test be used prior to correcting the refractive cylinder component? *Public Library of Science One,* 10(3): e0118874.

Gao, Z., Meng, N, Muecke., J, Chan, W.O., Piseth, H., Kong, A., Jnguyenphamh, T., Dehghan, Y., Selva, D., Casson, R. and Ang, K. 2012. Refractive error in school children in an urban and rural setting in Cambodia. *Ophthalmic Epidemiology*, 19(1): 16–22.

Gale, N.K., Heath, G., Cameron, E., Rashid, S. and Redwood, S. 2013. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *Journal of Medical Research Methodology,* 13: 117.

Garcia-Lievanos, O., Sanchez-Gonzalez, L., Espinosa-Cruz, N., Lernandez-Flores, LA., Salmeron-Leal, L., Torres-Rodriguez, H.D. 2014. Myopia in school children in a rural community in the state of Mexico, *Clinical Optometry,* 8: 53-5. Available from: http://dx.doi.org/10.2147/OPTO.S88353 (viewed 12 January 2019).

Gielen, A.C., McDonald, E.M., Gary, T., et al. 2008. Using the Precede-Proceed planning model to apply health behavior theories. In: Glanz, K., Rimer, B.K. and Lewis F.M. (eds) Health Behavior and Health Education: Theory, Research, and Practice. 4th ed. *San Francisco*, CA: Jossey-Bass: 407–433.

Glaser, B.G. and Strauss, A.L. 1967. *The discovery of grounded theory: Strategies for qualitative research*, New York: Aldine de Gruyter

Goh, P., Abqariyah, Y., Pokharel, P.G. and Ellwein, B.L. 2005. Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *American Academy of Ophthalmology*, 112(4): 678-685.

Green, L.W. 1974. Toward cost-benefit evaluations of health education: Some concepts, methods, and examples. *Health Education Monographs 2(Supplementary 1)*: 34–64.

Green, L.W. and Kreuter, M.W. 2005. *Health Program Planning: An Educational and Ecological Approach*, New York: McGraw-Hill.

Green, L.W. and Kreuter, M.W. 1991. *Health Promotion Planning: An Educational and Environmental Approach*, Mountain View, CA: Mayfield Publishing.

Guest, G; Bunce, A and Johnson, L 2006. "How many interviews are enough? An experiment with data saturation and variability". *Field Methods*, *18*(1), 59-82

Guba, E. G. 1990. *The alternative paradigm dialog*. In E. G. Guba (Ed.), *The paradigm dialog* (pp. 17–30). Newbury Park, CA: Sage.

Guggenheim, J.A., McMahon, G., Northstone, K., Mandel, Y., Kaiserman, I., Stone, R.A., Lin, X., Saw, S.M., Forward, H., Mackey, D.A., Yazar, S., Young, T.L. and Williams, C. 2013. Birth Order and Myopia, Ophthalmic Epidemiology, 20(6): 375 384. Available from: DOI: 10.3109/09286586.2013.848457 (Viewed 18 October 2021)

Guggenheim, J.A., Pong-Wong, R., Haley, C.S., Gazzard, G. and Saw, S.M. 2007. Correlations in refractive errors between siblings in a Singapore cohort study of risk factors for myopia. *British Journal of Ophthalmology*, 91(6): 781-784.

Guo, Y., Liu, L.J., Xu, L., Tang, P. and Lv, YY. 2013. Myopic Shift and Outdoor Activity among Primary School Children: One-Year Follow-Up Study in Beijing. *Public Library of Science ONE*, 8(9): e75260. doi:10.1371/journal.pone.0075260

Grosvenor, T. 2007. *Primary Care Optometry*, Elsevier, Amsterdam, Netherlands, 5th edition.

Harrington, S.C, Stack, J, Saunders, K. and O'Dwyer, V. 2019. Refractive error and visual impairment in Ireland school children. *British Journal of Ophthalmology,* 2019;103: 1112–1118.

Hartmann, E.E., Bradford, G.E., Chaplin, P.K., Johnson, T., Kemper, A.R., Kim, S. and Marsh-Tootle, W. 2006. Project universal preschool vision screening: a demonstration project. *Panel for the American Academy of Pediatrics*, 117(2): e226-37.

Hasemi, H., Fotuohi, A., Yekta, A., Pakzad, R., Ostadimoghaddam, H. and Khabazkhoob, M. 2018. Global and regional estimates of prevalence of refractive errors: Systemic review and meta-analysis. *Journal of Current Ophthalmology*, 30: 3-22.

Hayes, B.K., Heit, E. and Swendsen, H. 2010. Inductive reasoning. *Wiley Interdisciplinary Reviews: Cognitive Science*, 2(1): 278–292.

He, M., Zeng, J., Liu, Y., Xu, J., Pokharel, G.P. and Ellwein, L.B. 2004. Refractive error and visual impairment in urban children in southern China*. Investigative Ophthalmology and Vision Science*, 45(3):793-9. doi: 10.1167/iovs.03-1051. PMID: 14985292.

He, J., Lu, L., Zou, H., He, X., Li, Q., Wang, W. and Zhu, J. 2014. Prevalence and causes of visual impairment and rate of wearing spectacles in schools for children of migrant workers in Shanghai, China. *Bio Medical Central Public Health*, 14 (1312): 1-8. doi:10.1186/1471-2458-14-1312.

Heijthuijsen, A.A., Beunders, V.A., Jiawan, D., de Mesquita-Voigt, A.M., Pawiroredjo, J., Mourits, M., Tanck, M., Verhoeff, J. and Saeed, P. 2013. Causes of severe visual impairment and blindness in children in the Republic of Suriname. *British Journal of Ophthalmolology*, 97(7): 812-815.

Hepsen, I.F., Evereklioglu, C. and Bayramlar, H. 2001. The effect of reading and near-work on the development of myopia in the emmetropic boys. *Vision Research*, 41(19): 2511-20.

Holloway, M. and Galvin, K. 2017*. Qualitative research in nursing and healthcare*. 4th edition. Amherst, MA: John Wiley & Sons.

Isawumi, M., Agboola, S., Ayegoro, B. 2016. Paediatric refractive errors in an eye clinic in Osogbo, Nigeria. *Ethiopian Journal of Health Sciences*, 26(2); 2016: 147-154.

Jamali, P., Fotouhi, A., Hashemi, H., Younesian, M. and Jafari, A. 2009. Refractive errors and amblyopia in children entering school: Shahrood, Iran. *Optometry and Vision Science,* 86(4): 364-369.

Jha, A.S. 2014. *Research methods*. New Delhi: McGraw Hill Education Pty Ltd.

Jiménez R, Soler M, Anera RG, Castro JJ, Pérez MA and Salas C. 2012. Ametropias in school-age children in Fada N'Gourma (Burkina Faso, Africa). Optom Vis Sci. 2012 Jan;89(1):33-7. doi: 10.1097/OPX.0b013e318238b3dd. PMID: 22041590.

Jin, J.X., Hua, W.J., Jiang, X., Wu, X.Y., Yang, J.W., Gao, G.P., Fang, Y., Pei, C.L., Wang, S., Zhang, J.Z, Tao, L,M, and Tao, F.B. 2015. Effect of outdoor activity on myopia onset and progression in school-aged children in North-East China: The Suijiatun eye care study. *Bio Medical Center of Opthalmology*, 73: 1-11. DOI 10.1186/s12886-015-0052-9, P1-11.

Jonas, J.B., Xu, L., Wang, Y.X., Bi, H.S., Wu, J.F., Jiang, W.J., Nangia, V., Sinha, A., Zhu, D., Tao, Y, Guo, Y., You, Q., Wu, L.J., Tao, L.X., Guo, X.H., Ohno-Matsui, K. and Jonas, S.P.2016. *Public Library of Science One*, 11(5): e0154554

Jones, N. and Bartlett, H. 2018. The impact of visual impairment on nutritional status: A systematic review. *British Journal of Visual Impairment*, 36(1): 17-30.

Junghana, B.M. and Crewther, S.G. 2003. Prevalence of myopia among primary school children in eastern Sydney. *Clinical and Experimental Optometry*, 86(5): 339-345.

Kawuma, M. and Mayeku, R. 2002. A survey of the prevalence of refractive errors among children in lower primary schools in Kampala district. *African Health Sciences*, 2(2): 69-72.

Kemmanu, V., Giliyar, S.K., Shetty, B.K., Singh, A.K., Kunaramanickavel, G. and McCathy, C.A. 2018. Emerging trends in childhood blindness and ocular morbidity in India: The Pavagada Pediatric Eye Diseases Study 2. *Eye* 32(10): 1590-98.

Kemmanu, V., Hegde, K., Giliyar, S.K., Shetty, B.K., Kumaramanickavel, G. and McCarty C.A. 2016. Prevalence of childhood blindness and ocular morbidity in a rural pediatric population in Southern India: The Pavagada pediatric eye disease study-1. *Ophthalmic Epidemiology,* 23(3): 185-192. Available from: doi: 10.3109/09286586.2015.1090003. Epub 2016 May 4. PMID: 27142419 (Viewed 04 Septemer 2021)

Kemper, A.R., Bruckman, D. and Freed, G.L. 2004. Prevalence and distribution of corrective lenses among school-age children. *Optometry and Vision Science*, 81(1): 7-10.

Kemper, A.R., Helfrich, A., Talbot, J. and Patel, N. 2012. Outcomes of elementary school-based vision screening program in North Carolina. *The Journal of School Nursing*, 28(1): 24-30.

Kendall, S. and Halliday, L.E. 2014. Undertaking ethical qualitative research in public health: Are current ethical processes sufficient? *Australian and New Zealand Journal of Public Health*, 38(4): 306-310.

Khandekar, R., Kishore, H., Mansu, R.M and Awan, H. 2014. The status of childhood blindness and functional low vision in the Eastern Mediterranean region in 2012*. Middle East African Journal of Ophthalmology*, 21: 336-343.

Khokhar, S.K., Pillay, G., Dhull, C, Agarwal, E., Mahabir, M. and Aggarwal, P. 2017. Pediatric cataract. *Indian Journal of Ophthalmology*, 65(12): 1340-1349. doi: 10.4103/ijo.IJO_1023_17

Kodjebacheva, G., Maliski, S., Yu, F., Oelrich, F. and Coleman, A.L. 2014. Decreased uncorrected refractive error in the classroom through a multifactorial pilot intervention. *The Journal of School Nursing*, 30(1): 24-30.

Korpela, M., Mursu, A., Soriyan, A., Eerola, A., Häkkinen, H. and Toivanen, M. 2004 Information Systems Research and Development by Activity Analysis and Development: Dead Horse or the Next Wave?. In: Kaplan, B., Truex D.P., Wastell D., Wood-Harper A.T., DeGross J.I. (eds) Information Systems Research, International Federation for Information Processing, 143. Springer, Boston, MA. https://doi.org/10.1007/1-4020-8095-6_25

Krishnaiah, S., Srinivas, M., Khanna, C.R and Rao, N.G. 2009. Prevalence and risk factors for refractive errors in the South Indian adult population: The Andhra Pradesh Eye disease study. *Clinical Ophthalmology*, 3:17-27.

Kumar, R. 2014. *Research methodology: A Step-by-Step Guide for Beginners*. 4th edition. New Delhi: Sage.

Lanc, C., Serra, H. and Prista, J. 2014. Strabismus, visual acuity, and uncorrected refractive error in Portuguese children aged 6 to 11 years. *Informa Healthcare USA*, 22(3): 115–119. DOI: 10.3109/09273972.2014.932395.

Latorre-Arteaga, S., Gil-Gonzalez, D., Bascaran, C., Nunez, R.H., Morales, M.C.P and Orihuela, G.C. 2016. Visual health screening by schoolteachers in remote communities of Peru: Implementation research. *Bulleting of the World Health Organisation*. 94: 652-658. Available from: www.who.int/bulletin/volumes/94/9/15-163634/en/ (viewed 10 August 2017).

Latif, H. M., Asif, M., and Kashif, M. 2018. Prevalence of Eye Diseases in Children aging 5-15 Years in Malakand Tehsil of KPK. *Ophthalmology Update*, *16*(2): 628–630

Laura, F., Salazar, L.S., Crosby, R.A. and DiClemente, R.J. 2015. *Research methods in health promotion.* 2nd edition. United states of America: Jossey Bass.

Lee, D.T.F., Woo, J. and Mackenzie, A.E. 2002. The cultural context of adjusting to nursing home life: Chinese elders' perspectives. *The Gerontologist*, *42*(5), 667-675

Lester, S. 1999. *An introduction to phenomenological research*, Taunton, United Kingdom, Stan Lester Developments. Available from: www.sld.demon.co.uk/resmethy.pdf (Viewed 11 June 2021)

Lewallen, S. and Courtright, P. 2001. Blindness in Africa: Present situation and future needs. *British Journal of Ophthalmology,* 85.

Lim, K.H. 2006. Vision 2020 and prevention of blindness: Is it relevant or achievable in the modern era? *Annals of the Academy of Medicine Singapore*, 35(3): 215-22.

Lincoln, Y.S. and Guba, E.G. 1985. *Naturalistic inquiry*. California: Sage Publications

Limpopo Province Department of Health. 2020. *Nkhensani Hospital Optometry Statistics, 2019*. Limpopo Polokwane: Province Department of Health.

Lira, R.P.C., Arieta, C.E.L., Passos, T.H.M., Maziero, D., Astur, G.L., do Espírito-Santo, I.F., Bertolani, A.N., Pozzi, L.F., de Castro, R.S. and Alvaro, A.B. 2017. Distribution of ocular component measures and refraction in Brazilian school children. *Ophthalmic Epidemiology,* 24(1): 29-35. DOI:10.1080/09286586.2016.1254249

LoBiondo-Wood, G. and Haber, J. 2010. *Nursing research: Methods, critical appraisal and utilization*. 7th edition. St Louis: A Mosby.

Ma, X., Congdon, N., Yi, H., Zhou, Z., Pang, X., Meltzer, M.E., Shi, Y., He, M., Liu, Y. and Rozelle S. 2015. Safety of Spectacles for Children's Vision: A Cluster-Randomized Controlled Trial. American Journal of Ophthalmology, 160(5):897-904. Available from: doi: 10.1016/j.ajo.2015.08.013. (Viewed 10 June 2021)

Maake, M.M. and Oduntan, O.A. 2015. Prevalence and causes of visual impairment in patients seen at Nkhensani Hospital Eye Clinic, South Africa. *African Journal of Primary Health Care and Family Medicine,* 7(1). Available from: http://dx.doi.org/10.4102/phcfm.v7i1.728 (Viewed 17 July 2021).

Mabaso, R., Oduntan, A.and Mpolokeng, M. 2006. Refractive status of primary school children in Mopani District, Limpopo Province, South Africa. *South African Optometrist*, 65(4): 125-133.

MacDonald, M. and Mullett J. 2008. Dilemmas in Health Promotion Evaluation: Participation and Empowerment. In: Potvin L., McQueen D.V., Hall M., de Salazar L., Anderson L.M., Hartz Z.M. (eds) Health Promotion Evaluation Practices in the Americas. Springer, New York, NY. https://doi.org/10.1007/978-0-387-79733-5_9

McHugh, M.L., 2013. The chi-square test of independence. *Biochemia medica*, *23*(2):

143-149.

Mackay, D.D., Garza, P.S., Bruce, B.B., Newman, J. and Biousse, V. 2015. The demise of direct ophthalmoscopy. *Neurology Clinical Practice*, 5(2): 150-157.

Madrigal, D. and McClain, B. 2012. *Strengths and weaknesses of quantitative and qualitative research.* Available from: http://www.uxmatters.com/mt/archives/2012/09/strengths-and-weaknesses-of-quantitative-and-qualitative-research.php#sthash (Viewed 11 September 2018).

Magakwe, T.S.S., Xulu-Kasaba, Z.N.Q. and Hansraj, R. 2020. Prevalence and distribution of visual impairment and refractive error amongst school-going children aged 6–18 years in Sekhukhune District (Limpopo, South Africa). African Vision Eye Health, 79(1): a551. Available from: https://doi. org/10.4102/aveh.v79i1.551 (Viewed 17 October 2021)

Mahraj, Y.I., Naidoo, K.S., Dabideen, R. and Ramson, P. 2011. The KwaZulu-Natal child eye care programme: delivering refractive error services to primary school learners. *African Vision and Eye Health*, 70(2): 61-68.

Mahmudi, E., Mema, V., Burda, N., Selimi, B. and Zhugli, S. 2013. Incidence of the refractive errors in children 3 to 9 years of age, in the city of Tetovo, Macedenia, *Journal of Acute Disease,* 2: 52-55.

Marill, K.A., 2004. Advanced statistics: linear regression, part II: multiple linear regression. *Academic emergency medicine*, *11*(1): 94-102.

Marsden, J., Stevens, S. and Ebri, A. 2014. How to measure distance visual acuity. *Community Eye Health Journal*, 27(85): 16.

Mehboob, M.A., Nisar, H. and Khan, M. 2018. Ametropia in children with headache. *Pakistan Journal of Medical Sciences*, 2019, 35(3): 701-704. doi: https://doi.org/10.12669/pjms.35.3.268.

Mohammad, K., Mohammadreza, G. and Mohammadi, Z.I. 2009. Prevalence of refractive errors in primary school children [7-15 Years] of Qazvin City. *European Journal of Scientific Research*, 28: 174–185.

Mohamed, A.G., Wasfi, E.I., Kotb, S.A.M. and Khalek, E.M.A. 2014. Refractive Errors among Primary Schools Children in Assiut District, Egypt, *Journal of Education and Practice*, 5 (1):101-113

Morgan, D.L. 2007. Paradigms Lost and Pragmatism Regained: Methodological Implications of Combining Qualitative and Quantitative Methods. *Journal of Mixed Methods Research*,1(1):48-76. doi:10.1177/2345678906292462

Morgan, I.G. and Cotch, M.F. 2013. Birth order and myopia: what are the messages to readers? *Ophthalmic Epidemiology*, 20(6):333-334.

Mpyet, C., Odugbo, P., Adenuga, O., Velle, L. and Nyonkyes, A. 2010. Prevalence and causes of blindness and visual impairment in Plateau State, Nigeria, *TAF. Preventative Medicine Bulletin*, 9(5): 401-406.

Msiska, V., Njuguna, M. and Kariuki, M. 2020. Magnitude and pattern of significant refractive errors in primary school children of Ntcheu, a rural district in Malawi, *The Journal of Ophthalmology of Eastern, Central and Southern Africa*, 15(1). Available from: https://joecsa.coecsa.org/index.php/joecsa/article/view/157 (Viewed 28 September 2021).

Muhammad, A. 2016. Prevalence and patterns of refractive errors in school going children between 5 and 15 years. Ophthalmology Update, 14(3): 27-31.

Mukund, P., Gauri, S.S. and Niraj, D.J. 2014. Ocular morbidity among street children in Kathmandu Valley. *Ophthalmic Epidemiology*, 21(6): 356–361. DOI: 10.3109/09286586.2014.964035

Muma, S. and Obonyo, S. 2020. The prevalence and causes of visual impairment among children in Kenya – the Kenya eye study. *Bio Med Central Ophthalmology* 20 (399). https://doi.org/10.1186/s12886-020-01665-w

Muma, M.K., Kimani, K., Kariuki-Wanyoike, M.M., Ilako. D.R and Njuguna, M.W. 2009. Prevalence of refractive errors among primary school pupils in Kilungu Division of Makueni District*. Kenya Medical Journal of Zambia*, 36(4): 165-170.

Municipalities of South Africa, Available on: https://municipalities.co.za/map/128/mopani-district-municipality, viewed 27 March 2018

Mutti, O.D., Mitchell, G.L., Moescheberger, L.M., Jones, A.L and Zadnik, K. 2002. Parental myopia, near work, school achievement, and children's refractive error*. Investigative Ophthalmology and Visual Science*, 43(12): 3633-40.

Mursu, Á., Luukkonen, I., Toivanen, M. and Korpela M. 2007. Activity theory in information systems research and practice - theoretical underpinnings for an information systems development model, *Information Research*, 12(3): 311

Nadarević Vodenčarević, A., Halilbašić, M., Međedović, A., Jusufović, V., Pilavdžić, A., Drljević, A. and Burgić, M. 2021. Refractive errors in children: analysis among preschool and school children in Tuzla city, Bosnia and Herzegovina, *Medical Association of Zenica-doboj Canton, Bosnia and Herzegovina*, 18(1):96-101. DOI: 10.17392/1153-21. PMID: 32815670.

Naidoo, K.S., Raghunandan, A., Mashige, K.P., Govender, P., Holden, B.A., Pokharel, G.P. and Ellwein, L.B. 2003. Refractive error and visual impairment in African children of South Africa. *Investigative Ophthalmology and Visual Science*, 44(9): 3764-70.

Naidoo, K.S., Leasher, J., Bourne, R.R., Flaxman, S.R., Jonas, J.B., Keeffe, J., Limburg, H.P.K., Price, H., White, R.A., Wong, T.Y., Tyalor, H.R. and Resnikoff, S. 2016. Global vision impairment and blindness due to uncorrected refractive error, 1990-2010. *Optometry and Vision Science*, 93(3): 227-234.

Naidoo K, Kempen JH, Gichuhi S, Braithwaite T, Casson RJ, Cicinelli MV, Das A, Flaxman SR, Jonas JB, Keeffe JE, Leasher J, Limburg H, Pesudovs K, Resnikoff S, Silvester AJ, Tahhan N, Taylor HR, Wong TY, Bourne RRA and Vision Loss Expert Group of the Global Burden of Disease Study. 2020. Prevalence and causes of vision loss in sub-Saharan Africa in 2015: magnitude, temporal trends and projections. Brish Journal of Ophthalmology, 104(12):1658-1668.

Nelson, L.B. and Clitsky S.E. (eds). 2005. *Harley's pediatric ophthalmology*. 5th edition. Philadelphia: Lippincott Williams and Wilkins, Philadelphia.

Ntsoane, M.D. and Oduntan, O.A. 2010. A review of factors influencing the utilization of eye care services. South African Optometrist 69(4) 182-192.

Omona, J. 2013, Sampling in Qualitative Research: Improving the Quality of Research Outcomes in Higher Education, *Makerere Journal of Higher Education*, 4(2):169 – 185 DOI: http://dx.doi.org/10.4314/majohe.v4i2.4

Opubiri, I. and Pedro-Egbe, C.N. 2012. Screening of primary school children for refractive error in South Nigeria. Ethiopian Journal of Health Sciences, 22(2):129-34.

Ore, L., Tamir, A., Stein, N. and Cohen-Dar, M. 2009. Reliability of vision screening tests for school children. *Journal of Nursing Scholarship*, 41(3): 250–9. doi:10.1111/j.1547-5069.2009.01283.x

Ovenseri-Ogbomo, G. and Assien, R. 2010. Refractive error in school children in Agona Swedru, Ghana*. The South African Optometrist*, 69: 86-92.

Ovenseri-Ogbomo, G. and Omuemu, V.O. 2010. Prevalence of refractive error among school children in the Cape Coast Municipality, Ghana. *Clinical Optometry, 2: 59–66*

Padhye, A., Khandekar, R., Dharmadhikari, S., Dole, K., Gogate, P. and Deshpande, M. 2009. Prevalence of uncorrected refractive error and other eye problems among urban and rural school children. *Middle East African Journal of Ophthalmolog*y, 16(2): 69-74.

Pan, C.W., Ramumurthy, D. and Saw, S.M. 2012. Worldwide prevalence and risk factors for myopia. *Ophthalmic and Physiological Optics*, 32: 3-16. doi: 10.1111/j.1475-1313.2011.00884.x

Pan, C-W., Chen, X., Gong, Y., Yu, J., Ding, H., Bai, J., Chen, J., Zhu, H., Fu, Z. and Liu, H. 2016. Prevalence and causes of reduced visual acuity among children aged three to six years in a metropolis in China. *Ophthalmic and Physiological Optics*, 36: 152–157. doi: 10.1111/opo.12249

Pavithra, M.B, Hamsa, L. and Madhukumar, S. 2014. Factors associated with spectacle-wear compliance among school children of 7-15 years in South India. *International Journal of Medicine and Public Health,* 4(2): 146-150.

Peng, L., Gao, L., Zheng, Y., Dai, Y., & Xie, Q. (2021). Refractive errors and visual impairment among children and adolescents in southernmost China. *Bio Med Central ophthalmology,* 21 (227): 1-11. https://doi.org/10.1186/s12886-021-01993-5

Petrie, A. and Sabin, C., 2019. *Medical statistics at a glance*. John Wiley & Sons.

Polit, D.F. and Beck, C.T. 2012. *Generating and assessing evidence for nursing practice*. 9th edition. Philadelphia: Lippincott Williams & Wilkins.

Polit, D.F. and Beck, C.T. 2017. *Nursing research: Generating and assessing evidence for nursing practice.* 10th edition. Philadelphia: Wolters Kluwer.

Polit, D.F., Beck, C.T. and Hungler, B.P. 2001, *Essentials of Nursing Research: Methods, Appraisal and Utilization*. 5th Ed., Philadelphia: Lippincott Williams and Wilkins

Popović-Beganović, A., Zvorničanin, J., Vrblijanac, V. and Zvorničanin, E. 2018. The prevalence of refractive errors and visual impairment among school children in Brčko District, Bosnia and Herzegovina. *Seminars in Ophthalmology*, 33(7/8): 858–868. Available from: doi: 10.1080/08820538.2018.1539182. (Viewed 17 October 2021)

Porter, C.M. 2016. Revisiting Precede–Proceed: A leading model for ecological and ethical health promotion, *Health Education Journal*, 75(6) 753 –764 Available from: DOI: 10.1177/0017896915619645 (Viewed 17 October 2021)

Qureshi, N., Ahmed T and Ahmed T. 2016. Prevalence of ocular problems among school students of Karachi. *Pakistanian Journal of Surgery*, 32(4): 264-268.

Prevent Blindness America: The Sight Saving People, 2010. Available from: https://preventblindness.org/wp-content/uploads/2011/12/FS14_SightSavers.pdf. (Viewed 21 July 2018)

Rai, S.K., Thapa, H.B., Sharma, M.K., Dhakhwa, K. and Karki, R. 2012.The distribution of refractive errors among children attending Lumbini Eye Institute, Nepal. *Journal of Ophthalmology*, 4(7): 90-95.

Rajesh, K.S. and Gauri, S.S. 2017. Ocular morbidity among children of government schools of Kathmandu Valley: A follow-up study. *Journal of National Medical Association*, 56(206); Apr-Jun 2017: 243-247.

Raliavhegwa, M. and Oduntan, A.O. 2000. A study on the refractive status of a South African black population. *South African Optometrist,* 59: 73-77.

Ramenyi, D. and Bannister, F. 2013. *Writing up your research: The quick guide series*. United Kingdom: Ridgeway Press.

Ransdell, L.B., 2001. Using the PRECEDE-PROCEED Model to Increase Productivity in Health Education Faculty, *The International Electronic Journal of Health Education*, 4:276-282.

Rani, V.J. 2016. Methodologies of translation. *Journal of Humanities and Social Science.* Available from: www.iosrjournals.org (viewed 12 March 2018).

Rasesemola, R.M., Matshoge, G.P. and Ramukumba, T.S. 2019. Compliance to the Integrated School Health Policy: Intersectoral and multisectoral collaboration', *Curationis* 42(1), a1912. https://doi.org/10.4102/curationis.v42i1.1912

Rasheed, F., Khan, A.A. and Khan, R. 2010. Refractive errors among children aged 6-15 years playing video games. *Journal of Sheikh Zayed Medical College*, 1(4): 125-128.

Ravi Sekhar Rao K., Krishna N. and Vasantha G. 2016. Refractive errors in school children in Nizamabad district area. *International Archives of Integrated Medicine*, 3(10): 21-26.

Razia, C., Hassan, A. and Naheed, H.S. 2011. Frequency and underlying factors of myopia among medical students. *Biomedical*, 27: 154-160.

Reddy, Y.J., Babu, R., Reddy, Y.G. and Reddy Y.M. 2015. A study on prevalence of myopia among the Medicos of Osmania Medical College, Hyderabad. *Journal of Dental and Medical Sciences (IOSR-JDMS)*, 14(8): 112-117.

Resnikoff, S., Pascolini, D., Etya'ale, D., Parajasegaram, R., Pokharel, G.P. and Mariotti, S.P. 2008. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bulletin of the World Health Organisation*, 86: 63-70.

Rezvan, F, Khabazkhoob, M., Fotouhi, A., Hashemi, H., Ostadimoghaddam, H., Heravian, J., Azizi, E., Khorasani, A.A. and Yekta, A.A. 2012. Prevalence of refractive errors among school children in Northeastern Iran. *Ophthalmic and Physiological Optics,* 2012, 32: 25-30.

Rudnicka, A.R., Owen, C.G., Richards, M., Wadsworth, M.E.J and Strachan, D.P. 2008 Effect of breastfeeding and sociodemographic factors on visual outcome in childhood and adolescence, *The American Journal of Clinical Nutrition*, 87 (5): 1392–1399. https://doi.org/10.1093/ajcn/87.5.1392

Rubin, A. and Babbie, E.R. 2012. *Essential research methods for social work*. 6th edition. USA: Cengage Learning.

Sabherwal, S., Sood, I., Siddiqui, Z., DasGupta, S., Ganesh, S. and Basset, K. 2020. Out-of-School Vision Screening in North India: Estimating the Magnitude of Need. *Ophthalmic*

Epidemiology, 27:6, 449-452. DOI: 10.1080/09286586.2020.1766513

Saxena, R., Vashist., P., Tandon, R., Pandey, R.M., Bhardawaj, A, Menon, V., and Mani, K. 2015. Prevalence of myopia and its risk factors in urban school children in Delhi: The North India Myopia Study, *Public Library of Science ONE* 10(2): e0117349. (1-11) DOI:10.1371/journal.pone.0117349

Saw, S.M., Chua, W.H., Hong, C.Y., Wu, H.M., Chan, W.Y., Chia, K.S., Stone, R.A. and Tan, D. 2002. Near-work in early-onset myopia. *Investigative Ophthalmology and Visual Science*, 43: 332-339.

Sewunet, S.A., Aredo, K.K. and Gedefew, M., 2014. Incorrect refractive error and associated factors among primary school children in Debre Markos District, Northwest Ethiopia. *Bio Med Central* Ophthalmology 14, 95 (2014)

Sevilla, C.G., Ochave, J.A., Punsalan, T.W., Regala, B.P. and Uriarte, G.G. 2007. *Research Methods*. Rex Printing Company. Quezon City.

Sharma, M. and Romas, J.A. 2012. *Theoretical Foundations of Health Education and Health Promotion*. Sudbury, MA: Jones and Bartlett Learning.

MacDonald, M. and Mullett, J. 2009. *Dilemmas in health promotion evaluation: Participation and empowerment.* In: Potvin L, Anderson LM, Hall M, et al. (eds) *Health Promotion Evaluation Practices in the Americas.* New York: Springer,149–178.

Schmidt, N.A. and Brown, J. 2015. Evidence-Based Practice for Nurses: Appraisal and Application of Research. 3rd ed. Burlington, MA: Jones and Bartlett.

Sethi, M.J., Sethi, S. and Iqbal, R. 2009. Frequency of refractive errors in children visiting eye outpatient department agency*. Gomal Journal of Medical Sciences*, 7(2): 114-117.

Shannon-Baker, P. 2016. Making Paradigms Meaningful in Mixed Methods Research. *Journal of Mixed Methods Research* 2016, 10(4) 319–334 DOI: 10.1177/1558689815575861

Sharma, I.P., Lepcha, N.T., Lhamo, T., Ellwein, L.B., Pokharel, G.P., Sapkota, Y.D., Tandin Dorji, T. and Peldon, S. 2020. Visual impairment and refractive error in school children in Bhutan: The findings from the Bhutan School Sight Survey (BSSS 2019). *Public Library of Science ONE* 15(9): e0239117. https://doi.org/10.1371/journal.pone.0239117

Sharma, M. and Romas, J.A. 2008. Theoretical Foundations of Health Education and Health Promotion, Jones and Bartlett Publishers, Sudbury, Mass.

Sharma, M. and Romas, J.A. 2012. Theoretical Foundations of Health Education and Health Promotion.Sudbury, Jones and Bartlett Publishers, Sudbury, Mass.

Sharpe, D., 2015. Chi-square test is statistically significant: Now what? *Practical Assessment, Research, and Evaluation*, *20*(1): 8.

Sheeladevi, S., Seelam, B., Nukella, P.B., Modi, A., Ali, R. and Keay, L. 2018. Prevalence of refractive errors in children in India: a systematic review. *Clinical and Experimental Optometry*, 101:4, 495-503. DOI: 10.1111/cxo.12689

Shresthaa, G.S., Sujakhub, D. and Joshib, P. 2011. Refractive error among school children in Jhapa, Nepal. *Journal of Optometry*, 4(2): 49-55.

Shrestha, R.J. and Shrestha, G.S. 2017. Ocular morbidity among children of government schools of Kathmandu Valley: A follow-up study. *Journal of Nepal Medical Association*, 56(206): 243-247.

Shukla, P., Vashist, P., Singh, S.S., Gupta, V., Gupta, N., Wadhwani, M., Bharadwaj, A. and Arora, L. 2018. Assessing the inclusion of primary school children in vision screening for refractive error program of India. *Indian Journal of Ophthalmology*, 66:935-9.

Shung-King, M. 2012. Why child health policies in post-Apartheid South Africa had not performed as intended. The case of the School Health Policy. Doctor of Philosophy, Oxford: Oxford University.

Shung-King, M., Orgill, M., and Slemming, W. 2014. School health in South Africa: reflections on the past and prospects for the future. *South African Health Review 2013/14*: 59-72.

Signes-Soler, I., Hernández-Verdejo, J. L., Estrella Lumeras, M. A., Tomás Verduras, E., and Piñero, D. P. 2017. Refractive error study in young subjects: results from a rural area in Paraguay. *International Journal of Ophthalmology*, *10*(3), 467–472. https://doi.org/10.18240/ijo.2017.03.22

Singh, V., Malik, KP., Malik, V.K. and Jain, K. 2017. Prevalence of ocular morbidity in school going children in West Uttar Pradesh. *Indian Journal of Ophthalmology,* 65: 500-8.

Singh, K. 2007. *Qualitative social research methods*. London: SAGE Publications.

Smith, T. 2020. What is A Thematic Analysis, And How To Do It?. *Total Assignment Help* . https://www.totalassignmenthelp.com/blog/thematic-analysis.

Soler, M., Anera, R.G., Castro, J.J., Jiménez, R., Jiménez, J.R. 2015. Prevalence of refractive errors in children in Equatorial Guinea. Optometry and Vision Science, 92(1):53-8. doi: 10.1097/OPX.0000000000000448. PMID: 25360700.

Solebo, A.L. and Rahi, J. 2014. Epidemiology, aetiology and management of visual impairment in children. *Archives of Disease in Children*, 99: 375-379. http:// doi:10.1136/archdischild-2012-301970

Soni, M., Durrani, J. and Jadoon, Z. 2015. Pattern of common eye diseases in children visiting eye Department at Naseerullah Khan Babar Memorial Hospital, Peshawar. *Ophthalmology Update,* 13(4): 262-266.

Statistics South Africa/ StatsSA. 2011. *Census 2011*. Pretoria: StatsSA.

Streubert-Speziale, H.J. and Carpenter, D.R. 2011. *Qualitative research in nursing:*

advancing the humanistic imperative. 4th edition. Philadelphia: Lippincott, Williams & Wilkins.

Strydom, H. 2011. Information collection. In: A.S. De Vos. (editor). *Research at grassroots for the social sciences and human service professions.* 3rd edition. Pretoria: Van Schaik Publishers.

Swanson, R.A. 2013. *Theory building in applied disciplines*. San Francisco: Berrett-Koehler Publishers.

Syaratul-Emma, H., Hui-Ken, T., Wan-Hazabbah, W.H. and Mohtar, I. 2008. Prevalence of refractive error in Malay primary school children in the suburban area of Kota Bharu, Kelantan, Malaysia. *Annals Academy of Medicines Singapore,* 37(11): 940-946.

Teddlie, C. and Tashakkori, A. 2009. Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences, Sage, Thousand Oaks, CA.

Theophanous, C., Modjtahedi, B.S., Batech, M., Marlin, D.S., Luong, T.Q. and Fong, D.S. 2016. Myopia prevalence and risk factors in children. *Clinical Ophthalmology*, 12: 1581-1587.

Thiago, O.F.B., Denise, C., Miura, H. and Matsuhara, M.L. 2019. Evaluation of visual acuity in municipal elementary school students. Brazilian Journal of Ophthalmology*,* 78(1): 37-41.

Titiyal, J. S., Pal, N., Murthy, G. V., Gupta, S. K., Tandon, R., Vajpayee, R. B., and Gilbert, C. E. 2003. Causes and temporal trends of blindness and severe visual impairment in children in schools for the blind in North India. *The British journal of ophthalmology*, *87*(8), 941–945. https://doi.org/10.1136/bjo.87.8.941

Treiman, D.J. 2014. *Quantitative data analysis: Doing social research to test ideas. New York:* Jossey-Bass.

Turcin, L. and Jompan A. 2013. Need for refractive error screening in school-age children by objective methods. *Studia Universitatis “Vasile Goldiş”, Seria Ştiinţele Vieţii*, 23(3): 265-270.

Van der Roest, J. 2015. Mixed methods in emerging academic sub disciplines: The case of sport management. *Journal of Mixed Methods Research*, 9(1): 70-90.

Uyanık, G.K. and Güler, N., 2013. A study on multiple linear regression analysis. *Procedia-Social and Behavioral Sciences*, *106*,234-240.

Verma, A., and Verma, A. 2015. A novel review of the evidence linking myopia and high intelligence. *Journal of Ophthalmology*, 2015: 1-8. doi:10.1155/2015/271746

Vishal, R.K., Gupta, S.L. and Pathak, A.K. 2017. Prevalence of childhood blindness in the state of Jharkhand, Eastern India. *International Journal of Contemporary Medical Research*, 4(5): 1079-1082.

von-Bischhoffshausen, F.B., Munoz, B., Riquelme, A., Ormen, M.J. 2014. Spectacle-wear compliance in school children in conception in Chile. *Ophthalmic Epidemiology*, 21(6): 362–369. DOI: 10.3109/09286586.2014.975823

Vishnuprasad, R., Bazroy, J., Madhanraj, K., Prashanth, H.R., Singh, Z and Samuel, A.K. 2017. Visual impairment among 10–14-year school children in Puducherry: A cross-sectional study. *Journal of Family Medicine and Primary Care*, 6: 58-62.

Wang, X., Ma, Y., Hu, M., Jin, L., Xiao, B., Ni, M., Yi, H., Ma, X., Wang, C., Varga, B., Huang, Y., Rozelle, S. and Congdon, N. 2019. Teachers' influence on purchase and wear of children's glasses in rural China: The PRICE study. *Clinical and Experimental Optometry*, 47:179–186. https://doi.org/10.1111/ceo.13376

Wangtiraumnuay, N., Trichaiyaporn S., Lueangaram S., Surukrattanaskul S. andWongkittirux K. 2021. Prevalence of Prescription Glasses in the First-Grade Thai Students (7–8 Years Old). *Clinical Optomtometry (Auckl)* 13:235-24. Available on https://doi.org/10.2147/OPTO.S323999 (Viewed 16 August 2021)

Walliman, N. 2015. *Social research methods: The essentials*. Los Angeles, CA: Sage Publications.

Wedner S.H., Ross D.A., Balira R., Kajic L. and Fostera A. 2000. Prevalence of eye diseases in primary school children in a rural area of Tanzania, *British Journal of Ophthalmology* 84:1291-1297

Wildemuth, B.M. 2016. Applications of social research methods to questions in information and library science. Available from: https://books.google.co.za (viewed 02 July 2017).

Wong, T.Y., Foster, J.P., Hee, J., Ng, T.P., Tielsch, M.J., Chew, S.J., Johnson, J.G. and Seah, K.L.S. 2000. Prevalence and risk factors for refractive errors in adult Chinese in Singapore. *Investigative Ophthalmology and Visual Science*, 41(9): 2486-94.

World Health Organization. Blindness and Deafness Unit and International Agency for the Prevention of Blindness. 2000. Preventing blindness in children: report of a WHO/IAPB scientific meeting, Hyderabad, India, 13-17 April 1999. World Health Organization. Available from: https://apps.who.int/iris/handle/10665/66663

World Health Organization. 2007. Vision 2020: The Right to Sight: Global Initiative for the Elimination of Avoidable Blindness - Action Plan 2006-2011. Geneva: World Health Organization.

WHO. 2003. *International statistical classification of diseases and related health problems: blindness and low vision*. 10th revision. Available from: http://www.who.int/classifications/icd/en/ (viewed 14 May 2017).

WHO. 2004. *Magnitude and causes of visual impairment: Fact Sheet No. 282*. Available from: <http://www.who.int/mediacentre/factsheets/fs282/en (viewed 01 July 2017.

WHO. 2006. *List of official ICD-10 updates ratified October 2006*. Geneva: WHO. http://www.who.int/classifications/icd/2006Updates.pdf

WHO. 2007. *Vision 2020, the right to sight, global initiative of avoidable blindness action plan 2006-2011*. Geneva: WHO.

WHO. 2010. *Global data on visual impairments -2010*. Available from: <http://www.who.int/blindness/GLOBALDATAFINALforweb.pdf> (Viewed 06 June 2017).

WHO, 2010. Action plan for the prevention of avoidable blindness and visual impairment 2009 – 2013. Available from: https://www.who.int/blindness/ACTION_PLAN_WHA62-1-English.pdf

WHO. 2013. *Universal eye health: a global action plan 2014-2019*. Available from: www.who.int/blindness/en/ (viewed 10 August 2017).

WHO. 2016. *International statistical classification of disease and related health problems - 10th (ICD-10) version*. Geneva: WHO.

Yamamah, G., Alim, A., Mostafa Y., Ahmed, R. and Mahmoud, A.M. 2015. Prevalence of visual impairment and refractive errors in children of South Sinai, Egypt. *Ophthalmic Epidemiology*, 2015: 22(4): 246-252. DOI: 10.3109/09286586.2015.1056811.kum

Yared, A.W., Destaye, S., Ayanaw, T. and Zelalem, E. 2012. Prevalence of refractive errors among school children in Gondar Town. *East African Journal of Ophthalmology*, 19(4): 372-376.

Yasmin S, Minto H, Chan VF. 2015. School eye health - going beyond refractive errors. Community Eye Health, 28(89):14-5. PMID: 26435588; PMCID: PMC4579995.

Yekta, A.A., Fotouhi, A., Hashemi, H., Dehghani, C., Ostadimoghaddam, H., Heravian, J., Derakhshan, A., Yekta, R., Behnia, M. and Khabazkhoob, M. 2010. Prevalence of refractive errors among schoolchildren in Shiraz. *Iran Clinical and Experimental Ophthalmology,* 38: 242–248. doi: 10.1111/j.1442-9071.2010.02247

Ying, G.S., Maguire, M.G., Glynn, R. and Rosner, B., 2018. Tutorial on biostatistics: statistical analysis for correlated binary eye data. *Ophthalmic epidemiology*, *25*(1), 1-12.

Yingyong, P. 2010.Risk factors for refractive errors in primary school children (6-12 years old) in Nakhon Pathom Province. *Journal of the Medical Association of Thailand*, 93 (11): 1288-93.

Zhao, J., Pan X, Sui R, Munoz SR, Sperduto RD and Ellwein LB. 2000. Refractive Error Study in Children: results from Shunyi District, China. American Journal of Ophthalmology, 129(4):427-35. doi: 10.1016/s0002-9394(99)00452-3. PMID: 10764849.

APPENDICES

Appendix 1: UNISA Ethical Clearance

UNISA university of south africa

RESEARCH ETHICS COMMITTEE: DEPARTMENT OF HEALTH STUDIES

REC-012714-039 (NHERC)

6 June 2018

HSHDC/855/2018
Mr Voster Hlawulani Austine Baloyi
Student No: 396-910-8
Supervisor: Prof ON Makhubela-Nkondo
Qualification: PhD
Joint Supervisor: -

Dear Mr Voster Hlawulani Austine Baloyi

Decision: Ethics Approval

Name: Mr Voster Hlawulani Austine Baloyi

Proposal: Refractive error among primary school children of Mopani District, Limpopo Province

Qualification: DPCHS04

Thank you for the application for research ethics approval from the Research Ethics Committee: Department of Health Studies, for the above mentioned research. Final approval is granted from 6 June2018 to 6 June 2023.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the Research Ethics Committee: Department of Health Studies on 6 June 2018.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*

2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Research Ethics Review Committee, Department of Health Studies. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*

RECEIVED
2018 -06- 15
Executive Dean

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

4) *You are required to submit an annual report by 30 January of each year that the study is active. Reports should be submitted to the administrator* *HSREC@unisa.ac.za* *Should the reports not be forthcoming the ethical permission might be revoked until such time as the reports are presented*

Note:

The reference numbers [top middle and right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the Research Ethics Committee: Department of Health Studies.

Kind regards,

pp

Prof JE Maritz
CHAIRPERSON
maritje@unisa.ac.za

Prof LV Monareng
ACTING ACADEMIC CHAIRPERSON
monarlv@unisa.ac.za.

Prof A Phillips
DEAN COLLEGE OF HUMAN SCIENCES

Appendix 2: Letter of Request to Limpopo Provincial Department of Health

PO BOX 226

Elim Hospital

0960

Private Bag X9489

POLOKWANE

0700

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS

Dear Head of Department

My name is Baloyi Voster Hlawulani Austine, and I am a Doctor of Literature and philosophy in Health Science student at the University of South Africa. I wish to conduct a research for my Doctoral thesis which involves “Refractive Error among Primary School Children of Mopani District, Limpopo Province”. This project will be conducted under the supervision of Prof. O.N Makhubele-Nkondo (University of South Africa).

I have provided you with a copy of my research proposal which includes copies of the data collection and consent forms to be used in the research process, as well as a copy of the approval letter which I received from the University of South Africa Research and Publication Committee.

Upon completion of the study, I undertake to provide the Department of Health with a bound copy of the full research report.

Thank you for your time and consideration in this matter.

Yours sincerely.

Voster Hlawulani Austine Baloyi (University of South Africa)

Email address: Baloyivha@webmail.co.za.

Cell: 078 707 2735

Appendix 3: Permission Letter from Limpopo Provincial Department of Health

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH

Enquiries: Stander SS (015 293 6650) Ref: LP_2018

Baloyi VHA
UNISA

Greetings,

RE: **Refractive error among primary school children of Mopani District, Limpopo Province**

The above matter refers.

1. Permission to conduct the above mentioned study is hereby granted.
2. Kindly be informed that:-
   - Research must be loaded on the NHRD site (http://nhrd.hst.org.za) by the researcher.
   - Further arrangement should be made with the targeted institutions, after consultation with the District Executive Manager.
   - In the course of your study there should be no action that disrupts the services, or incur any cost on the Department.
   - After completion of the study, it is mandatory that the findings should be submitted to the Department to serve as a resource.
   - The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
   - The above approval is valid for a 3 year period.
   - If the proposal has been amended, a new approval should be sought from the Department of Health.
   - Kindly note, that the Department can withdraw the approval at any time.

Your cooperation will be highly appreciated.

Head of Department

03/09/2018
Date

Private Bag X9302 Polokwane
Fidel Castro Ruz House, 18 College Street. Polokwane 0700. Tel: 015 293 6000/12. Fax: 015 293 6211.
Website: http/www.limpopo.gov.za

The heartland of Southern Africa – Development is about people!

Appendix 4: Letter of Request to the Limpopo Provincial Department of Education

PO BOX 226

Elim Hospital

0960

Private Bag X9489

POLOKWANE

0700

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS

Dear Head of Department

My name is Baloyi Voster Hlawulani Austine, and I am a Doctor of Literature and Philosophy in Health Science student at the University of South Africa. I wish to conduct research for my Doctor of literature and Philosophy thesis which involves “Refractive Error among Primary School Children of Mopani District, Limpopo Province”. This project will be conducted under the supervision of Prof. O.N. Makhubele-Nkondo (University of South Africa)

I have provided you with a copy of my research proposal which includes copies of the data collection and consent forms to be used in the research process, as well as a copy of the approval letter which I received from the University of South Africa Research and

Publication Committee.

Upon completion of the study, I undertake to provide the Department of Education with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me at 078 707 2735 or email address: Baloyivha@webmail.co.za

Thank you for your time and consideration in this matter.

Yours sincerely.

Voster Hlawulani Austine Baloyi

University of South Africa

Appendix 5: Letter of Request to Schools

P O BOX 226

Elim Hospital

0960

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR SCHOOL

Dear Principal

My name is Baloyi Voster Hlawulani Austine, and I am a Doctor of Literature and Philosophy in Health Sciences student at the University of South Africa. I am conducting research on “Refractive Error among Primary School Children in Mopani District, Limpopo Province” under the supervision of Prof. O.N. Makhubele-Nkondo (University of South Africa)

The Provincial Department of Education has given approval to approach schools for my research. A copy of their approval is contained with this letter. I invite you and your school to consider taking part in this research.

I am providing you with a copy of my research proposal which includes copies of the data collection and consent forms to be used in the research process, a copy of the approval letter which I received from the University of South Africa Research and Publication Committee, as well as a copy of approval from the Provincial Departments of Education and Health

Upon completion of the study, I undertake to provide the School with a bound copy of the full research report as well as report back to the parents/guardians the results of the study.

Thank you for your time and consideration in this matter.

Yours sincerely.

Voster Hlawulani Austine Baloyi (University of South Africa).

Email address: Baloyivha@webmail.co.za.

Cell: 078 707 2735

Appendix 6: Permission Letter from the Provincial Department of Education

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

Ref: 2/2/2 Enq: MC Makola PhD Tel No: 015 290 9448 E-mail: MakolaMC@edu.limpopo.gov.za

Baloyi VHA
P O Box 226
Elim Hospital
0960

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"REFRACTIVE ERROR AMONG PRIMARY SCHOOL CHILDREN OF MOPANI DISTRIC,LIMPOPO PROVINCE ".**
3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the schools concerned.

3.3 The conduct of research should not in anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

REQUEST FOR PERMISSION TO CONDUCT RESEARCH: TAU M

CONFIDENTIAL

Cnr. 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X9489, POLOKWANE, 0700
Tel: 015 290 7600, Fax: 015 297 6920/4220/4494

The heartland of southern Africa - development is about people!

Appendix 7: Information Letter

Refractive Error among Primary School Children of Mopani District, Limpopo Province

Dear Parent/ Legal guardian

Introduction

I, Baloyi VHA, an Optometrist, and a University of South Africa Doctor of Literature and Philosophy in Health Science student invites you and your child to volunteer as participants in a study being conducted by me. This letter provides you with the information you will need when considering whether to participate in this study or not. If you decide to participate, you will be asked to sign this consent form which states that you have read the summary of the study, that any questions you have about the study have been answered, and that you agree to participate. You will be given a copy of this form to keep for your records.

Purpose

The purpose of this study is to determine the extent refractive error (poor vision at near or at far) and its risk factors among primary school children in Mopani District of Limpopo Province.

Procedures

Children are selected using class registers and as parents/guardians of the selected children I will kindly request you to complete a questionnaire in order to provide me with the information about you and the child related to vision. After completion of questionnaires your child will have an eye examination at School by an optometrist.

Risk and Benefits

Participation in this study involves no risks. However children with low concentration span might be impatient. If your child has eye problems he/she will be referred to relevant eye professionals for further management and and you will be notified of the problem. There are no cost implications for both you as the parent/guardian and the child for all assessments done for the purpose of this study. This study will enable me and the Departments of Health and Education to establish relevant strategies to eliminate these eye problems.

Right to Refuse or Withdraw

The decision to participate in this study is entirely up to you. Participation is voluntary. You can refuse to participate, or withdraw from the study at any time, and such a decision will not affect your relationship and that of your child with the University of South Africa, the School or Department of Health, either now or in the future. Nor will a refusal or withdrawal of participation result in the loss of any other benefits to which you are otherwise entitled. Signing this form does not waive any of your legal rights.

Ethical Approval

The study has received written approval from the University of South Africa Research and Publication Committee and research committee of the Department of Health as well as the Department of Education.

Confidentiality

If you consent to participate in this evaluation, your personal information and that of your child will be kept strictly confidential. Research presentations and reports will not include any information that may identify you or your child.

Information

If you have any questions, please ask, and I will do my best to answer them**. Please contact Baloyi Voster Hlawulani Austine at** Baloyivha@webmail.co.za **or 078 707 2735**

Kind regards.

Austine Baloyi

Email: Baloyivha@webmail.co.za

Tel: 0787072735

Appendix 8: Information Leaflet (Grades 5 to 7)

Refractive Error among Primary School Children of Mopani District, Limpopo Province

Dear Learner

My name is Austine Baloyi an Optometrist and a student from University of South Africa (UNISA). My supervisor is Prof. ON Makhubele-Nkondo. I am busy doing a study on eye problems amongst primary school children. These eye problems can affect learning, playing and wellbeing of children. This study will assist teachers, healthcare practitioners, mommies, daddies and everyone involved in caring for children in solving eye problems for primary school children.

I have asked your mommy/daddy/granny/auntie/uncle if you can help in the study and they said it is ok. If you would like to take part in the study, I will request you to read alphabets on a chart to check how far you can see and also shine light in your eye using a small torch to check for eye diseases.

Your name will not be recorded and your personal information will be kept safe. Only me and the supervisor will have access to your information.

If you say yes, but change your mind later, you can tell us you want to stop. You can ask us any question you want about the study.

Thank you.

Austine Baloyi.

Email: Baloyivha@webmail.co.za

Cell: 0787072735

Appendix 9: Participants' Informed Consent

Refractive Error Among Primary School Children of Mopani District, Limpopo Province

I have read the information letter (or had the information read to me). I have had my questions answered and know that I can ask questions later if I have them. I know that it is voluntary for me and my child to participate in the study, that my child will be examined and we are allowed to withdraw if we so wish.

I agree to take part in the research.

Child's name: ________________________________ (Please print)

Participant's name: ____________________________ (Please print)

Participant's signature; __________________________ Date: _____________

Witness' name:_________________________________ (Please print)

Witness' signature: ____________________________ Date: ________________

Appendix 10: Assent Form

Refractive Error among Primary School Children of Mopani District, Limpopo Province

I have read the information leaflet (or someone read the information leaflet to me). I have had my questions answered and know that I can ask questions later if I have them.

If you say yes  to take part in the study, please write your name below:

Name ____

Surname ______________________________________

Date_____________

Witness' name______________________________________(Teacher/Parent)

Appendix 11: Ocular Assessment Form

Primary School Children of Mopani District, Limpopo Province

Section A: Personal Information of the Child

1. Gender: □ Female □ Male

2. Age:

3. School: ______________________________

4. Grade: ______________________________

Section B: Unaided Visual Acuity (UVA) and Pin Hole Visual Acuity (PHVA)

	UVA	PHVA
Right eye		
Left eye		

Section C: Retinoscopy results

Right eye	
Left eye	

Section D: Subjective refraction results

Right eye	
Left eye	

Section E: Ophthalmoscopy (Assessment of other Ocular abnormalities)

OCULAR STRUCTURE	RIGHT EYE	LEFT EYE
Eyelids		
Conjunctiva		
Cornea		
Pupil		
Lens		
Vitreous		
Fundus		
Cd ratio		
Peripheral retina		

Section D: Diagnosis

□ No refractive error

□ Myopia

□ Hyperopia

□ Pathological condition …………………………………

Please specify ………………………………….

□ Unknown condition

Appendix 12: Questionnaire

Refractive Error among Primary School Children in Mopani District, Limpopo Province

Instructions

- Please read carefully and answer all questions (e.g. by ticking the right box ☑)
- The questionnaire should be completed by the biological mother or father, or guardian or any adult responsible for the care of the child on a day-to-day basis and lives with the child.
- Please feel free to ask me if you experience any difficulties with filling in the questionnaire

DEMOGRAPHIC FACTORS AND EDUCATION LEVEL

Personal information of the child

1. Gender: □ Female □ Male

2. Age:

3. School: ____________________

4. Grade: ____________________

Parental information

5. Questionnaire completed by: □ Biological mother

□ Biological father

□ Legal guardian

□ Other (please specify): ______________________

6. What is your age?

Father	Mother
□ 25-35	□ 25-35
□ 35-45	□ 35-45
□45-55	□45-55
□above 55	□above 55

7. What is your highest level of education?

Father	Mother
□ None	□ None
□ Primary school	□ Primary school
□ Secondary School	□ Secondary School
□ Higher education	□ Higher education
□ Don’t know	□ Don’t know

8. Is the parent currently employed?

Father	Mother

□ Yes □ Yes

□ No □ No

FAMILY HISTORY/GENETIC FACTORS

9. What is the position of the child in the family?............................

The history of the child's eye examination

10. Has the child ever had an eye test? □ Yes □ No	If yes, when was the last eye exam? □ in the past/current year □ in the last 2years □ in the last 5 years. Other (Specify)_________.	What was the reason for the eye test □ General eye test or school screening □ Painful, itchy eyes or injury □Poor vision Other (Specify)__________________.

Information on the child' visual correction

11. Does the child wear spectacles or contact lenses?	If yes, at what age did the child start wearing spectacles or contact lenses?	What is the reason for wearing spectacles or contact lenses?
□Yes □ No	□ _____ years □ Don't know	□ Seeing clearly in distance □ For reading, working at a computer or other close

		work □ for all of the above □ Don't know

Family eye history

12. Is there a history of poor eyesight in the family?

□ Yes

□ No

If yes, who is affected? ....

13. Is there a history of blindness in the family?

□ Yes

□ No

If yes, who is affected? ....

14. Does the father or mother/ father wear spectacles?		If yes, at what age did the father/mother start wearing spectacles or contact lenses?		What is the reason for wearing spectacles or contact lenses?	
mother	Father	Mother	Father	Mother	Father
□ Yes □ No	□Yes □ No	□ _____ years	□ _____ years	□ Seeing clearly in distance	□ Seeing clearly in distance

		□ Don't know	□ Don't know	□ For reading, working at a computer or other close work □ for all of the above □ Don't know	□ For reading, working at a computer or other close work □ for all of the above □ Don't know
15. Do any of the siblings wear spectacles?		If yes, at what age did the sibling 1/2 start wearing spectacles or contact lenses?		What is the reason for wearing spectacles or contact lenses?	
Sibling 1	Sibling 2	Sibling 1	Sibling 2	Sibling 1	Sibling 2
□ Yes □ No	□Yes □ No	□ _____ years □ Don't know	□ _____ years □ Don't know	□ Seeing clearly in distance □ For reading, working at a computer or other close work □ for all of the above □ Don't know	□ Seeing clearly in distance □ For reading, working at a computer or other close work □ for all of the above □ Don't know

EXTRACURRICULAR ACTIVITIES/SOCIAL HABITS

16. How much time does the child spend on the following activities after school?

Activities	Computer games/watching TV	Reading, writing, drawing and coloring	Engaging in sports (outdoor)
Estimated time	□ less than 30 minutes □more than 30 minutes but less than 1hr □More than 1hr □None	□ less than 30 minutes □more than 30 minutes but less than 1hr □More than 1hr □None	□ less than 30 minutes □more than 30 minutes but less than 1hr □More than 1hr □None

Thank you very much for your participation.

Appendix 13: Consent form for educators

Refractive Error Among Primary School Children of Mopani District, Limpopo Province

I have read the information letter (or had the information read to me). I have had my questions answered and know that I can ask questions later if I have them. I know that it is voluntary for me and my child to participate in the study, that my child will be examined and we are allowed to withdraw if we so wish.

I agree to take part in the research.

Participant's name: ______________________________ (Please print)

Participant's signature; ___________________________ Date: ______________

Appendix 14: Interview Guide for Educators

Refractive Error among Primary School Children in Mopani District, Limpopo Province

A. EDUCATOR'S DEMOGRAPHIC FACTORS

1. Gender: □ Female □ Male

2. School: □ Public School □ Private School

3. Phase: □ Foundation □ Intermediate Phase □ Senior Phase

4. Age	**5. Teaching experience in years**
□ 20-25	□ 0-10
□ 26-30	□ 11-20
□31-35	□ 21-30
□41-45	□ Above 30
□46-50	
Above 50	

6. Highest level of education	
□ Diploma	□ Degree
□ Honors	□ Masters
□ PHD	

B. INTERVIEW GUIDE

1. **Questions related to the occurrence of vision problems among the school children**
   1.1. What are the common eye problems experienced by children?
   1.2. Would you mind sharing with me how you identify children with vision/eye problems?
   1.3. Probing question: please describe some of the signs of vision problems the children present with.

2. **Questions related to vision problems' effects on teaching and learning**
   2.1. What are the challenges experienced by children with vision problems?
   2.2. Would you mind sharing how the challenges posed by vision problems affect the children socially.
   2.3. Please explain how the vision problems affect the general health of the children.
   2.4. How do these challenges affect teaching of children who experience vision problems?
   2.5. Please share with me how the children's learning is affected by the vision problems.

3. **Questions related to the possible actions taken to manage refractive error error**
   3.1. After identifying children with vision problems, please share with me how you assist these children?
   3.2. What challenges do you encounter when taking these actions?

4. **Questions related to the educators' recommendations**
   4.1. Based on your description of the vision problem and the current systems that are in place to identify and manage the children, what would be your recommendation for improvement in the following areas:

4.1.1. the identification or referral of children with eye problems;

4.1.2. the provision of appropriate treatment to the affected children;

4.1.3. the prevention of eye problems among children.

5. Awareness of the term "Refractive error"

5.1. With this last question, I would want to understand how familiar you are with the terminology "refractive error". Please share with me whether you have heard of the word and what your understanding of the word is.

We have come to the end of our discussion, thank you so much for your participation in this study.

Appendix 15: Xitsonga narrative statements

*"…*i…i…i [stuttering] hi kuya hi mina. Nito kungava kuri leswi aswi fanele kuva swika swi endleka mara swinga koteki ku endleka…swi fikelela laha aswi fanele swi endleka ha kona…" (Educator 9)

> "…[giggles first] Nah, I don't know. [*She continues giggling and then states*] Anise tshama ni swi twa, le ka mahlo no twa ti glaucoma sweswiya, ni twa onge swi yelana na lava kulukumba loko va karhata hi machukela, mar aka swihlangi ani tivi…" *(Educator 10)*

"…Yaa, ti kona, ku fana na loko a langutisa a chalk boardweni ati komba a langutisa onge wa tikeriwa inwu vona ku ize a tsipa na matihlo onge hiloko kuri na dyambu aka a lwela ku aze aswi vona kahle…" (educator 5)

"… Iku aka aka anga kopi swona yena, ivha iswi vona ku leswi anga kopa a hi swona leswi mhe ninga tsala swona la chalkdoardweni… (Educator 7)

"…Ya ka performance yiva yi affectaka hiku aniri nwana loko anga voni anga koti kuswi tiva, inga nwu dyondisa ku "a"angayi voni ku i "a" yina ximhandzani, lexi xi tsaleriwa kwini, ka left kumbe ka right. Kasi loyi wa ku vona, loko u tsala laya ka chalkboard, I vhe a swi vona ku I "a"hiliya, yi tsarisiwa leswi. Se luyani iva aya swi realizer kuri late…" (educator 1).

"hi swi vona I kuma kuri, kumbexani inwu nyika a passage kuri a hlaya, I kuma ku loko a hlaya, swinwanyana anga hlayi swona. Nkarhi wunwanyani I kuma kuri wa struggler ku hlaya a word, uvhe unwu vona ku nwana loyi wani anga voni". (Educator 6).

"…Swava affecta, aswi minor, swava affecta, ningaswi vekisa ku yini? I kuma ku nkarhi wunwani nwana wa nwu vona ku nkarhi wunwani I fane a tsala ntirho, from the text book, kumbe kuna activity leyi faneleke vayi endla, kumbe hikuva vayi tsala Kunene. I kuma ku nwana nkarhi wunwani o tshama anga tsali, o tshika, loko inwu vutisa ku why inga tsali ivi aku aniswi twisisi. I kuma ku wena as a teacher waswi twisisa ku hooo, inwana luya angina problem ya matihlo" …(Educator 7)

"…Nkarhi wunwani loko a tsala wa kota ku tsala mikumaku swi huma a layinini swinga fambi hi patu leri aswika swi famba hi rona…" (educator 10)

"…Kuna xihlangi xinwani xintsongo, swindla ingaku matihlo ya kona yo nwayisa nyana so. Condition ya kona very loko munhu aya a kula swa antswa, ya suka hi swoxe. Matlhe ma cinca nyana na color nyana. Aniswi tivi kuri swi vitaniwa yini. Hi yona ni talaku kuyi vona ngopfu. I condition ya matihlo leyi yi karhataku vana. Na namuntlha ni vone yinwani…" (Educator 8)

"…Vana va kona, ngopfu ngopfu kwahala hansi. Vana vo tala mita kuma ku vana problem yo mahlo ya huma ngopfu mihloti. Va nwani mahlo ya vona ma vonaka ya tshukile swinene. Vanswani yava ya endle leswiya swo ku huma, ingaku I rhaxi nyana yi ntsongo nyana kwalomiya matlhelo lomu"…(Educator 9)

"…ya, hi yona yi rhangaku ngopfu a mahlweni …" (Educator 8)

"…Ni swi vona hiloko anga heti ku tsala. Vana lavangana problem ya mahlo ani angaswi voni swinene swo fana na swale xitsalelweni, se mi kuma ku ntirhjo anga heti. Vanwani vava va hete khale yena…kumbexani a tshama anga tsali. Vanwani wava fair a vula kuri aniswi voni,,," (Educator 1)

"Eeh, aka rihanyo ra nwana yaloye na vana vanwani swona anisi swi langutisa. Anise swi nangutisa hi ndlela yaleyo kuri swingava swika swi nwu affecta njhani. Hiku aniri na loko vaka va huwha, eeh, swilu leswi va huwhaku hi swona I swilu leswi swingariku swintsongo. Vo huwha nkarhiwunwani hiku famba famba, kumbe a va huwhi ngopfu hiku tsala leswi na mina ni nga swi vonaku. Kambe ku tsutsumisana na ku endla swinwani hi mavoko. Swilo swo khama, aswi koti kuva ari valeni kuri nwana loyi angava a karhatiwa hi mahlo" (Educator 5)

"…like loyi hinwu vulaku I hetelele a referiwa a Rivoni [Special School for visually impaired children] hi mhaka yaku ya yena ayari severe. Se aswi fika laha ko loko a fane a famba a fane a khomiwa Kunene, lomiya switepisini. Kuri a vonela ku suhi ngopfu, leswa lee anga kotikuswi vona" (Educator 10)

"…Nkarhi wunwanyani vatswari va ta hi voxe va fika vaku nwana ina problem ya matihlo…" (Educator 8)

"…Ivi hi hetelela hiva positiona la loko a vona atleast swingata fika swinwu antswela. So normally nwana wakona mi kuma kuri loko a fane a langutisa ka chalkboard, na loko a kopa mita kuma anga kopi swona nkarhi wunwani, ku kopa Kunene. Lero swati komba swinene kuri iva ari na problem ya mahlo…" (Educator 10)

*"…*Loko nwana a tshamile aze a tshunelela board hita swi vona ku loyiwani anga voni …" (Educator 4)

"…As a school hi tala ku hi tayi report aka management ya xikolo, kuri hina nwana wa so so so. I vi mutswari a tsaleriwa papilla hilava ku twisisa ku mutswari wayi tiva problem leyi na, ya nwana wa yena. Hiku vanwani mi kuma ku vava vanga reportangi vatswari. So, from there ita fane aya aya kamberiwamaneen…" (Educator 10)

"…And xinwanyani kava nwanyani, tani hiloko ni swi xiya xiya ka malembe lawa ninga tirha na vana, eeh, loko kuruku hi vona ku swinwu tikela swinene, ha swikota kuri hi vitana vatswari hi vulavurisana na vona. Then hiva advicer kuri vanganwu yisa e xibedlhele…" (Educator 5).

"…Eh, loko hiri la xikolweni hi vitana vatswari a swileku pfuneni ngopfu hiku swa endla u vitana mutswari ka 5 angati. Mara nwana na nwu vona kuri ina problem, mara leswi antswaka hiloko nwina, mi tirhaku hi swona mihi endzela kwala. Mi fika miswi kuma, ani swa antswa maswi kota kuva tsalela phepha. Loko miva tsalele phepha ra kuya Nkhensani ha landzelelrisa ku veteri amiti, wena na mani amiti rini miya Nkhensani. Na loko a vuya Nkhensano I fane ani komba phepha kuri a yili. Se nitwa ingaku loko nwina mi endza aswi kolweni swa antswa. Vatswari vo tala va ignorant ngopfu, loko uva vitanela ti mhaka ta nwana wa vona avati exikolweni, immh…" (Educator 6)

"…Imm, ka hari na xiphiqo xexiya xa va tswari. Ni tsundzuka Department yi tshama yi ta la. La ka grade 1 la kuve na va tswari vanwani lava avaku vana va vona van a ti problems. Hambi atiri ta meno hambi akuri ta yini? Eeh, Va suke va hi tsalele ti note. Hi landelerisa hi landelerisa hi kuma kuri mutswari anga kumeki. Hito ti barriers leti hi hlanganaku na tona hiku ani loko anga kumeki ahi koti kuya e mahlweni…" (Educator 3)

"*Kova sweswiya swa tliliniki loko vata vata kambela vu vabyi hinkwabyu ka grade R, va siya ma papilla ku lava ngana problem vata tliliniki, se hi teka mapapila hi nyika vatswari ...*" *(Educator 7)*

"… Ya leyo ningeku hindisi kahle hiku aniri va cheka ma grade R. Loko kuruku kumbexani ingani nyika nkarhi niya va vutisa, loko kuruku aswi jahangi, antava vutisa niku fonela munduku niku byela kuri swi famba njhani. Mara vanwani ni vona vaka va responda va ta vata teka vana vava yisa a tliliniki. Mara ani hiku mina ani kona laya …? (Educator 7)

"… Loko va hari ka grade R, clinic yi tirhisa na xikolo ani yile ku suhi. Loko vahari ka grade R minkarhi hinkwayu vata vata checkiwa mavabyi hinkwawu yo hambana hambana. Lava va kumaku vari na vu vabyi byo karhi va tsala mapapila va tsalela matswari wa yena ku ayi xibedlhele, ivi a sungula ku pfuneka from there loko kuruku se I fane a hamba aya xibedlele kumbe a hamba aya a clinic a hamba aya…" (Educator 5)

"… Eeh, mmm, Ku swi hatla swi kumeka, ningo vula kuri mudyondisi u fane a vona kuri vana lavaya ava hlayisaku ti nomboro and then ava hlayisa ti nomboro letiyani akari a kombetela nwana. Xikombiso loko nwana aku nharhu, a komba nharhu, mara loko kuruku angaswi kota ku hlaya va nharhu lavaya mi kuma ku angaswi tivi kuri nharhu yi tsarisiwa ku yini. Hikuva swingava swika swi vangiwa hiku angayi voni na yona loko kuruku tihlo rina problem, hikuva angase tshama ayi vona. Naku waswi kota ku hlaya new, mbirhi, nharhu mune ntlhanu mara hiku tsala angayi tivi, hi mhaka yaku angase tshama ayi vona. Loko yiri a chalkboardweni I vona yiri kule mara angaswi twisisi kuri I nharhu kumbe I mbirhi. Se mara loko ho kota ku hi kota kuswi vona ku aya a komba kumbe hiti mikisela tinomboro letiya, aze a fika a komba nharhu. Hitasw vona kuri wa vona kahle, loko hinwu ringeta ka mbirhi ka nharhu angayi kombi nharhu liya, hitaswi vona kuri swikomba kuri angayi tivi ene swi komba kuri angase tshama ayi vona …" (Educator 5)

"…Leswi niswi vonaku iku lembe raha sungula vana ava fane va kamberiwa ngopfu ngopfu kwahala hansi kava Grade R, Grade 1 ani vata hiku nwanyani. Eeh, Loko va fika hala va fika va kamberiwa, nwana a tiveka taha suka loko ari na problem kuri ina problem ya so…" (Educator 8)

"Mara lexi ni vonaku ku axi fane xi endliwa hiloko eeh, aku fane ku nkarhi wu nwanyani la vale clinic kumbe va ongori lava humaku a clinic, ava kota kuva va endzela vana. Vata vatahi checkela vona hi matihlo ya xi doctor nyana. Ku pima ku vana lavaya avata kota kuva va pfuneka hikuva hina hingaswi nagutisa hiloko anga voni, kumbexani vona avata vona ti sign tinwani leti hambi swinga se ti kombisa, mara vona hiku nanguta ku loko matihlo ya tshukile kumbe ya ndise swo karhi karhi, ya komba ku yana problem, Aswi ta hatla swi kumeka" (Educator 5)

"…Ee, se loko vo kota ku kuri na mirhi kahle swi tshunguriwa, haaa, ku ngava kahle…" (Educator 3)

"…Ti mhaka ta matshungulele ahi taku swofana na swihlanginyana leswi nstongo loko akova na mirhi ya enough a xibedlhele, swihlangi nyana swa hina loko swi yisiwa kwalomu swibedlhele swikota ku cheriwa ti eye drops na liya yo kamela. kuya hi leswi vona vanga kuma swona. Hi vona onge loko kova na mirhi a swibedlhele, swingava kahle ku tlula ti……Mina kahle kahle ni prefer ngopfu mirhi ku tlula ti glass hikuva ma byi vona byahari byi ntsanana lebyi, ti glass byinga fayelana. Kunga tshama kuri ti case ta ku uni fayerili. Maswi vona…" (Educator 3)

"…Ok, ninga vula ku vahari ka foundation phase aku fanele kuva na check up leyi faneleke yiva kona. Yiva yika yi checka matihlo ya vana. Eh, eh, kumbe loko va kota ku sivela avata kota ku hatla va swivona ku va va tlhava ti nayiti" (educator 2)

Appendix 16: Proof of language editing