

**THE PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG EYE CLINIC  
PATIENTS AT NKHENSANI HOSPITAL, LIMPOPO PROVINCE, SOUTH AFRICA**

by

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## **DECLARATION**

I declare that the **PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG EYE CLINIC PATIENTS AT NKHENSANI HOSPITAL, LIMPOPO PROVINCE, SOUTH AFRICA** (mini-dissertation) hereby submitted to the University of Limpopo, for the degree of Master of Public Health has not previously been submitted by me for a degree at this or any other university; that it is my own work in design and in execution, and that all material contained herein has been duly acknowledged.

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Maake M M

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Date

## **DEDICATION**

This dissertation is dedicated to my three lovely sons (Tshegofatso Retang, Kgwerano Bohlale and Seboifeng Immanuel Ofentse). Thank you for your understanding and patience during this research project. You guys are my inspiration and pillars of strength. To my late Dad (Maupa Abram Maake), I take off my hat in your honor Mokone, Phelaetsweni!

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## ABSTRACT

**Purpose:** The purpose of this study was to determine the prevalence and causes of visual impairment (low vision and blindness) among eye clinic patients at Nkhensani hospital in Limpopo province, South Africa.

**Methods:** This was a cross sectional design in which 400 stratified participants aged  $\geq 6$  years were selected {100 participants in each stratum (6 – 18; 19 – 35; 36 – 59 and  $\geq 60$  years)}. Presenting, pinhole and best corrected visual acuities were measured using a logMAR E chart. Where reduced visual acuity (VA) was due to uncorrected refractive errors (UREs), ophthalmic lenses were used to compensate for the refractive errors using subjective refraction method and best corrected VA was measured. All participants underwent external and internal ocular examinations using ophthalmoscope to detect eye diseases. Participants with ocular pathology were referred to the ophthalmic nurse and/or ophthalmologist for further management. Refractive error findings were elaborated on in this study in order to highlight the importance and impact of this eye condition.

**Results:** The ages of participants ranged from 6 to 92 years with mean of  $39.5 \pm 23.5$  years. They included 161 (40.3%) males and 239 (59.8%) females. The prevalence of significant visual impairment (SVI) (VA  $< 6/18$  to no light perception, i.e. low vision and blindness), low vision and blindness based on presenting visual acuity (PVA) in the right eye were 34.8%, 16.3% and 18.5% respectively while the prevalence based on the best corrected VA were 24.0%, 7.5% and 16.5% respectively. Based on the PVA, there was a significant association between age (Chi = 71.6; df =3;  $p = 0.00$ ) and gender (Chi = 8.9; df =1;  $p = 0.003$ ) with visual impairment (VI) of the right eye. In the left eye, the prevalence of SVI, low vision and blindness based on PVA were 35.8%, 17.5% and 18.3% respectively, while the prevalence based on best corrected VA were 24.8%, 8.5% and 16.3% respectively. Based on PVA, there was a significant association between age and visual impairment in the left eye (Chi = 52.9; df =3;  $p = 0.00$ ) but there was no association between gender and VI (Chi = 1.9; df =1;  $p = 0.163$ ). In both eyes, the prevalence of SVI, low vision and blindness based on PVA were 27.0%, 17.5% and 10.3% respectively, while the prevalence based on best corrected VA were 16.8%, 3.8% and 9.5% respectively. Based on the PVA, there was a significant association between age and VI (Chi = 54.1; df =3;  $p = 0.00$ ) and gender and VI (Chi = 4.7; df =1;  $p = 0.03$ ) in both eyes.

The causes of significant visual impairment were uncorrected refractive errors (38.0%), cataract (25.9%) and glaucoma (17.6%) in both eyes. Among all participants, the leading causes of low vision based on presenting VA were uncorrected refractive errors (56.7%), cataract (20.9%) and glaucoma (9.0%). The main causes of blindness in both eyes were cataract (34.1%), glaucoma (31.7%) and corneal anomalies (17.1%) based on presenting visual acuity. After optical corrections, the main causes of VI were cataract (39.4%), glaucoma (28.8%) and corneal anomalies (18.2%). The main causes of low vision were cataract (42.9%), glaucoma (21.4%) and corneal anomalies (17.9%), while the main causes of blindness were cataract (39.5%), glaucoma (34.2%) and corneal anomalies (15.8%).

**Conclusion:** The findings in this study indicate that the overall prevalence of visual impairment, low vision and blindness among patients attending the Nkhensani hospital eye clinic were 27.0%, 16.8% and 10.3% respectively. The main causes of visual impairment, low vision and blindness were uncorrected refractive errors, cataract and glaucoma. A focus on the optical correction of refractive errors and surgical intervention in the case of cataract would lead to a significant reduction in the burden of visual impairment among patients who utilise Nkhensani hospital for eye care services. Also, early detection and appropriate management of glaucoma will reduce the burden of this ocular morbidity. A significant proportion of these prevailing ocular morbidities are avoidable and with appropriate management, visual impairment is preventable.

## DEFINITION OF TERMS

**Age related macular degeneration** is an eye disorder which usually affects elderly people in which there is a degeneration of the photoreceptors of the macula area (which is the part of the retina responsible for the sharp, central vision). This degeneration is characterized by the presence of fine pigment stippling with the later appearance of gross pigment clumps and white-yellowish spots (drusen) in the macular region (Paulus and De Jong 2006).

**Albinism** is a genetically determined heterogeneous group of disorders of melanin synthesis in which either eyes alone (ocular albinism) may be affected (Kanski 2000).

**Amblyopia** is a unilateral or bilateral decrease of visual acuity caused by form vision deprivation and /or abnormal binocular interaction for which no organic causes can be detected by the physical examination of the eye. Amblyopia itself produces no change in the appearance of ocular structures (Greenwald and Parks 2006).

**Astigmatism** is a non-spherical refractive error which occurs when incident of light rays does not converge at a single focal point whereby objects appear broadened or elongated. The refractive power of the eye varies depending on which meridian light enters the eye (Johnstone 2008).

**Cataract** is the loss of transparency of the crystalline lens or its capsule where there is light scattering reduction in transparency in the lens due to disorganization of the lens fibre, or disorganization of the cytoplasm within the fiber, causing scattering (Brown 2001).

**Dioptre** is a unit by which the strength of lenses is measured (Johnstone 2008).

**Diabetic retinopathy** is a microangiopathy affecting the retinal precapillary, arterioles, capillaries and venules. It has features of both microvascular occlusion and leakage (Kanski 2000).

**Glaucoma** is an eye disease occurring in many forms, having as its primary characteristics involving intraocular pressure; optic nerve head damage; visual field loss and drainage angle (Kanski 2000).

**Hyperopia** (long-sighted) eye, distant objects are brought to focus behind the retina. This may be because the eyeball is too short (axial hypermetropia) or the refractive elements of the eye are inadequate which is referred to as refractive hypermetropia (Johnstone 2008).

**LogMAR E chart** is an acuity chart that expresses visual acuity in terms of the logarithm of the angular limb width (in minutes of arc) of the smallest letters recognized at six meter (Kniestedt and Stamper 2003).

**Low vision** refers to visual acuity of worse than 6/18 but equal to or better than 3/60 (visual impairment categories 1 and 2) (WHO 2008).

**Myopia** is defined as an optical condition of the non accommodating eye in which parallel rays of light entering the eye are brought to a focus anterior to the retina. It also can be described as the condition in which the far point of focus is located at some finite distance in front of the cornea (Whitmore and Curtin 2006).

**Nystagmus** is a regular repetitive, involuntary to- and fro oscillation of the eyes. The plane of oscillation may be horizontal, vertical, torsional or non-specific (Kanski 2000).

**Onchocerciasis** is a parasitic disease caused by *Onchocerca volvulus*, which is transmitted to humans by black flies (genus *Simulium*). It can cause severe skin and eye disease, including blindness. It is commonly known as “river blindness” because the black fly vectors breed in fast-flowing rivers (WHO 2014).

**Ophthalmoscope** is an instrument which allows for the visual examination of the external and internal structures of the eye. Direct ophthalmoscope uses the patient’s eye as a simple magnifier by aligning its viewing and illuminating beams. This produces an erect, magnified, well-detailed real image of the retina (Roux 2004).

**Pinhole disc** is an opaque disc with a central circular aperture of about 1 mm in diameter (Franklin 2007).

**Prevalence** is defined as the number of cases of a disease that exist in a defined population at a specified point in time (Mann 2003).

**Refractive error** is a state in which the optical system of the non accommodating eye fails to bring parallel rays of light to focus on the retina resulting in blurred vision. There are 3 types of refractive error: myopia, hypermetropia and astigmatism (Johnstone 2008).

**Retinopathy of Prematurity (ROP)** is a proliferative retinopathy affecting premature infants of very low birth weight, who have been exposed to high ambient oxygen concentrations (Kanski 2000).

**Spherical equivalent power (SEP)** is defined as sphere power plus half cylinder power (Raliavegwa and Oduntan, 2000).

**Subjective refraction** is where the result depends on the patient’s ability to discern changes in clarity. This process relies on the cooperation of the patient (Franklin 2007).



**Visual acuity** is a measurement of a patient's ability to resolve fine detail and usually involves directing a patient to identify targets at a set distance which are of ever-decreasing size and typically of high-contrast until they can no longer be identified. It is the measurement of the ability to discriminate two stimuli separated in space at high contrast compared with the background (Kniestedt and Stamper 2003).

**Trachoma** is a chronic conjunctival inflammation caused by infection with Serotypes A, B, Ba, and C of *chlamydial trachomatis*. It is associated with poverty, overcrowding, and poor hygiene to which the fly is an important vector (Kanski 2000).

## **LIST OF ABBREVIATIONS**

VA = Visual acuity

PVA = Presenting visual acuity

PHVA = Pinhole visual acuity

BCVA = Best corrected visual acuity

OD = Right eye

OS = Left eye

OU = Both eyes

SVI = significant visual impairment

D = Dioptre

Y/N = Yes/ No

VI = Visual impairment

WHO = World Health Organization

*N* = Number of participants

S/N = Serial number

SEP = Spherical equivalent power

URE = Uncorrected refractive errors

RE = Refractive errors

ATR = Against-the-rule

WTR = With-the-rule

OBL = Oblique

<b>TABLE OF CONTENTS</b>	<b>Page</b>
<b>DECLARATION</b>	i
<b>DEDICATION</b>	ii
<b>ACKNOWLEDGEMENTS</b>	iii
<b>ABSTRACT</b>	iv
<b>DEFINITION OF TERMS</b>	vi
<b>LIST OF ABBREVIATIONS</b>	ix
<b>CHAPTER 1</b>	<b>1</b>
<b>1.1 Introduction</b>	1
<b>1.2 Statement of the problem</b>	3
<b>1.3 Purpose of the study</b>	3
<b>1.4 Objectives of the study</b>	3
<b>1.5 Research questions</b>	4
<b>CHAPTER 2</b>	<b>4</b>
<b>2. LITERATURE REVIEW</b>	4
<b>2.1 Introduction</b>	4
<b>2.2 International Perspective</b>	5
<b>2.3 National Perspective</b>	7
<b>CHAPTER 3</b>	<b>8</b>
<b>3. RESEARCH METHODOLOGY</b>	8
<b>3.1 Study Site</b>	8
<b>3.2 Research Design, Population and Sampling</b>	9
<b>3.3. Inclusion and Exclusion criteria</b>	10
<b>3.4. Data Collection</b>	10
<b>3.5. Data Analysis</b>	12
<b>3.6. Reliability</b>	12
<b>3.7. Validity</b>	12

<b>3.8. Ethical Considerations</b>	13
<b>3.9. Significance of the study</b>	14
<b>CHAPTER 4</b>	14
<b>4. RESULTS</b>	14
<b>4.1 Demographic profiles</b>	14
<b>4.2 Presenting visual acuities</b>	15
4.2.1 <i>Presenting visual acuities in the right eye</i>	15
4.2.2 <i>Presenting visual acuities in the left eye</i>	16
4.2.3 <i>Presenting visual acuities in both eyes</i>	16
<b>4.3 Presenting visual acuities by age</b>	17
4.3.1 <i>Presenting visual acuities in the right eye</i>	17
4.3.2 <i>Presenting visual acuities in the left eye</i>	18
4.3.3 <i>Presenting visual acuities in both eyes</i>	19
<b>4.4 Presenting visual acuities by gender</b>	19
4.4.1 <i>Presenting visual acuities in the right eye</i>	19
4.4.2 <i>Presenting visual acuities in the left eye</i>	20
4.4.3 <i>Presenting visual acuities in both eyes</i>	21
<b>4.5 Visual impairment based on presenting visual acuity</b>	22
4.5.1 Visual impairment by age	22
a. <i>Visual impairment in the right eye</i>	22
b. <i>Visual impairment in the left eye</i>	23
c. <i>Visual impairment in both eyes</i>	24
4.5.2 Visual impairment by gender	24
a. <i>Visual impairment in the right eye</i>	24
b. <i>Visual impairment in the left eye</i>	25
c. <i>Visual impairment in both eyes</i>	26
<b>4.6 Low vision based on presenting visual acuity</b>	26
4.6.1 Low vision by age	26
a. <i>Low vision in the right eye</i>	26
b. <i>Low vision in the left eye</i>	27

c. <i>Low vision in both eyes</i>	28
4.6.2. Low vision by gender	28
a. <i>Low vision in the right eye</i>	28
b. <i>Low vision in the left eye</i>	29
c. <i>Low vision in both eyes</i>	30
<b>4.7. Blindness based on presenting visual acuity</b>	30
4.7.1 Blindness by age	30
a. <i>Blindness in the right eye</i>	30
b. <i>Blindness in the left eye</i>	31
c. <i>Blindness in both eyes</i>	32
4.7.2 Blindness by gender	32
a. <i>Blindness in the right eye</i>	32
b. <i>Blindness in the left eye</i>	33
c. <i>Blindness in both eyes</i>	34
<b>4.8 Presenting eye anomalies</b>	34
a) <i>Conjunctival anomalies</i>	34
b) <i>Eyelid anomalies</i>	34
c) <i>Corneal anomalies</i>	34
d) <i>Lens anomalies</i>	35
e) <i>Retinal anomalies</i>	35
f) <i>Uveal anomalies</i>	35
g) <i>Others</i>	35
4.8.1 Presenting eye anomalies in the right eye	35
4.8.2 Presenting eye anomalies in the left eye	36
<b>4.9 Refractive errors</b>	37
4.9.1 Refractive errors by age	37
a. <i>Refractive errors in the right eye</i>	37
b. <i>Refractive errors in the left eye</i>	38
4.9.2 Refractive errors by gender	39
4.9.3 Types Refractive errors	39
a. <i>Types Refractive errors in the right eye</i>	39

b. <i>Types Refractive errors in the left eye</i>	40
4.9.4 Astigmatism among the sample population	41
a. <i>Astigmatism in the right eye</i>	41
b. <i>Astigmatism in the left eye</i>	41
4.9.5 Refractive errors among the sample population by gender	42
a. <i>Refractive errors in the right eye by gender</i>	42
b. <i>Refractive errors in the left eye by gender</i>	43
4.9.6. Axes of astigmatism	44
4.9.6.1 Axes of astigmatism by age	44
a. <i>Axes of astigmatism in the right eye</i>	44
b. <i>Axes of astigmatism in the left eye</i>	45
4.9.6.2 Axes of astigmatism by gender	45
a. <i>Axes of astigmatism in the right and left eye by gender</i>	45
<b>4.10 Causes of visual impairment among participants</b>	46
a. <i>Causes of visual impairment in the right eye</i>	46
b. <i>Causes of visual impairment in the left eye</i>	47
c. <i>Causes of visual impairment in both eyes</i>	47
4.10.1 Causes of visual impairment by age	48
a. <i>Causes of visual impairment in the right eye</i>	48
b. <i>Causes of visual impairment in the left eye</i>	49
c. <i>Causes of visual impairment in both eyes</i>	50
4.10.2 Causes of visual impairment by gender	50
a. <i>Causes of visual impairment in the right eye</i>	50
b. <i>Causes of visual impairment in the left eye</i>	51
c. <i>Causes of visual impairment in both eyes</i>	52
<b>4.11 Causes of low vision among participants</b>	53
a. <i>Causes of low vision in the right eye</i>	53
b. <i>Causes of low vision in the left eye</i>	54
c. <i>Causes of low vision in both eyes</i>	54
4.11.1 Causes of low vision by age	55
a. <i>Causes of low vision in the right eye</i>	55

b. <i>Causes of low vision in the left eye</i>	56
c. <i>Causes of low vision in both eyes</i>	56
4.11.2 Causes of low vision by gender	57
a. <i>Causes of low vision in the right eye</i>	57
b. <i>Causes of low vision in the left eye</i>	58
c. <i>Causes of low vision in both eyes</i>	59
<b>4.12 Causes of blindness among participants</b>	60
a. <i>Causes of blindness in the right eye</i>	60
b. <i>Causes of blindness in the left eye</i>	61
c. <i>Causes of blindness in both eyes</i>	62
4.12.1 Causes of blindness by age	62
a. <i>Causes of blindness in the right eye</i>	62
b. <i>Causes of blindness in the left eye</i>	63
c. <i>Causes of blindness in both eyes</i>	64
4.12.2 Causes of blindness by gender	64
a. <i>Causes of blindness in the right eye</i>	64
b. <i>Causes of blindness in the left eye</i>	65
c. <i>Causes of blindness in both eyes</i>	66
<b>4.13 Refractive status in relation to visual impairment</b>	67
4.13.1 Refractive status by age	67
a. <i>Refractive status in the right eye</i>	67
b. <i>Refractive status in the left eye</i>	68
4.13.2 Astigmatism and visual impairment	69
a. <i>Astigmatism in the right eye by age</i>	69
b. <i>Astigmatism in the left eye</i>	69
4.13.3 Refractive status by gender	70
a. <i>Refractive status by gender in the right eye</i>	70
b. <i>Refractive status by gender in the left eye</i>	71
<b>4.14 Visual impairment after optical correction</b>	71
4.14.1 Visual impairment after optical corrections by age	71
a. <i>Visual impairment in the right eye</i>	71

b. <i>Visual impairment in the left eye</i>	72
c. <i>Visual impairment in both eyes</i>	73
4.14.2 Causes of visual impairment after optical corrections	73
a. <i>Causes of visual impairment in the right eye</i>	73
b. <i>Causes of visual impairment in the left eye</i>	74
c. <i>Causes of visual impairment in both eyes</i>	75
4.14.3 Low vision after optical corrections	75
a. <i>Low vision in the right eye</i>	75
b. <i>Low vision in the left eye</i>	76
c. <i>Low vision in both eyes</i>	77
4.14.4 Causes of low vision after optical corrections	77
a. <i>Causes of low vision in the right eye</i>	77
b. <i>Causes of low vision in the left eye</i>	78
c. <i>Causes of low vision in both eyes</i>	79
4.14.5 Blindness based after optical corrections	79
a. <i>Blindness in the right eye</i>	79
b. <i>Blindness in the left eye</i>	80
c. <i>Blindness in both eyes</i>	81
4.14.6 Causes of blindness after optical corrections	81
a. <i>Causes of blindness in the right eye</i>	81
b. <i>Causes of blindness in the left eye</i>	82
c. <i>Causes of blindness in both eyes</i>	83
<b>CHAPTER 5</b>	83
<b>5. DISCUSSION</b>	83
<b>5.1 Classifications</b>	83
<b>5.2 Visual impairment</b>	84
5.2.1 Prevalence of visual impairment	84
5.2.2 Age and visual impairment	85
5.2.3 Gender and visual impairment	86
<b>5.3 Causes of visual impairment, low vision and blindness</b>	86



<b>5.4 Causes of visual impairment, low vision and blindness after optical corrections</b>	87
<b>5.5 Causes of visual impairment by age</b>	87
<b>5.6 Causes of visual impairment by gender</b>	89
<b>5.7 Prevalence of refractive errors</b>	89
5.7.1 Relationship between gender and age with refractive errors	92
<b>5.8 Visual impairment and uncorrected refractive errors</b>	92
<b>5.9. Limitations of this study</b>	93
<b>5.10. Conclusion</b>	93
<b>5.11 Recommendations</b>	94
<b>6. REFERENCES</b>	95

## **LIST OF APPENDICES**

<b>APPENDIX 1: Medunsa Research &amp; Ethics Committee Clearance Certificate</b>	104
<b>APPENDIX 2: DATA COLLECTION TOOL</b>	105
<b>APPENDIX 3 (a): Application for approval to conduct a study</b>	107
Department of Health: Limpopo Province	
<b>APPENDIX 3 (b): Approval to conduct a study</b>	108
Department of Health: Limpopo Province	
<b>APPENDIX 4 (a): Application for permission to collect data</b>	109
Department of Health: Mopani district	
<b>APPENDIX 4 (b): Permission to collect data (Department of Health: Mopani district)</b>	110
<b>APPENDIX 5 (a): Application for permission to collect data (Nkhensani Hospital)</b>	111
<b>Appendix 5 (b): Permission to conduct a study (Nkhensani Hospital)</b>	112
<b>Appendix 6 (a): English consent form</b>	113
<b>Appendix 6 (b): Xitsonga consent form</b>	114
<b>Appendix 6 (c): Sepedi consent form</b>	115

## LIST OF FIGURES

<b>Figure 4.1: Presenting visual acuities in the right eye</b>	15
<b>Figure 4.2: Presenting visual acuity ranges in the left eye</b>	16
<b>Figure 4.3: The presenting visual acuity ranges of both eyes</b>	17
<b>Figure 4.4: Visual acuity ranges in the right eye by gender</b>	20
<b>Figure 4.5: Visual acuity ranges in the left eye by gender</b>	21
<b>Figure 4.6: Visual acuity ranges by gender in both eyes</b>	22
<b>Figure 4.7: Visual impairment in the right eye by age</b>	23
<b>Figure 4.8: Visual impairment in the left eye by age</b>	23
<b>Figure 4.9: Visual impairment in both eyes by age</b>	24
<b>Figure 4.10: Visual impairment in the right eye by gender</b>	25
<b>Figure 4.11: Visual impairment in the left eye by gender</b>	25
<b>Figure 4.12: Visual impairment in both eyes by gender</b>	26
<b>Figure 4.13: Low vision in the right eye by age</b>	27
<b>Figure 4.14: Low vision in the left eye by age</b>	27
<b>Figure 4.15: Low vision in both eyes by age</b>	28
<b>Figure 4.16: Low vision in the right eye by gender</b>	29
<b>Figure 4.17: Low vision in the left eye by gender</b>	29
<b>Figure 4.18: Low vision in both eyes by gender</b>	30
<b>Figure 4.19: Blindness in the right eye by age</b>	31
<b>Figure 4.20: Blindness in the left eye by age</b>	31
<b>Figure 4.21: Blindness in both eyes by age</b>	32
<b>Figure 4.22: Blindness in the right eye by gender</b>	33
<b>Figure 4.23: Blindness in the left eye by gender</b>	33
<b>Figure 4.24: Blindness in both eyes by gender</b>	34
<b>Figure 4.25: Presenting eye anomalies in the right eye</b>	36
<b>Figure 4.26: Presenting eye anomalies in the left eye</b>	37
<b>Figure 4.27: Refractive errors in the right eye by age</b>	38
<b>Figure 4.28: Refractive errors in the left eye by age</b>	38
<b>Figure 4.29: Astigmatism in the right eye by age</b>	41

<b>Figure 4.30: Astigmatism in the right eye by age</b>	42
<b>Figure 4.31: Causes of visual impairment in the right eye</b>	46
<b>Figure 4.32: Causes of visual impairment in the left eye</b>	47
<b>Figure 4.33: Causes of visual impairment in both eyes</b>	48
<b>Figure 4.34: Causes of visual impairment in the right eye by gender</b>	51
<b>Figure 4.35: Causes of visual impairment in the left eye by gender</b>	52
<b>Figure 4.36: Causes of visual impairment in both eyes by gender</b>	53
<b>Figure 4.37: Causes of low vision based in the right eye</b>	53
<b>Figure 4.38: Causes of low vision in the left eye</b>	54
<b>Figure 4.39: Causes of low vision based in both eyes</b>	55
<b>Figure 4.40: Causes of low vision in the right eye by gender</b>	58
<b>Figure 4.41: Causes of low vision in the left eye by gender</b>	59
<b>Figure 4.42: Causes of low vision in both eyes by gender</b>	60
<b>Figure 4.43: Causes of blindness in the right eye</b>	61
<b>Figure 4.44: Causes of blindness in the left eye</b>	61
<b>Figure 4.45: Causes of blindness in both eyes</b>	62
<b>Figure 4.46: Causes of blindness in the right eye by gender</b>	65
<b>Figure 4.47: Causes of blindness in the left eye by gender</b>	66
<b>Figure 4.48: Causes of blindness in both eyes by gender</b>	67
<b>Figure 4.49: Astigmatism in the right eye by age</b>	69
<b>Figure 4.50: Astigmatism in the left eye by age</b>	70
<b>Figure 4.51: Visual impairment in the right eye after optical corrections</b>	72
<b>Figure 4.52: Visual impairment in the left eye after optical corrections</b>	72
<b>Figure 4.53: Visual impairment in both eyes after optical corrections</b>	73
<b>Figure 4.54: Causes of visual impairment in the right eye</b>	74
<b>Figure 4.55: Causes of visual impairment in the left eye</b>	74
<b>Figure 4.56: Causes of visual impairment in both eyes</b>	75
<b>Figure 4.57: Low vision in the right eye</b>	76
<b>Figure 4.58: Low vision in the left eye</b>	76
<b>Figure 4.59: Low vision in both eyes</b>	77
<b>Figure 4.60: Causes of low vision in the right eye</b>	78

<b>Figure 4.61: Causes of low vision in the left eye</b>	78
<b>Figure 4.62: Causes of low vision in both eyes</b>	79
<b>Figure 4.63: Blindness in the right eye</b>	80
<b>Figure 4.64: Blindness in the left eye</b>	80
<b>Figure 4.65: Blindness in both eyes</b>	81
<b>Figure 4.66: Causes of blindness in the right eye</b>	82
<b>Figure 4.67: Causes of blindness in the left eye</b>	82
<b>Figure 4.68: Causes of blindness in both eyes</b>	83

## LIST OF TABLES

<b>Table 3.1: Illustration of distribution of participants in each age strata</b>	10
<b>Table 3.2: Visual acuity ranges, categories and classification of visual impairment</b>	11
<b>Table 4.1: Illustrations of distribution of age and gender</b>	15
<b>Table 4.2: Presenting visual acuity in the right eye by age</b>	18
<b>Table 4.3: Presenting visual acuity in the left eye by age</b>	18
<b>Table 4.4: Presenting visual acuity in both eyes by age</b>	19
<b>Table 4.5: Refractive errors by gender in the right and left eye</b>	39
<b>Table 4.6: Refractive status in the right eye by age</b>	40
<b>Table 4.7: Refractive status in the left eye by age</b>	40
<b>Table 4.8: Refractive errors status by gender in the right eye</b>	43
<b>Table 4.9: Refractive status by gender in the left eye</b>	43
<b>Table 4.10: Axes of astigmatism by age range in the right eye</b>	44
<b>Table 4.11: Axes of astigmatism in the left eye by age</b>	45
<b>Table 4.12: Axes of astigmatism in the right and left eye</b>	46
<b>Table 4.13: Causes of visual impairment in the right eye by age</b>	49
<b>Table 4.14: Causes of visual impairment by age in the left eye</b>	49
<b>Table 4.15: Causes of visual impairment in both eyes by age</b>	50
<b>Table 4.16: Causes of low vision in the right eye by age</b>	55
<b>Table 4.17: Causes of low vision in the left eye by age</b>	56
<b>Table 4.18: Causes of low vision in both eyes by age</b>	57
<b>Table 4.19: Causes of blindness in the right eye</b>	63
<b>Table 4.20: Causes of blindness in the left eye by age</b>	63
<b>Table 4.21: Causes of blindness in both eyes by age</b>	64
<b>Table 4.22: Refractive status in the right eye by age among participants who were visually impaired due to uncorrected refractive errors</b>	68
<b>Table 4.23: Refractive status in the left eye by age among participants who were visually impaired due to uncorrected refractive errors</b>	68
<b>Table 4.24: Refractive status by gender in the right eye</b>	70
<b>Table 4.25: Refractive status by gender in the left eye</b>	71

## **CHAPTER 1**

### **1.1 Introduction**

Visual impairment is a measurable loss of functional capability relative to the normal variation in healthy eyes or a psychophysical measurement which is outside the normal range (Leat et al. 1999). According to the World Health Organization (WHO), visual impairment includes both low vision and blindness based on presenting visual acuity. Low vision includes moderate visual impairment and severe visual impairment based on presenting distance visual acuity (VA). Moderate visual impairment is defined as visual acuity of less than 6/18, but equal to or better than 6/60 based on the presenting distance VA (International Classification of Diseases ICD-10 visual impairment category 1); severe visual impairment is VA less than 6/60, but equal to or better than 3/60 (ICD-10 visual impairment category 2) based on presenting VA. Blindness is visual acuity of less than 3/60 based on presenting VA (ICD-10 categories 3, 4 and 5) (WHO 2008). These classifications of visual impairment by the WHO are commonly used in relevant situations in vision research.

The WHO shows that about 285 million people in the world are visually impaired from various causes and of these, 39 million people are blind and 246 million have low vision. The main cause of moderate and severe visual impairment is uncorrected refractive errors whereas cataracts remain the leading cause of blindness in middle- and low-income countries. Eighty percent (80%) of all visual impairment can be prevented or cured (WHO 2014). In 1999, the WHO and non-governmental organizations (NGOs) launched the Vision 2020: the Right to Sight, which is a global initiative for elimination of avoidable blindness by the year 2020. Cataract, trachoma, onchocerciasis, childhood blindness, refractive errors and low vision were identified as immediate priorities within the framework of Vision 2020. The choice of these anomalies was based on the burden of visual impairment they presented and the feasibility and affordability of intervention to prevent and treat them (WHO 2000). Most people with visual impairment are the elderly people aged 50 years and older and children below age 15 years old (WHO 2014).

Visual impairment from uncorrected refractive errors have immediate and long term consequences in children and adults, such as lost educational and employment opportunities, lost

economic gain for individuals, families and societies, and impaired quality of life as indicated by Resnikoff et al. (2008) and Smith et al. (2009). Taylor (2000) indicated that poor vision due to uncorrected or under-corrected myopia can lead to inability to read material written on the black-board and can have a serious impact on a child's participation and learning in class. This results in poor school performance which will adversely affect a child's education, occupation and socio-economic status of life.

Broman et al. (2002) found that visual impairment was associated with a decrease in quality of life in most domains among the Mexican-American persons aged 40 or more. Subjects with uncorrected refractive error, cataract, diabetic retinopathy, and glaucoma had associated decrements in quality of life. In a study to assess the impact of visual impairment on health-related quality of life (HRQOL) in an older population of the Blue Mountains region, west of Sydney in Australia and comparing it with the impact of major medical conditions; it was reported that uncorrectable visual impairment was associated with reduced functional status and well-being, with a magnitude comparable to major medical conditions (Chia et al. 2004). Coleman et al. (2006) showed that correction of refractive error among older people, improved the vision specific quality of life of community-dwelling older person of Los Angeles County, California.

In a national guideline for the prevention of blindness in South Africa, the Department of Health reported a 0.75% prevalence of blindness in the South African population. Eighty percent of blindness was reported avoidable and 80% of blind people live in the rural areas (Department of Health 2002). Also, the Department of Health (2004) reported a severe lack of epidemiological data on the magnitude of uncorrected visually disabling refractive errors in South Africa.

Considering the burden and impact of visually disabling anomalies within the society and economy, data on their prevalence among all age groups will be a valuable tool for appropriate planning and resources allocation. Currently, there is no information regarding the prevalence and causes of visual impairment in the Mopani district of Limpopo Province South Africa. The purpose of this study therefore, was to determine the prevalence and causes of visual impairment among patients seen at Nkhensani hospital eye clinic. Findings from this study will be useful,



from an informed position in making appropriate recommendations for appropriate prevention of visual impairment and management of prevailing visual disorders and disabilities.

## **1.2 Statement of the problem**

Existing eye clinic records at Nkhensani Hospital, Limpopo Province, South Africa show that most patients seen in the eye clinic present with distance visual acuity (VA) of less than 6/18 in either one or both eyes. In a few cases, the VA improves to 6/18 or better with pinhole measurement, optical compensation and eye medication or surgical treatment. This indicates that in such cases, the impairment can be corrected. In other cases however, the vision does not improve following these interventions. However, the prevalence and causes of visual impairment among these clinical cases have not been studied.

## **1.3 Purpose of the study**

The purpose of this study was to determine the prevalence and causes of visual impairment among patients attending the Nkhensani Hospital Eye clinic.

## **1.4 Objectives of the study**

- a) To determine the prevalence of visual impairment among patients seen at eye clinic;
- b) To identify eye conditions or diseases causing visual impairment.
- c) To investigate the relationship between demographic factors such as age and gender with visual impairment.

## **1.5 Research questions**

- a) What is the prevalence of visual impairment (VI) among eye clinic patients at Nkhensani hospital?
- b) What are the causes of VI among eye clinic patients at Nkhensani hospital?
- c) What is the relationship between demographic profiles such as age and gender with VI among patients attending the eye clinic at Nkhensani hospital?

## **CHAPTER 2**

### **2. LITERATURE REVIEW**

#### **2. 1 Introduction**

Several studies have been conducted to estimate the prevalence and causes of visual impairment internationally. Resnikoff et al. (2004) showed that the burden of visual impairment is not uniformly distributed throughout the world and the least developing countries carry the largest share of the condition. Visual impairment was found to be uniquely distributed across age groups, being more common in adults 50 years of age and older (Resnikoff et al. 2004). This is consistent with studies by Fotouhi et al. (2004) and Ramke et al. (2007) where increasing age was reported to be a risk factor for visual impairment.

The global leading causes of visual impairment according to the WHO (2014) are: uncorrected refractive errors (43.0%), cataract (33.0%) and glaucoma (2.0%). It has been reported that, in all age groups, females have a significantly higher risk of having visual impairment than males in every region of the world (WHO 2009). This is consistent with other studies by Zainal et al. (2002), Resnikoff et al. (2004), Shahriari et al. (2007) and Abdull et al. (2009).

## 2.2 International perspective

In a study to estimate the number of individuals aged 12 years or older who have impaired distance vision due to uncorrected refractive error in the United States of America (USA); Vitale et al. (2006) found that out of the 1,190 study participants who had visual impairment, 83.3% could achieve good visual acuity with correction (95% confidence interval CI, 80.9% - 85.8%). Extrapolating the findings to the general USA population, it was estimated that approximately 14 million individuals aged 12 years and older have visual impairment and of those, more than 11 million individuals could have their vision improved to 6/12 or better with refractive corrections.

In a population based data study to determine the prevalence and causes of visual impairment among children and adults aged 1 – 91 years old in Botucatu, Brazil, Schellini et al. (2009) reported a prevalence of presenting low vision and blindness of 5.2% (95% CI: 4.3 – 6.1) and 2.2% (95% CI: 1.6 – 2.8) of the population respectively. The main causes of visual impairment (low vision and blindness) were uncorrected refractive errors, cataract and retinal diseases.

In a study to investigate the prevalence and causes of vision impairment or blindness in older adults ( $\geq 50$  years) in a lower-middle income area of São Paulo in Brazil; Salomão et al. (2007) reported that the prevalence of visual impairment ( $< 6/19$  to  $\geq 6/60$  in the better eye) was 4.74% (95% CI: 3.97 to 5.53) and 2.00% (95% CI: 1.52 to 2.49) with best correction. The prevalence of subjects presenting with bilateral blindness ( $< 6/60$ ) was 1.51% (95% CI: 1.20 – 1.82) and 1.07% (95% CI: 0.79 – 1.35) with best correction. Retinal disorders (35.3%) and cataract (28.3%) were the most common causes of blindness. Cataract (33.2%), refractive errors (32.3%) and retinal disorders (20.3%) were the main causes of visual impairment (vision  $< 6/19$  to  $\geq 6/60$ ).

Ramke et al. (2007) found that among the people aged  $\geq 40$  years in Timor-Leste; the age, gender and domicile-adjusted prevalence of functional blindness (presenting vision worse than 6/60 in the better eye) was 7.4% (95% CI: 6.1 – 8.8) and for blindness at 3/60 was 4.1% (95% CI: 3.1 – 5.1). The adjusted prevalence of low vision ( $< 6/18$  – 6/60) was 17.7% (95% CI: 15.7 – 19.7). Cataract accounted for 72.9% of blindness and 17.8% of low vision. Uncorrected refractive errors were responsible for 81.3% of low vision.

In Papua New Guinea, the prevalence of vision impairment among the elderly ( $\geq 50$  years old); the presenting VA less than 6/18 in the better eye was 29.2% (95% CI: 27.6 – 35.1, Design Effect deff = 2.3). The prevalence of functional blindness (presenting visual acuity  $< 6/60$  in the better eye) was 8.9% (95% CI: 8.4 – 12.0, deff = 1.2) and for blindness (PVA  $< 3/60$  in the better eye) was 3.9% (95% CI: 3.4 – 6.1, deff = 1.0). Uncorrected refractive errors and cataract were the leading causes of vision impairment (Garap et al. 2006).

Among the Chinese adults ( $\geq 50$  years old) living in the urban area of Southern China, the prevalence of blindness and low vision based on the presenting visual acuity (PVA) was 0.6% (95% confidence interval CI: 0.2 to 1.0) and 10.1% (95% CI: 8.5 to 11.7), respectively. These values were reduced to 0.5% and 3.1% respectively when best corrected VA was considered. The main causes for blindness based on presenting VA were cataract (39.6%), glaucoma (11.0%) and myopic maculopathy (6.6%). Majority of low vision cases were caused by cataract (45.3%) and uncorrected refractive errors accounted for 43.9% (Haung et al. 2009). In an eye study conducted in Tehran (Iran) by Fotouhi et al. (2004); the prevalence of visual impairment on the basis of best corrected and presenting visual acuity were 1.39% (95% CI: 1.07 – 1.71) and 2.52% (95% CI: 2.07 – 2.97) respectively. The causes of visual impairment according to the best corrected vision were cataract (36.0%), macular degeneration (20.0%) and amblyopia (10.7%) respectively. However, according to presenting vision, uncorrected refractive errors were the most frequent primary cause (33.6%) and cataract (25.4%), macular degeneration (12.7%) and amblyopia (8.2%). Haq et al. (2009) reported that the prevalence of visual impairment, low vision and blindness among the adult population ( $\geq 20$  years) of Aligarh in India based on presenting visual acuity were 13.0%, 7.8% and 5.3% respectively. The main causes of visual impairment were cataract, refractive error, glaucoma and corneal opacities. Dineen et al. (2007) reported that in Pakistan among adults aged  $\geq 30$  years old, cataract was the most common cause of blindness (51.5%, based on PVA  $< 3/60$  in the better eye) followed by corneal opacity (11.8%), uncorrected aphakia (8.6%) and glaucoma (7.1%). Refractive error was the cause of 43% of moderately visually impaired ( $< 6/18$  to  $\geq 6/60$ ), followed by cataract (42%). Refractive error as a cause of severe visual impairment or blindness was significantly higher in rural area than in the urban (odds ratio OR: 3.5, 95% CI: 1.1 – 11.7).

In Nigeria, Abdull et al. (2009) found among adults aged  $\geq 40$  years that in 84% of people examined, blindness was avoidable. Uncorrected refractive errors were responsible for 57.1% of moderate ( $< 6/18 - 6/60$ ) visual impairment. Cataract (43%) was the commonest cause of blindness ( $< 3/60$ ). Prevalence of cataract-related blindness was 1.8% (95% CI: 1.57 – 2.05) and glaucoma-related blindness was 0.7% (95% CI: 0.55 – 0.88). Patrick-Ferife et al. (2005), found that among the adults in Ozoro, a rural community in Delta State of Nigeria, the prevalence of blindness (VA  $< 3/60$  in the better eye) for people of 40 years and above was 6.3% (95% CI: 4.6 – 8.0) and low vision (VA 6/24 to 3/60 in the better eye) was 25.2%. The estimated prevalence of bilateral blindness for all ages was 1.3% and low vision was 5.0%. The main causes of blindness and low vision were cataract, posterior segment diseases, glaucoma, uncorrected aphakia, and globe abnormalities. Refractive error was the second major cause of low vision accounting for 22.0%. The rate of blindness and low vision increased with increasing age.

### **2.3 National perspective**

In South Africa, the most common causes of visual impairment as reported by the Department of Health (2002) are cataract, glaucoma, diabetic retinopathy, childhood blindness, refractive errors and trachoma. The causes of childhood blindness are reported to be changing, where corneal diseases are gradually reducing while cataract and glaucoma are noted to be on the increase. Retinopathy of prematurity is reported to be emerging in the country's urban areas. The causes of low vision among adults are corneal scarring, macular degeneration, diabetic retinopathy, optic atrophy, retinal dystrophy and advanced glaucoma. Among children, the causes of low vision were found to be amblyopia, retinal dystrophies, aphakia, optic atrophy, albinism and macular dystrophies (Department of Health 2002). Oduntan (2001) reported albinism to be the major cause of low vision (based on best corrected visual acuity) among the South African children attending special education schools in the Northern Province (now Limpopo Province). Other causes included cataract, glaucoma and nystagmus.

In a refractive error and visual impairment study among school-aged children population (5 – 15 years old) in Durban, South Africa, Naidoo et al. (2003) found that the prevalence of

uncorrected, presenting and best-corrected visual acuity of 6/12 or worse in the better eye were 1.4%, 1.2% and 0.32%, respectively. Refractive error was the cause in 63.6% of the 191 eyes with reduced vision, amblyopia in 7.3%, retinal disorders in 9.9%, corneal opacities in 3.7%, other causes in 3.1% and unexplained causes in the remaining 12.0%.

Previous studies on the prevalence and causes of visual impairment in South Africa are few, and none has specifically been conducted in Mopani district of Limpopo Province. Data on this important health problem is important for eye care planning and for prevention of visual impairment in the country.

## **CHAPTER 3**

### **3. RESEARCH METHODOLOGY**

#### **3.1 Study site**

Nkhensani hospital is situated in the Greater Giyani sub–district municipality (about 4 km South East of Giyani town) in Section A of Giyani Township of the Mopani district, Limpopo Province, South Africa. This is a level 1 district hospital, which supports primary health care services and operates as gateway for referral to secondary (Level 2) and tertiary (Level 3) health care facilities. Most people utilising the Nkhensani hospital are from the rural areas of greater Giyani sub-district municipality. Eye care services at the hospital are provided by optometrists and ophthalmic nurses. Patients seen at the hospital include those that are self-referred, those referred by the outreach optometrists and ophthalmic nurses from district clinics serving under the Greater Giyani municipality (23 clinics and 2 health centres); mobile clinics and school learners from various primary schools within the district municipality. The learners are screened and referred by optometrists and primary health care nurses during the school health campaign project which is carried throughout the year. Other patients include those referred from other sources such as general doctors and other health practitioners from outside and in the hospital.

### **3.2. Research design, population and sampling**

This was a quantitative, cross sectional study design. Quantitative research is the conduct of investigation primarily using numerical methods. It is an approach in which the investigator primarily uses post positivist claims for developing knowledge (i.e. cause and effect thinking, reduction to specific variable and hypothesis and questions, use of measurements and observations, and the test of theories) employs strategies of enquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data (Cresswell 2003). Cross-sectional studies are studies aimed at determining the frequency (or level) of a particular attribute, such as a specific exposure, disease or any other health-related event, in a defined population at a particular point in time. Exposure and outcome are determined simultaneously for each subject. Cross sectional studies are used to determine prevalence and infer causation (Mann 2003). The study population was the patients attending the Nkhensani hospital eye clinic for eye care services during August 2012 till March 2013 study period and were estimated to be 3420 patients based on previous records. A total of 400 participants were included in the study based on the Krejcie and Morgan's criteria for determining sample size for research activities (Krejcie and Morgan 1970). Stratified sampling and convenience sampling techniques were used to select participants. A stratified sampling involves dividing the population into distinct subgroups according to some important characteristics, such as sex, age or socioeconomic status (Olsen and St.George 2004). Participants were stratified by age as shown in Table 3.1 below in order to enhance representativeness and to determine the prevalence and causes of visual impairment among different age groups. Convenience sampling involves drawing samples that are both easily accessible and willing to participate in a study (Teddlie and Yu 2007). All patients seen by the researcher during the study period and were willing to participate in the study were selected until a desired number of participants in each age stratum has been reached.

**Table 3.1: Illustration of distribution of participants in each age strata**

Age range (years)	<i>N</i>
6 – 18	100
19 – 35	100
36 – 59	100
≥ 60	100
<b>Total (<i>N</i>)</b>	<b>400</b>

*\*N (number of participants)*

### **3.3. Inclusion and exclusion criteria**

All patients who were 6 years and older presenting at eye clinic for eye care services during the study period were included in the study until the desired number of participants in each age stratum has being reached. This age reference criteria is because a person aged 6 years and older is presumed to be school going and/ or understand the instruction given during the examination procedures. All legible participants coming for reviews and follow-ups were excluded from the study to avoid repetition.

### **3.4. Data collection**

A logMAR illiterate E acuity chart was used to measure presenting (habitual), pinhole and best corrected visual acuity. Where a participant could not see the largest acuity letters at the standard viewing distance, the distance was halved to measure the visual acuity. The visual acuity values were then converted to the standard distance equivalent. Pinhole disc was used to detect if reduced visual acuity (VA) was due to refractive error or eye disease/ anomaly. Where reduced VA was due to refractive error, ophthalmic lenses were used to compensate for the refractive error using subjective refraction (lenses providing the best vision were determined by the choice made by the patient, when differing lenses were placed in front of their eyes) was performed and best corrected VA was measured and recorded. Ophthalmoscope was used to examine the external and internal structures of the eye. The patient was comfortably seated in a dimly lit



room and instructed to look straight ahead focusing on a distant letter. Light from the ophthalmoscope was directed at the pupil at an angle of 15-20 degrees temporally from the patient's line of sight (visual axis). Starting at a distance of approximately 30cm from the patient's eye, the distance between the instrument and the eye was reduced slowly until the target structures are clearly visible. Tonometer was used to measure the intraocular pressure. Confrontation test was performed to measure the extent of visual fields. Those with eye diseases were referred to the ophthalmic nurse and/or ophthalmologist for further management. Where necessary, the diagnosis of the ophthalmologist was used to confirm ocular diagnosis made by the researcher. Data was recorded on a designed data collection tool (Appendix 2) which was approved by the University of Limpopo Research Statistician. The original data collection tool was later amended to include cases of both eyes as approved by the statistician. Table 2 below shows the categories and classification of the visual acuity (VA) ranges based on presenting visual acuity, categories and classification of visual impairment (VI) as adapted from WHO (2008). Also the researcher adapted information from a chart designed with the conventions from Snellen acuity to logMAR acuity (Holladay 1997) and Johnson (2003) to include logMAR equivalent cases of no light perception. In this study, visual impairment was defined as visual acuity range of 0.52 – 4.0 logMAR (Snellen equivalent of < 6/18 – no light perception). Visual acuity of 0.52 – 1.30 logMAR (Snellen equivalent < 6/18 – 3/60) was classified as low vision; 1.32 – 4.0 logMAR (Snellen equivalent < 3/60 – No light perception) was classified as blindness. Visual impairment included moderate visual impairment; severe visual impairment and blindness.

**Table 3.2: Visual acuity ranges, categories and classification of visual impairment**

Snellen VA	LogMAR VA	Category	Classification
≥ 6/18	0.0 – 0.50	0	Mild or no VI
< 6/18 – 6/60	0.52 – 1.0	1	Moderate VI
< 6/60 – 3/60 (6/120)	1.02 – 1.30	2	Severe VI
< 3/60 – 1/60	1.32 – 1.80	3	Blindness
< 1/60 – Light perception	1.82 – 3.0	4	Blindness
No light perception	4.0	5	Blindness

*VA = visual acuity, VI = visual impairment*

### **3.5. Data analysis**

Data was analyzed using the descriptive statistics of the statistical package for social sciences (SPSS) version 21 and 22 to establish the ranges, means, standard deviations, frequencies and correlations. Chi-square and Pearson's R correlation tests were used to investigate relationships between age and gender with visual impairment and also the relationship between refractive error spherical equivalent powers of the right and left eye. The statistician was consulted before (to discuss the measurable variables); at the beginning of data collection for amendment of the data collection tool and after data collection for data coding and analysis.

### **3.6. Reliability**

Reliability is the degree of consistency or dependability, with which an instrument yields a certain result when an entity being measured has not changed. This refers to the accuracy and consistency of information obtained in a study Roberts and Priest (2006) and McHugh (2012). Inter-rater reliability refers to the extent of agreement among data collectors i.e. reliability across multiple data collectors. In this study, all data were collected by the researcher alone, therefore there was no inter-rater influence. Intra-rater reliability refers to reliability of a single data collector i.e. and presenting data with exactly the same situation and phenomenon; interpreting data the same way, and recording the same value for the variable each time these data are collected (McHugh 2012). The same equipment were used for data collection for all participants. All data were collected in same consulting room and all clinical procedures were carefully followed to ensure data accuracy and recording, therefore there was no negative intra-rater influence in data collection and presentation.

### **3.7. Validity**

Validity is the extent to which the instrument measures what it is supposed to measure as defined by Twycross and Shields (2004) and Golafshani 2003. To ensure validity in this study, standard

optometric equipment which are used in clinical practice were used. A logMAR illiterate E acuity chart was used to measure the presenting, pinhole and best corrected visual acuity at 4 metre distance. Magnitude of refractive errors were measured and compensated for using ophthalmic lenses (trial lenses). Direct ophthalmoscope was used for external and internal eye examination to detect and diagnose eye diseases/ anomalies. Appropriate illumination levels were used during eye examination, .i.e. presenting, pinhole and best corrected visual acuity were measured in an illuminated consulting room whereas for external and internal eye examination the luminance was reduced to dim illuminated by switching off the consulting room light and adjusting the lamp stand. Data was recorded in a data collection tool (Appendix 2). Subsequently, the vision status was determined and the prevalence and causes of visual impairment established.

### **3.8. Ethical consideration**

Approval to conduct the study was obtained from University of Limpopo Ethics Committee (Appendix 1). Approval to use Nkhensani hospital facility as a base for data collection was sought (Appendix 3.a) and granted (Appendix 3.b) from Limpopo provincial department of health. Permission to collect data at Nkhensani hospital was sought and granted by Mopani district health (Appendix 4.a and 4.b respectively) and the Chief Executive officer of Nkhensani Hospital (Appendix 5.a and 5.b respectively). Informed consent means that participants have adequate information regarding the study or research, are capable of comprehending the information, and have the power of free of choice enabling them to consent to or decline participation voluntarily. Anonymity means namelessness and occurs when even the researcher cannot link participants to their data, i.e. there is no identifying information linked to participants. Confidentiality means that any information participants provide will not be publicly reported in a manner that identifies them and will not be made accessible to others unless given explicit permission to share it. This refers to the researcher's ability to prevent all data gathered during the study from being divulged or made available to any other person (Shahnazarian et.al. 2014). Participants were informed about the purpose of the study, how the study will affect them, risks and benefits and their right to decline from participation if they chose to do so. They were

informed that declining will not prejudice them receiving eye care services and other health care services. The researcher also explained to the participants what was expected to them in terms of participation. All participants were requested to sign a consent form of their preferred language {Appendix 6.a (English), 6.b (Xitsonga) and 6.c (Sepedi)} in order to participate in the study. All those who were invited to participate in the study signed the consent form; hence none was excluded based on the refusal to sign the form. Anonymity was ensured by providing individual codes to all participants and they were requested not to tell their names before and during the conduction of the study. To maintain confidentiality of data collected, the research data record sheets are kept in a secured locker and will be shredded after 5 years. Electronic data are kept securely; password protected in a computer and will be deleted after 5 years.

### **3.9. Significance of the study**

Visual impairment is an important public health issue as it impairs the quality of life and adds a socioeconomic burden on society. The findings of this study will assist the Department of Health in efficient eye care planning, resources allocation and effective management of avoidable visual disabling anomalies in the hospital and greater Giyani district municipality. This study will also serve as baseline information for similar studies within the province and elsewhere in the future.

## **CHAPTER 4**

### **4. RESULTS**

#### **4.1 Demographic profiles**

The total participants included in the study were 400 patients attending the Nkhensani hospital eye clinic, in Giyani for eye care services during the period of the study. Their ages ranged from 6 to 92 years with mean of  $39.5 \pm 23.5$  years. They included 161 (40.3%) males and 239 (59.8%) females. The age ranges and gender distributions are shown in Table 3 below.

**Table 4.1: Illustrations of distribution of age and gender**

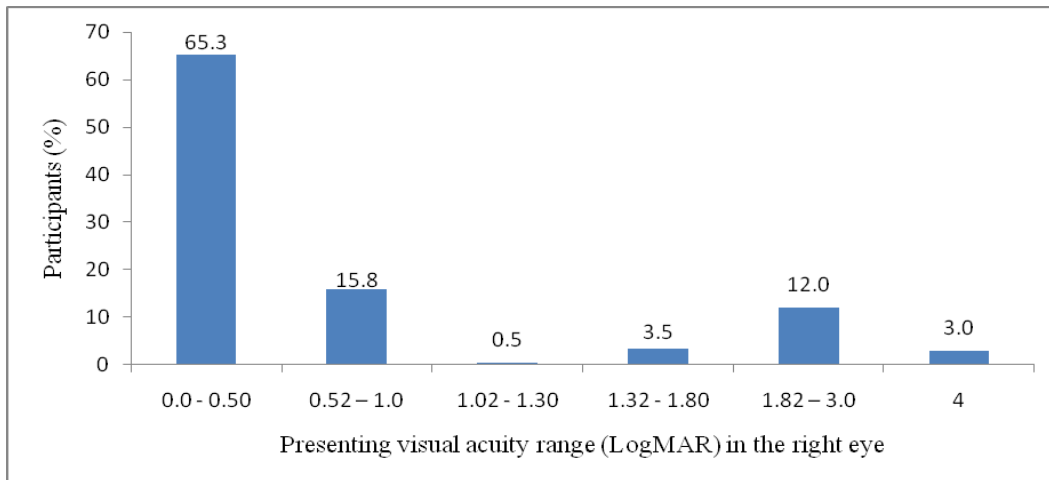
Gender	Age range (years), <i>N</i> (Percentages)				<i>N</i> (%)
	6 – 18	19 – 35	36 – 59	≥ 60	
Male	64 (16.0)	43 (10.8)	26 (6.5)	28 (7.0)	161 (40.3)
Female	36 (9.0)	57 (14.3)	74 (18.5)	72 (18.0)	239 (59.8)
<i>N</i> (%)	100 (25.0)	100 (25.0)	100 (25.0)	100 (25.0)	400 (100)

*N* = 400

## 4.2 Presenting visual acuities

### 4.2.1 Presenting visual acuities in the right eye

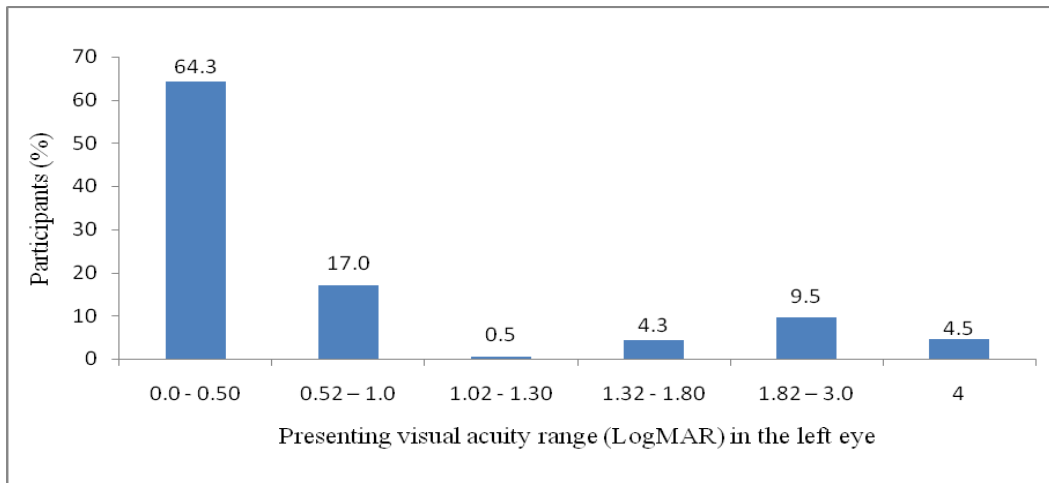
Most participants (65.3%) presented with visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) with the least participants (0.5%) presenting with visual acuity range of 1.02 – 1.30 logMAR. (< 6/60 – 3/60 Snellen equivalent), *N* = 400. The presenting visual acuities ranged from 0.0 – 4.0 logMAR (6/6 to no light perception Snellen equivalent) with mean of 0.71 ± 1.05 logMAR. In Figure 4.1 below, 0.0 – 0.50 logMAR represents mild or no visual impairment (VI); 0.52 – 1.0 logMAR represents moderate VI; 1.02 – 1.30 logMAR represents severe VI; 1.32 – 1.80 logMAR represents blindness; 1.82 – 3.0 logMAR represents blindness and 4.0 logMAR represents blindness. The distributions of presenting visual acuity ranges of the right eye are shown in Figure 4.1 below.



**Figure 4.1: Presenting visual acuities in the right eye**

#### 4.2.2 Presenting visual acuities in the left eye

Most participants (64.3%) presented with visual acuity between 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) with the least participants (0.5%) presenting with visual acuity range of 1.02 – 1.30 logMAR (< 6/60 – 3/60 Snellen equivalent),  $N=400$ . The presenting visual acuities of the left eye ranged from 0.0 – 4.0 logMAR (6/6 to no light perception Snellen equivalent) with mean of  $0.74 \pm 1.06$  logMAR. In Figure 4.2 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of presenting visual acuity ranges of the left eye are shown in Figure 4.2 below.

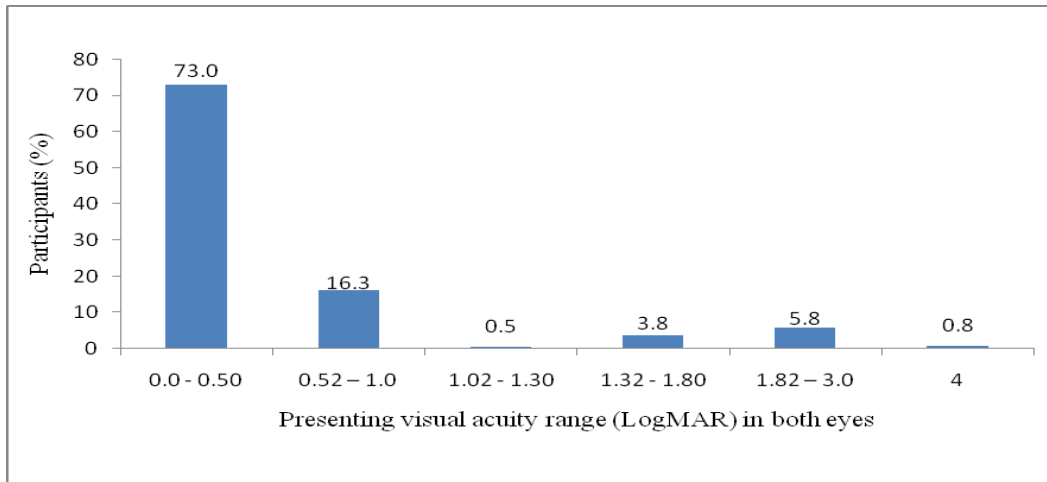


**Figure 4.2: Presenting visual acuity ranges in the left eye**

#### 4.2.3 Presenting visual acuities in both eyes

Most participants (73.0%) presented with bilateral visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent),  $N=400$ . The presenting visual acuities of both eyes ranged from 0.0 – 4.0 logMAR (6/6 to no light perception) with mean of  $0.46 \pm 0.76$  logMAR. In Figure 4.3 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness.

4 represents blindness. The distributions of presenting visual acuity ranges of both eyes are shown in Figure 4.3 below.



**Figure 4.3: The presenting visual acuity ranges of both eyes**

### 4.3 Presenting visual acuities by age

#### 4.3.1 Presenting visual acuities in the right eye

There was higher occurrence of visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) among participants aged 6 – 18 years (22.0%). Also, participants aged 19 – 35 years presented with highest visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) accounting for 19.5%. Most participants aged 36 – 59 years presented with visual acuity range of 0.0 – 0.50 logMAR acuity (6/6 – 6/18 Snellen equivalent) accounting for 15.0%. Participants aged 60 years and older had higher occurrence of visual acuity range of 1.82 – 3.0 logMAR (< 1/60 – light perception Snellen equivalent) than all other age ranges accounting for 6.8%. In Table 4.2 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. Illustrations of distribution of presenting visual acuity by age are shown in Table 4.2 below.

**Table 4.2: Presenting visual acuity in the right eye by age**

Ages (years)	Mild/ no VI	Low vision			Blindness			Total (%)
	Categ. 0	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5		
	0.0 – 0.50	0.52 – 1.0	1.02 – 1.30	1.32 – 1.80	1.82 – 3.0	4.0		
6 – 18	88 (22.0)	6 (1.5)	1 (0.3)	1 (0.3)	4 (1.0)	0 (0.0)	100 (25.0)	
19 – 35	78 (19.5)	11 (2.8)	0 (0.0)	1 (0.3)	6 (1.5)	4 (1.0)	100 (25.0)	
36 – 59	60 (15.0)	17 (4.3)	0 (0.0)	6 (1.5)	11 (2.8)	6 (1.5)	100 (25.0)	
≥ 60	35 (8.8)	29 (7.3)	1 (0.3)	6 (1.5)	27 (6.8)	2 (0.5)	100 (25.0)	
<i>N</i> (%)	261 (65.3)	63 (15.8)	2 (0.5)	14 (3.5)	48 (12.0)	12 (3.0)	400 (100.0)	

*N* = 400

Categ. = category

#### 4.3.2 Presenting visual acuities in the left eye

There was higher occurrence of visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) among participants aged 6 – 18 years accounting for 20.8% with least being among those aged 60 years and older accounting for 9.3%. Also, participants aged 19 – 35 years and 36 – 59 years presented with high visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) accounting for 18.8% and 15.5% respectively. Participants aged 60 years and older had higher (4.3%) occurrence of visual acuity range of 1.82 – 3.0 logMAR (< 1/60 to light perception) than all other age ranges. In Table 4.3 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of visual acuity ranges of the left eye by age are shown in Table 4.3 below.

**Table 4.3: Presenting visual acuity in the left eye by age**

Ages (years)	Mild/ no VI	Low vision			Blindness			Total (%)
	Categ. 0	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5		
	0.0 – 0.50	0.52 – 1.0	1.02 – 1.30	1.32 – 1.80	1.82 – 3.0	4.0		
6 – 18	83 (20.8)	7 (1.8)	1 (0.3)	3 (0.8)	6 (1.5)	0 (0.0)	100 (25.0)	
19 – 35	75 (18.8)	10 (2.5)	0 (0.0)	3 (0.8)	5 (1.3)	7 (1.8)	100 (25.0)	
36 – 59	62 (15.5)	20 (5.0)	0 (0.0)	4 (1.0)	10 (2.5)	4 (1.0)	100 (25.0)	
≥ 60	37 (9.3)	31 (7.8)	1 (0.3)	7 (1.8)	17 (4.3)	7 (1.8)	100 (25.0)	
<i>N</i> (%)	257 (64.3)	68 (17.0)	2 (0.5)	17 (4.3)	38 (9.5)	18 (4.5)	400 (100.0)	

*N* = 400

Categ. = category



### 4.3.3 Presenting visual acuities in both eyes

There was higher occurrence of visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) among participants aged 6 – 18 years, 19 – 35 years and 36 – 59 years accounting for 22.5%, 20.8% and 18.0% respectively with least being among those aged  $\geq 60$  years accounting for 11.8%. Participants aged 60 years and older had higher occurrence of visual acuity range of 1.82 – 3.0 logMAR (<1/60 to light perception) accounting for 3.3% than all other age ranges. In Table 4.4 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of visual acuity ranges in both eyes by age are shown in Table 4.4 below.

**Table 4.4: Presenting visual acuity in both eyes by age**

Ages (years)	Mild/ no VI	Low vision		Blindness			Total (%)
	Categ. 0	Categ. 1	Categ. 2	Categ. 3	Categ. 4	Categ. 5	
	0.0 – 0.50	0.52 – 1.0	1.02 – 1.30	1.32 – 1.80	1.82 – 3.0	4.0	
6 – 18	90 (22.5)	6 (1.5)	1 (0.3)	1 (0.3)	2 (0.5)	0 (0.0)	100 (25.0)
19 – 35	83 (20.8)	10 (2.5)	0 (0.0)	2 (0.5)	3 (0.8)	2 (0.5)	100 (25.0)
36 – 59	72 (18.0)	17 (4.3)	1 (0.3)	4 (1.0)	5 (1.3)	1 (0.3)	100 (25.0)
$\geq 60$	47 (11.8)	32 (8.0)	0 (0.0)	8 (2.0)	13 (3.3)	0 (0.0)	100 (25.0)
<i>N</i> (%)	292 (73.0)	65 (16.3)	2 (0.5)	15 (3.8)	23 (5.8)	3 (0.8)	400 (100.0)

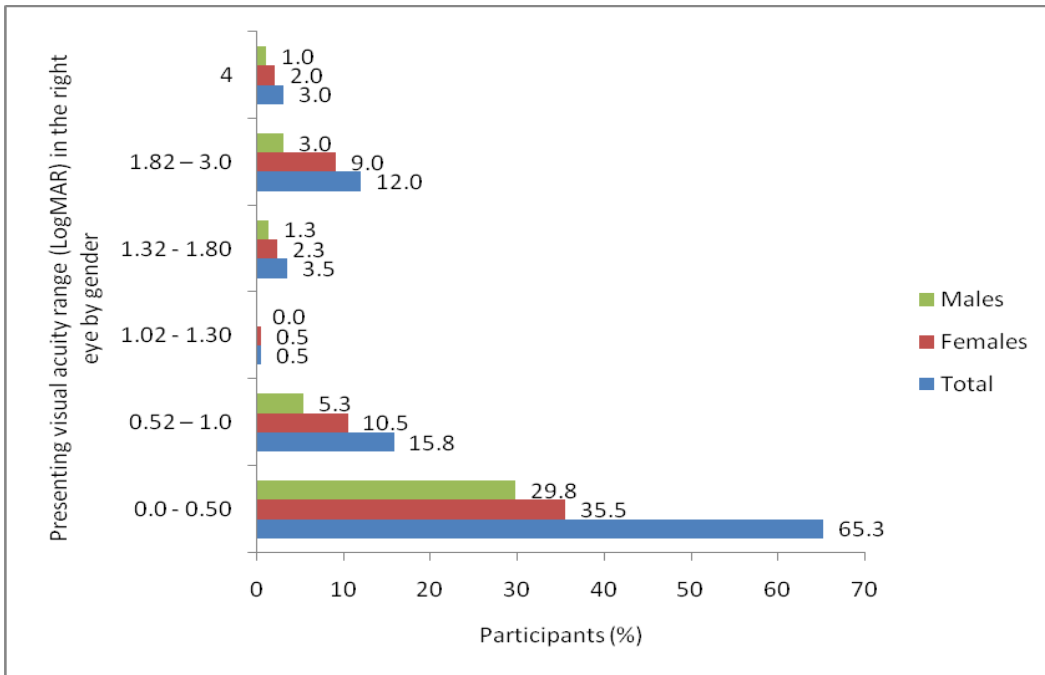
*N* = 400

Categ. = category

## 4.4 Presenting visual acuities by gender

### 4.4.1 Presenting visual acuities in the right eye

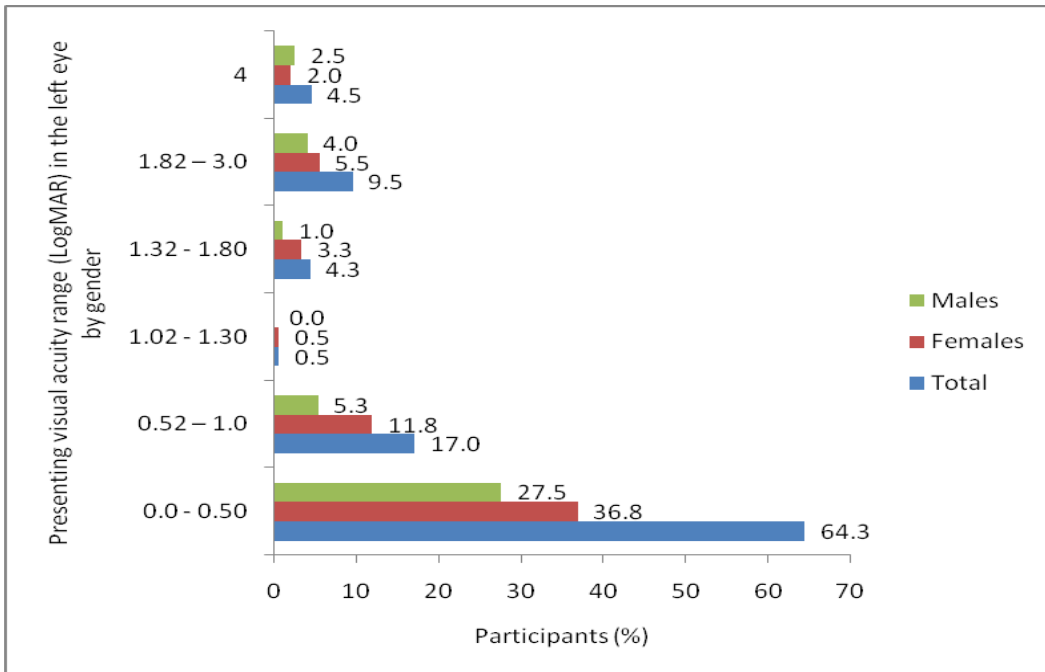
Females had higher occurrence (*N* = 400) of presenting visual acuity range of 0.0 - 0.50 logMAR (6/6 – 6/18) accounting for 35.5% than males (29.8%). The most common visual impairment category was moderate visual impairment (0.52 – 1.0 logMAR acuity) accounting for 10.5% among females and 5.3% among males. In Figure 4.4 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of visual acuity ranges of the right eye by gender are shown in Figure 4.4 below.



**Figure 4.4: Visual acuity ranges in the right eye by gender**

#### 4.4.2 Presenting visual acuities in the left eye

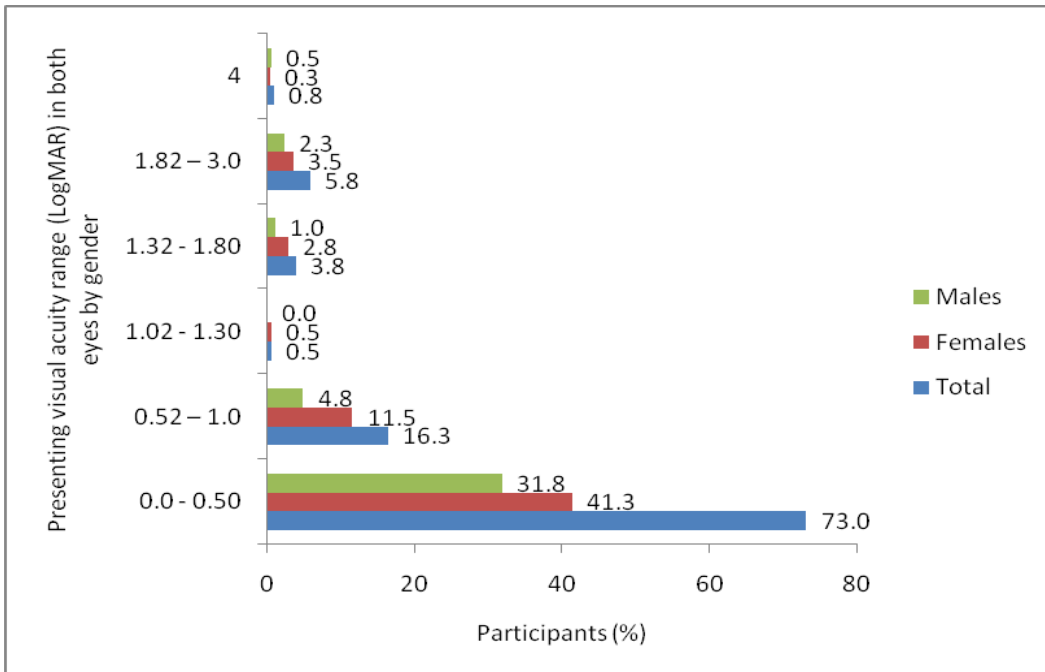
Females ( $N=400$ ) had higher occurrence of presenting visual acuity range of 0.0 – 0.50 logMAR (6/6 – 6/18 Snellen equivalent) accounting for 36.8% than males (27.5%). However, males (2.5%) had high occurrence of visual acuity of 4.0 logMAR (equivalent to no light perception) than females (2.0%). The most common visual impairment category was moderate visual impairment (0.52 – 1.0 logMAR acuity) accounting for 11.8% among females and 5.3% among males. In Figure 4.5 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of visual acuity ranges of the left eye by gender are shown in Figure 4.5 below.



**Figure 4.5: Visual acuity ranges in the left eye by gender**

#### 4.4.3 Presenting visual acuities in both eyes

Females had higher occurrence of presenting visual acuity range of 0.0 – 0.5 logMAR (6/6 – 6/18 Snellen equivalent) accounting for 41.3% than males (31.8%). There was high occurrence of males (0.5%) with visual acuity of 4.0 logMAR (equivalent to no light perception) than females (0.3%). Majority of both males and females presented with visual acuity range of 0.0 – 0.50 logMAR acuity (6/6 – 6/18 Snellen equivalent). Majority of both females and males presented with visual acuity range of 0.0 – 0.50 logMAR acuity (mild or no visual impairment). The most common presenting visual impairment category was moderate visual impairment (0.52 – 1.0 logMAR acuity) accounting for 11.5% among the females and 4.8% among the male participants. In Figure 4.6 below, 0.0 – 0.50 represents mild or no visual impairment (VI); 0.52 – 1.0 represents moderate VI; 1.02 – 1.30 represents severe VI; 1.32 – 1.80 represents blindness; 1.82 – 3.0 represents blindness and 4 represents blindness. The distributions of visual acuity ranges in both eyes by gender are shown in Figure 4.6 below.



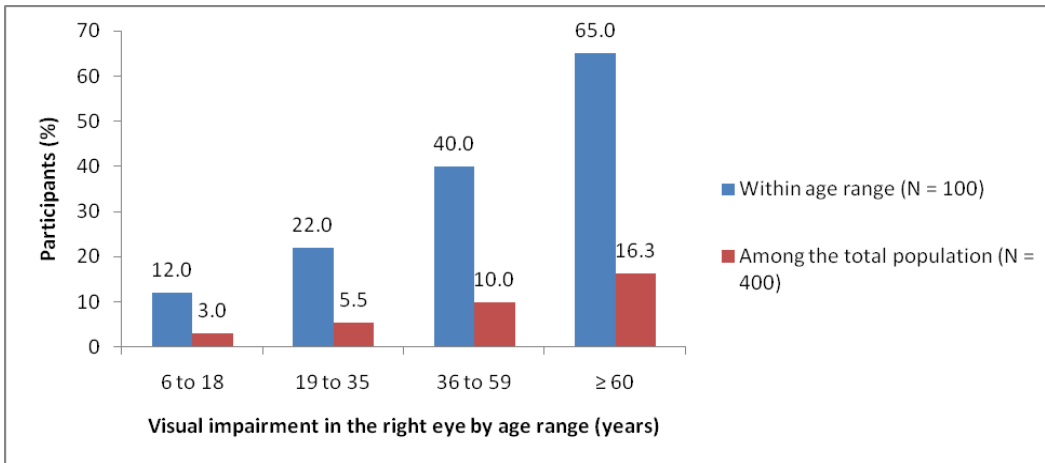
**Figure 4.6: Visual acuity ranges by gender in both eyes**

#### 4.5 Visual impairment based on presenting visual acuity

##### 4.5.1 Visual impairment by age

###### a. *Visual impairment in the right eye*

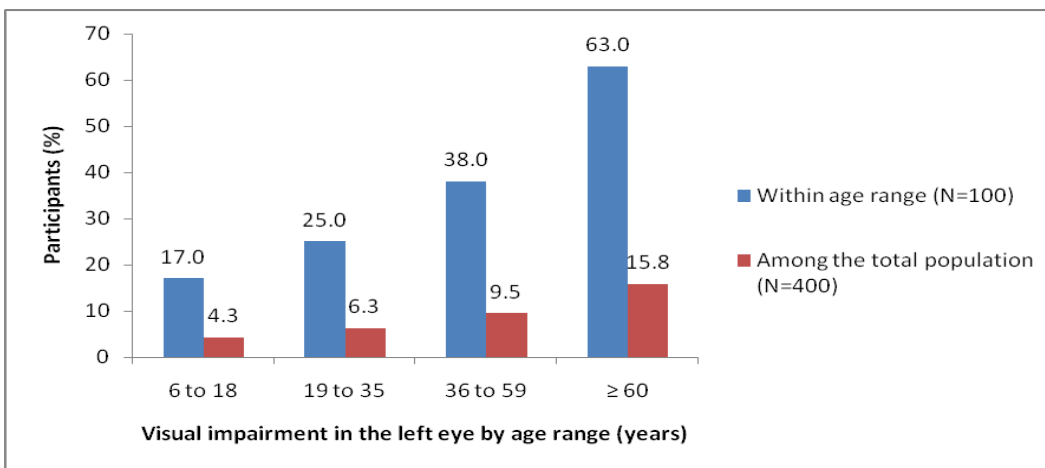
The percentage occurrence of visual impairment in the total population ( $N = 400$ ) in the right eye was 34.8%, being highest (16.3%) among those  $\geq 60$  years and older and lowest (3.0%) among those 6 – 18 years old (Figure 4.7). The prevalence was highest (65.0%) among those  $\geq 60$  years and older and lowest (12.0%) among those 6 – 18 years old ( $N=100$ ). There was a significant association between age and visual impairment in the right eye ( $\text{Chi} = 71.6$ ;  $\text{df} = 3$ ;  $p = 0.00$ ). The ages of the participants with visual impairment ranged from 6 – 92 years with mean of  $53.92 \pm 22.5$  years. The mean value for the visual acuity of the right eye among those who were visually impaired was  $1.81 \pm 1.11$  logMAR. The distributions of visual impairment in the right eye in relation to age ranges are shown in Figure 4.7 below.



**Figure 4.7: Visual impairment in the right eye by age**

b. *Visual impairment in the left eye*

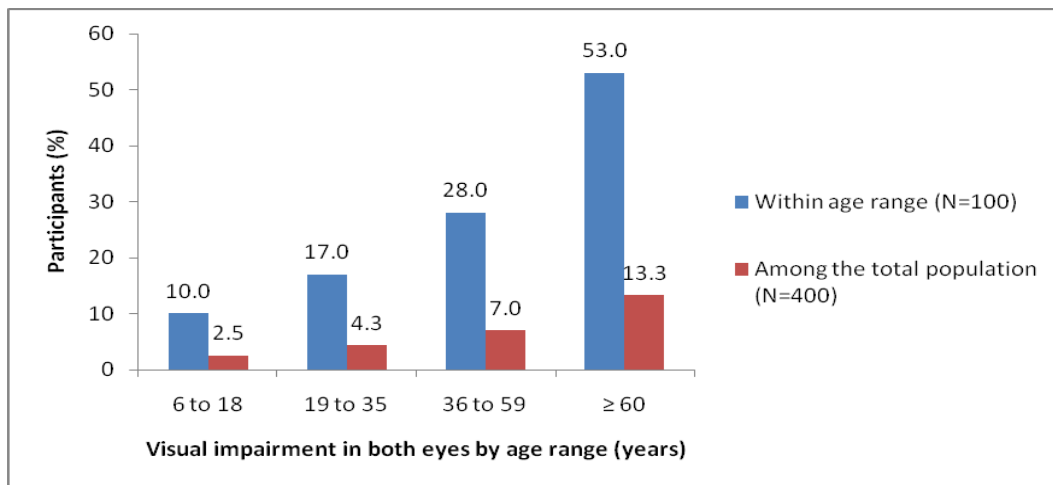
The percentage occurrence of visual impairment in the total population ( $N=400$ ) in the left eye was 35.8% and was highest (15.8%) among those  $\geq 60$  years and lowest (4.3%) among those 6 – 18 years old (see Figure 4.8 below). The prevalence was highest (63.0%) among those  $\geq 60$  years and lowest (17.0%) among those 6 – 18 years old ( $N=100$ ). There was a significant association between age and visual impairment in the left eye ( $\text{Chi} = 52.9$ ;  $\text{df} = 3$ ;  $p = 0.00$ ). The ages of the participants with visual impairment in the left eye ranged from 6 – 92 years with mean of  $52.17 \pm 23.58$  years. The mean value for the visual acuity of the left eyes among those who were visually impaired was  $1.81 \pm 1.16$  logMAR. The distributions of visual impairment in the left eyes in relation to age are shown in Figure 4.8 below.



**Figure 4.8: Visual impairment in the left eye by age**

c. *Visual impairment in both eyes*

The percentage occurrence of visual impairment in the total population ( $N=400$ ) in both eyes was 27.0% and was highest (13.3%) among those  $\geq 60$  years and lowest (2.5%) among those 6 – 18 years old (see Figure 4.9 below). The prevalence in both eyes was highest (53.0%) among those  $\geq 60$  years and was lowest (10.0%) among those 6 – 18 years old ( $N=100$ ). There was a significant association between age and visual impairment of both eyes ( $\text{Chi} = 54.1$ ;  $\text{df} = 3$ ;  $p = 0.00$ ). The ages of the participants with visual impairment in both eyes ranged from 6 – 92 years with mean of  $54.81 \pm 23.84$  years. The mean value for the visual acuity of both eyes was  $1.41 \pm 1.80$  logMAR. The distributions of visual impairment in both eyes in relation to age are shown in Figure 4.9 below.



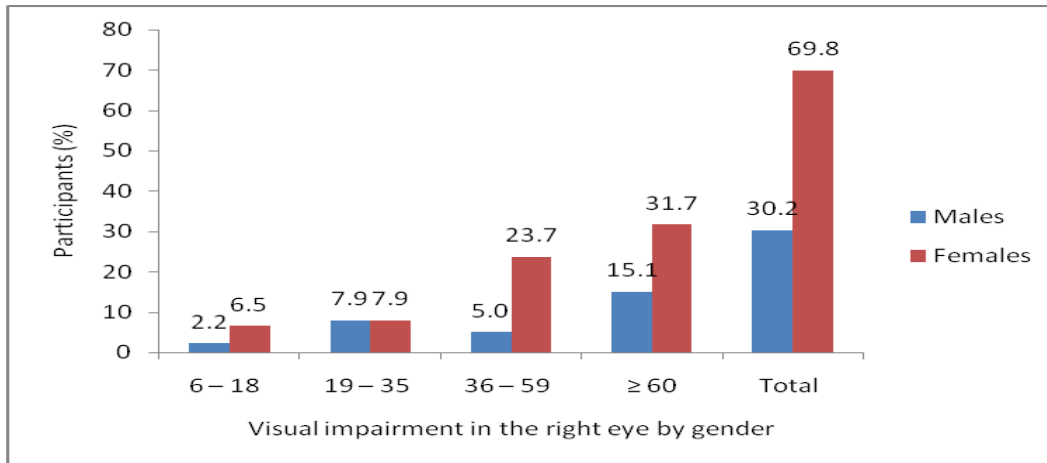
**Figure 4.9: Visual impairment in both eyes by age**

4.5.2 Visual impairment by gender

a. *Visual impairment in the right eye*

Females ( $N = 239$ ) had higher prevalence of visual impairment in the right eye (40.6%) than males ( $N = 161$ ) accounting for 26.1% and among the total study sample ( $N = 400$ ), females had higher occurrence (24.3%) of visual impairment than males (10.5%) and the occurrence increased with increasing age. There was a significant association between gender and visual

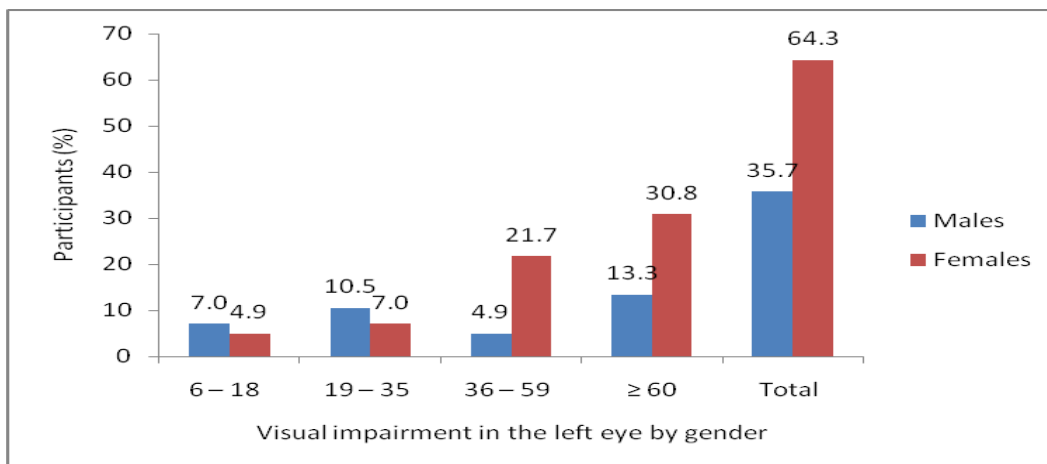
impairment of the right eye ( $\text{Chi} = 8.9$ ;  $\text{df} = 1$ ;  $p = 0.003$ ). The distribution of visual impairment in the right eye by gender is shown in Figure 4.10 below.



**Figure 4.10: Visual impairment in the right eye by gender**

b. *Visual impairment in the left eye*

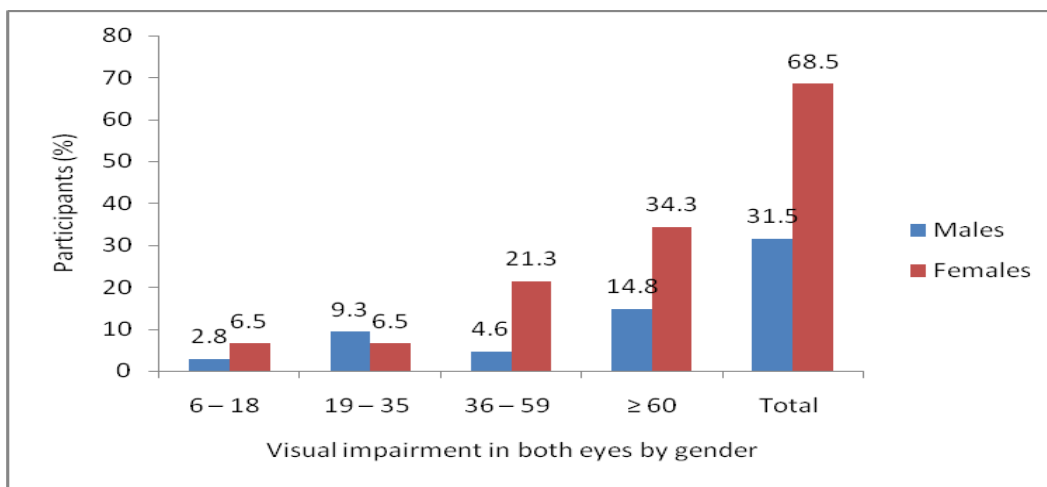
Females ( $N = 239$ ) had higher prevalence of visual impairment in the left eye (38.5%) than males ( $N = 161$ ) accounting for 31.7% and among the total study sample ( $N = 400$ ), females had higher occurrence (23.0%) of visual impairment than males (12.8%) and the occurrence increased with increasing age. There was no association between gender and visual impairment of the left eye ( $\text{Chi} = 1.9$ ;  $\text{df} = 1$ ;  $p = 0.163$ ). The distribution of visual impairment in the left eye by gender is shown in Figure 4.11 below.



**Figure 4.11: Visual impairment in the left eye by gender**

c. *Visual impairment in both eyes*

Females ( $N = 239$ ) had higher prevalence of visual impairment in both eyes (31.0%) than males ( $N = 161$ ) accounting for 21.1% and among the total study sample ( $N = 400$ ), females had higher occurrence (18.5%) of visual impairment than males (8.5%) and the occurrence increased with increasing age. There was a significant association between gender and visual impairment of both eyes ( $\text{Chi} = 4.7$ ;  $\text{df} = 1$ ;  $p = 0.03$ ). The distribution of bilateral visual impairment by gender is shown in Figure 4.12 below.



**Figure 4.12: Visual impairment in both eyes by gender**

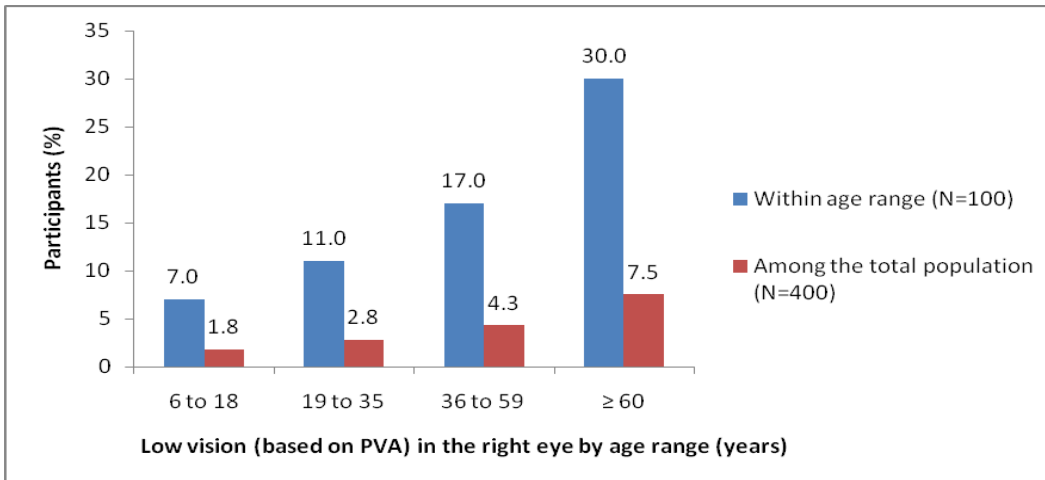
#### **4.6 Low vision based on presenting visual acuity**

##### 4.6.1 Low vision by age

###### a. *Low vision in the right eye*

The percentage occurrence of low vision in the total population ( $N = 400$ ) in the right eye was 16.3%, being highest (7.5%) among those  $\geq 60$  years and older and lowest (1.8%) among those 6 – 18 years old (Figure 4.13). The prevalence was highest (30.0%) among those  $\geq 60$  years and older ( $N = 100$ ) and lowest (7.0%) among those 6 – 18 years old ( $N = 100$ ). There was a significant association between age and low vision in the right eye ( $\text{Chi} = 22.25$ ;  $\text{df} = 3$ ;  $p = 0.00$ ). The distribution of low vision in the right eye by age is shown in Figure 4.13 below.



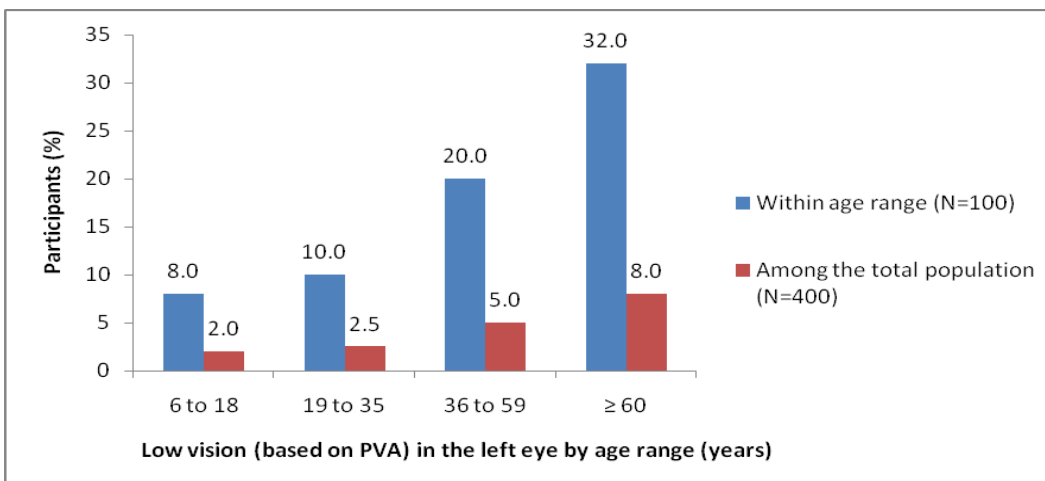


**Figure 4.13: Low vision in the right eye by age**

\*PVA = presenting visual acuity

*b. Low vision in the left eye*

The distribution of low vision in the total population (N=400) in the left eye based on presenting visual acuity was 17.5% and was highest among those  $\geq 60$  years (8.0%) and lowest (2.0%) among those 6 – 18 years old (Figure 4.14). The prevalence was highest (32.0%) among those  $\geq 60$  years and older (N = 100) and lowest (8.0%) among those 6 – 18 years old (N = 100). There was a significant association between age and low vision in the left eye (Chi = 25.14; df =3;  $p = 0.00$ ). The distribution of low vision based on presenting visual acuity in the left eye by age is shown in Figure 4.14 below.

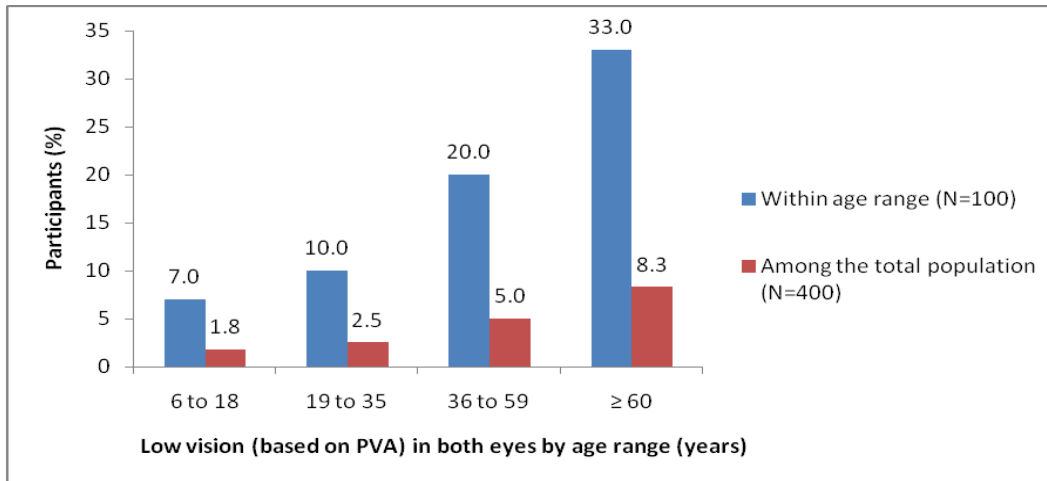


**Figure 4.14: Low vision in the left eye by age**

\*PVA = presenting visual acuity

c. *Low vision in both eyes*

The distribution of low vision in the total population (N=400) in both eyes based on presenting visual acuity was 17.5% and was highest among those  $\geq 60$  years (8.3%) and lowest (1.8%) among those 6 – 18 years old (Figure 4.15). The prevalence was highest (33.0%) among those  $\geq 60$  years and older (N = 100) and lowest (7.0%) among those 6 – 18 years old (N = 100). There was a significant association between age and low vision in both eyes (Chi = 33.84; df =3; p = 0.00). The distribution of low vision based on presenting visual acuity in both eyes by age is shown in Figure 4.15 below.



**Figure 4.15: Low vision in both eyes by age**

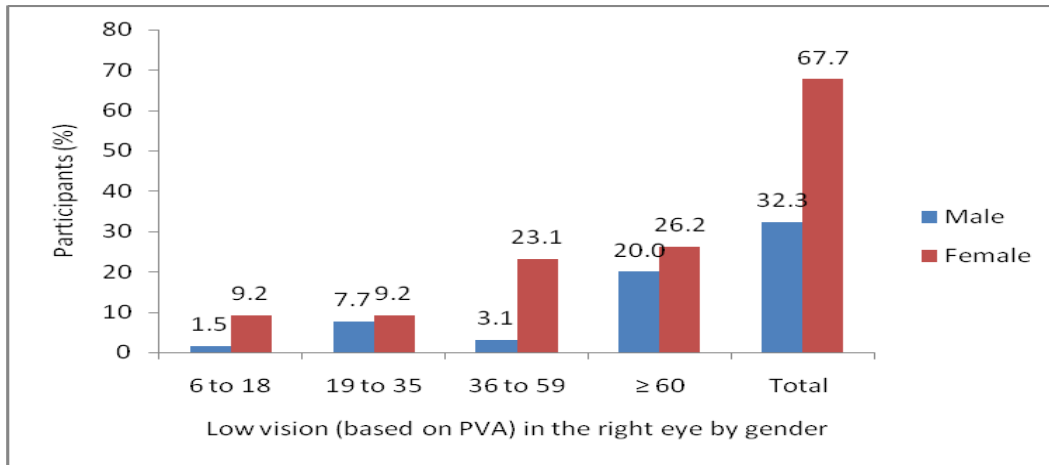
\*PVA = presenting visual acuity

4.6.2. Low vision by gender

a. *Low vision in the right eye*

Females (N = 239) had higher prevalence of low vision in the right eye (18.4%) than males (N = 161) accounting for 13.0% and among the total study sample (N = 400), females had higher occurrence (11.0%) of low vision than males (5.3%) but it was not statistically significant. There was no association between gender and low vision in the right eye (Chi = 2.04; df =1; p = 0.15).

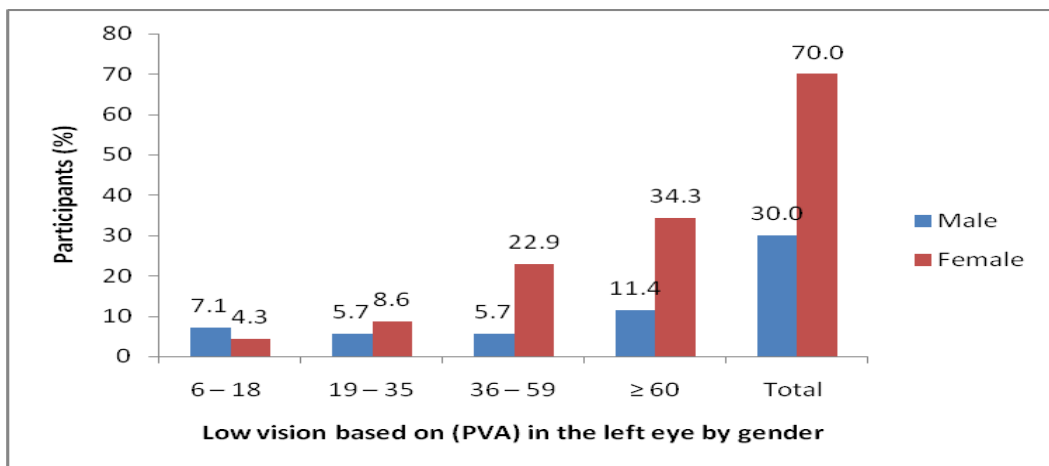
The distribution of low vision based on presenting visual acuity in the right eye by gender is shown in Figure 4.16 below.



**Figure 4.16: Low vision in the right eye by gender**

*b. Low vision in the left eye*

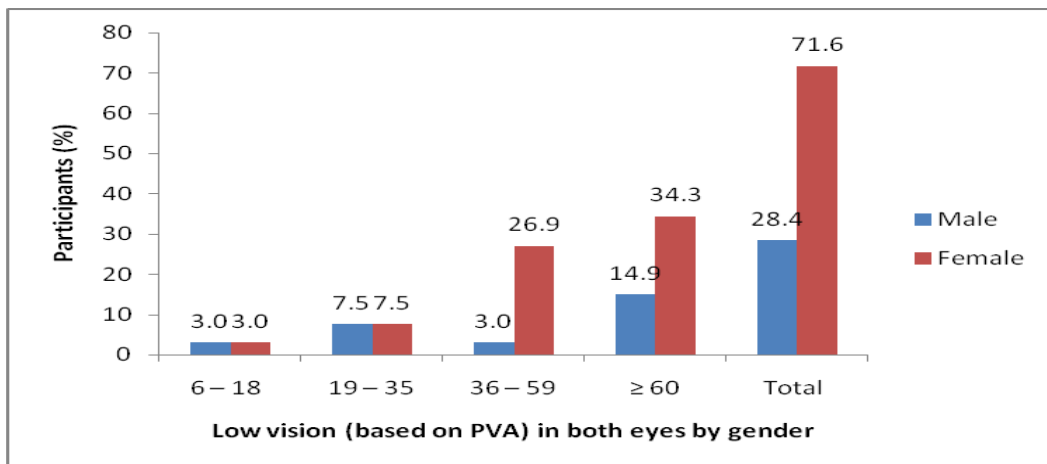
Females ( $N = 239$ ) had higher prevalence of low vision in the left eye (20.5%) than males ( $N = 161$ ) accounting for 13.0% and among the total study sample ( $N = 400$ ), females had higher occurrence (12.3%) of low vision than males (5.3%). There was an association between gender and low vision in the left eye ( $\text{Chi} = 3.71$ ;  $\text{df} = 1$ ;  $p = 0.05$ ). The distribution of low vision based on presenting visual acuity in the left eye by gender is shown in Figure 4.17 below.



**Figure 4.17: Low vision in the left eye by gender**

c. *Low vision in both eyes*

Females ( $N = 239$ ) had higher prevalence of low vision in both eyes (20.3%) than males ( $N = 161$ ) accounting for 11.8% and among the total study sample ( $N = 400$ ), females had higher occurrence (12.1%) of low vision than males (4.8%). There was significant association between gender and low vision in both eyes ( $\text{Chi} = 4.97$ ;  $\text{df} = 1$ ;  $p = 0.03$ ). The distribution of low vision based on presenting visual acuity in both eyes by gender is shown in Figure 18 below.



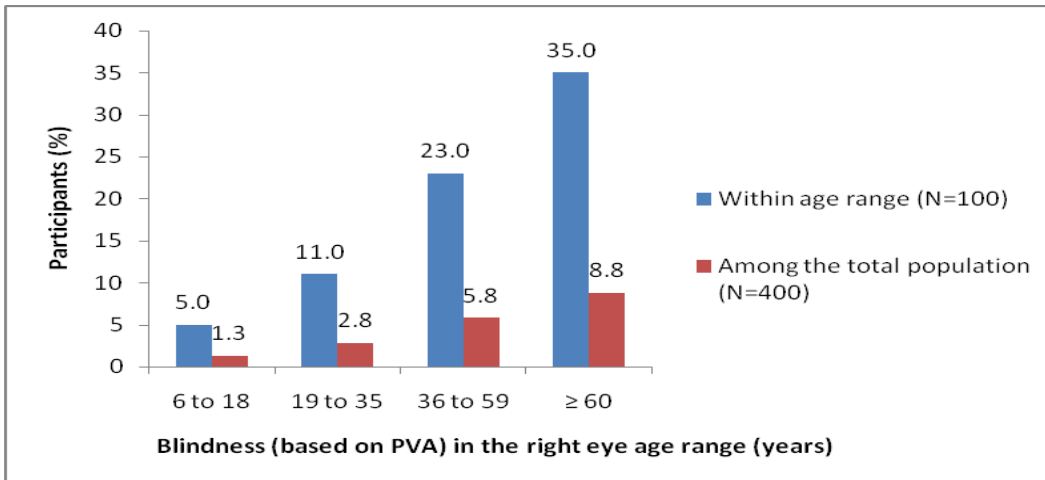
**Figure 4.18: Low vision in both eyes by gender**

#### 4.7 Blindness based on presenting visual acuity

##### 4.7.1 Blindness by age

a. *Blindness in the right eye*

The percentage occurrence of blindness in the total population ( $N = 400$ ) in the right eye was 18.5%, being highest (8.8%) among those  $\geq 60$  years and older and lowest (1.3%) among those 6 – 18 years old (Figure 4.19). The prevalence was highest (35.0%) among those  $\geq 60$  years and older ( $N = 100$ ) and lowest (5.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age and blindness in the right eye ( $\text{Chi} = 35.22$ ;  $\text{df} = 3$ ;  $p = 0.00$ ). The distribution of low vision in the right eye by age is shown in Figure 4.19 below.

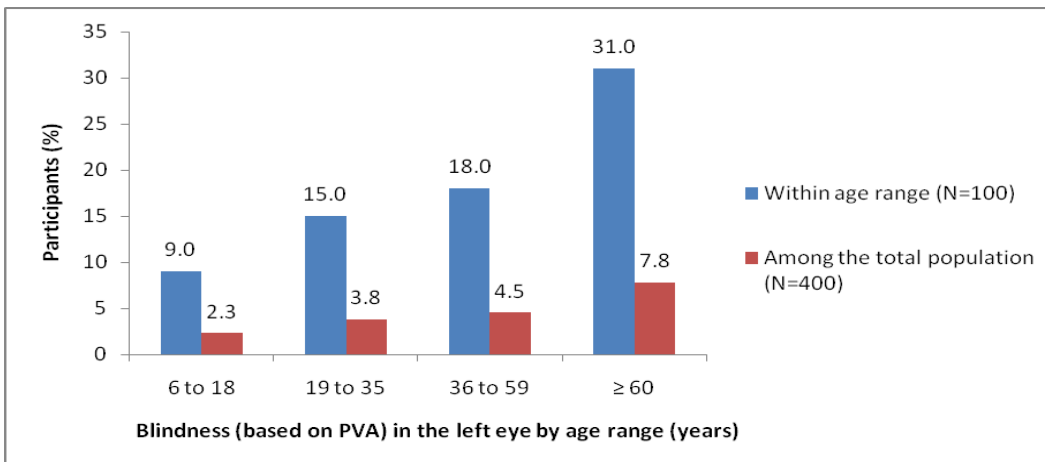


**Figure 4.19: Blindness in the right eye by age**

\*PVA = presenting visual acuity

*b. Blindness in the left eye*

The distribution of blindness in the total population (N=400) in the left eye based on presenting visual acuity was 18.3% and was highest among those  $\geq 60$  years (7.8%) and lowest (2.3%) among those 6 – 18 years old (Figure 4.20). The prevalence was highest (31.0%) among those  $\geq 60$  years and older and lowest (9.0%) among those 6 – 18 years old (N = 100). There was significant association between age and blindness in the left eye (Chi = 17.34; df =3;  $p = 0.00$ ). The distribution of blindness in the left eye by age is shown in Figure 4.20 below.

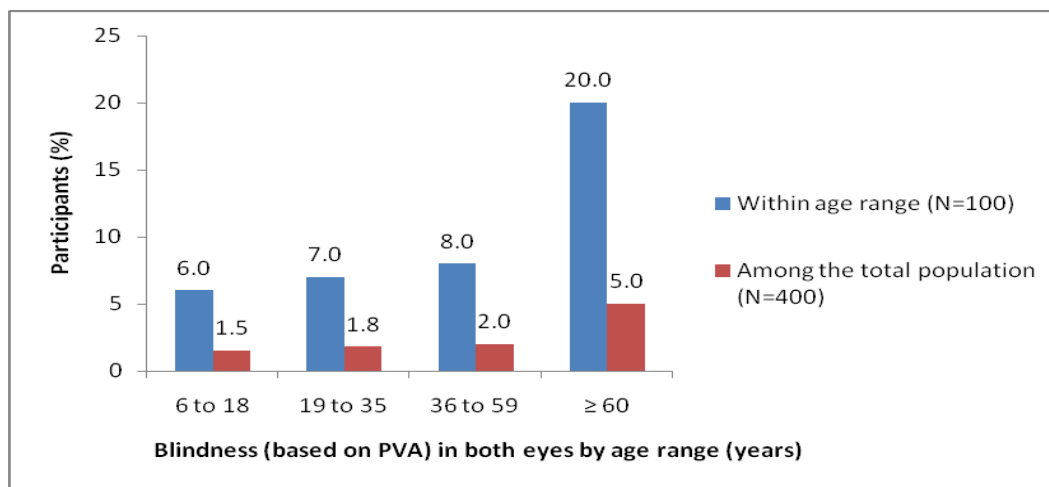


**Figure 4.20: Blindness in the left eye by age**

\*PVA = presenting visual acuity

### c. Blindness in both eyes

The distribution of blindness in the total population (N=400) in both eyes based on presenting visual acuity was 10.3% and was highest among those  $\geq 60$  years (5.0%) and lowest (1.5%) among those 6 – 18 years old (Figure 4.21). The prevalence was highest (20.0%) among those  $\geq 60$  years and older ( $N = 100$ ) and lowest (6.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age and blindness in both eyes (Chi = 13.68; df =3;  $p = 0.00$ ). The distribution of blindness in both eyes by age is shown in Figure 4.21 below



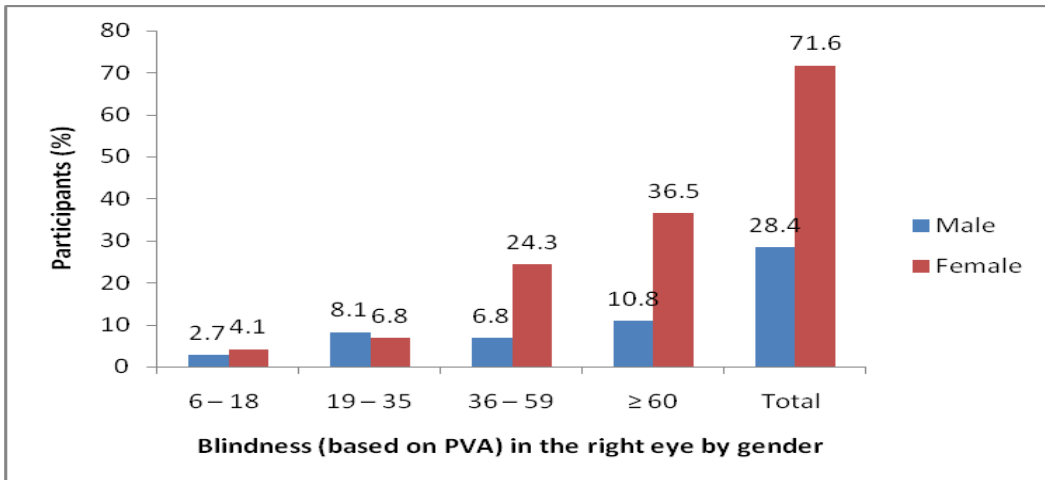
**Figure 4.21: Blindness in both eyes by age**

\*PVA = presenting visual acuity

## 4.7.2 Blindness by gender

### a. Blindness in the right eye

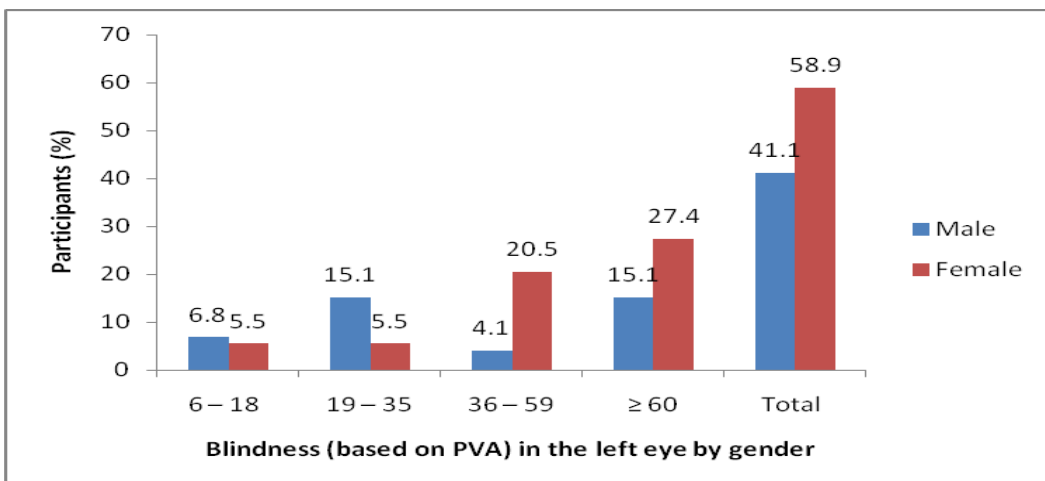
Females ( $N = 239$ ) had higher prevalence of blindness in the right eye (22.2%) than males ( $N = 161$ ) accounting for 13.3% and among the total study sample ( $N = 400$ ), females had higher occurrence (13.3%) of blindness than males (5.3%). There was an association between gender and blindness in the right eye (Chi = 5.32; df =1;  $p = 0.02$ ). The distribution of blindness based on presenting visual acuity in the right eye by gender is shown in Figure 4.22 below.



**Figure 4.22: Blindness in the right eye by gender**

*b. Blindness in the left eye*

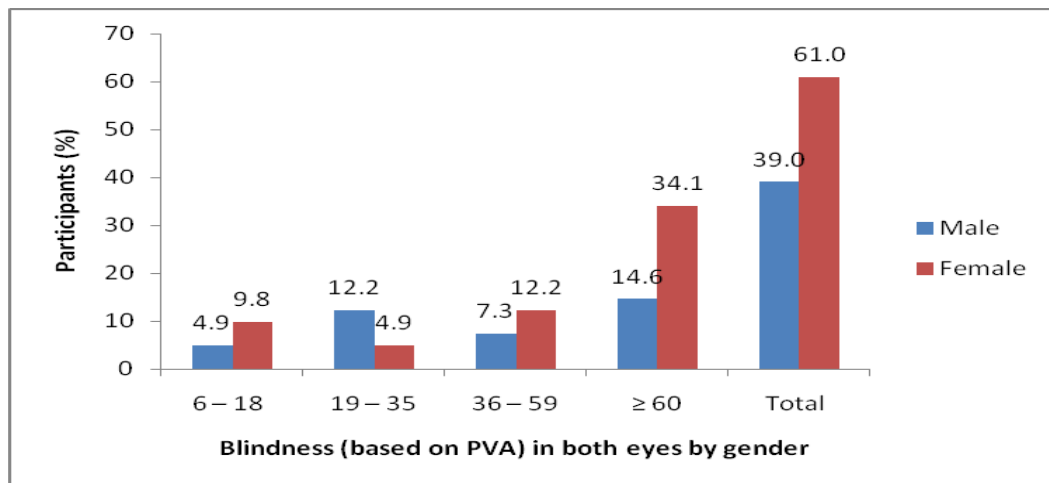
Females ( $N = 239$ ) had lower prevalence of blindness in the left eye (18.0%) than males ( $N = 161$ ) accounting for 18.6% and among the total study sample ( $N = 400$ ), females had higher occurrence (10.8%) of blindness than males (7.5%) but it was not statistically significant. There was no association between gender and blindness in the left eye ( $\text{Chi} = 0.03$ ;  $\text{df} = 1$ ;  $p = 0.87$ ). The distribution of blindness based on presenting visual acuity in the left eye by gender is shown in Figure 4.23 below.



**Figure 4.23: Blindness in the left eye by gender**

### c. Blindness in both eyes

Females ( $N = 239$ ) had higher prevalence of blindness in both eyes (10.6%) than males ( $N = 161$ ) accounting for 9.9% and among the total study sample ( $N = 400$ ); females had higher occurrence (6.3%) of blindness than males (4.0%). There was significant association between gender and low vision in both eyes ( $\text{Chi} = 0.04$ ;  $\text{df} = 1$ ;  $p = 0.83$ ). The distribution of low vision based on presenting visual acuity in both eyes by gender is shown in Figure 4.24 below.



**Figure 4.24: Blindness in both eyes by gender**

## 4.8 Presenting eye anomalies

### a) Conjunctival anomalies

These included vernal conjunctivitis, allergic conjunctivitis, bacterial conjunctivitis, viral conjunctivitis, pterygium, pinguecula, tumor and keratoconjunctivitis sicca

### b) Eyelid anomalies

These included blepharitis, entropion, trichiasis, ptosis and ectropion.

### c) Corneal anomalies

These included opacities, dystrophies and keratopathies.



d) *Lens anomalies*

These included cataract, aphakia and pseudophakia.

e) *Retinal anomalies*

These included hypertensive and diabetic retinopathies, optic atrophy, hypoplasia due to albinism and retinal detachment.

f) *Uveal anomalies*

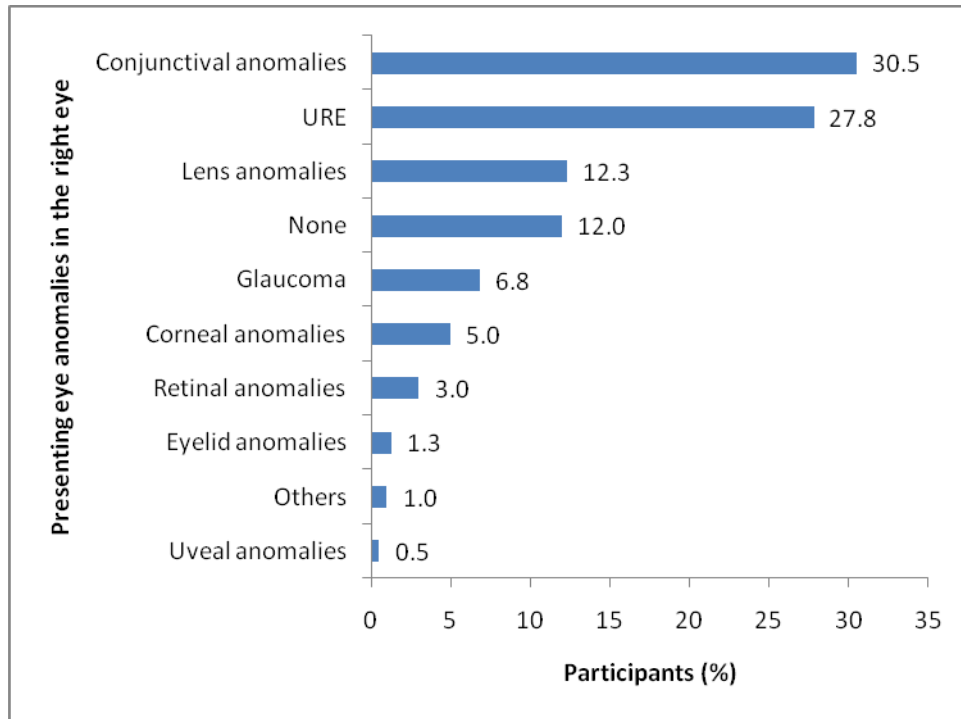
These included iris anomalies, uveitis and vitreal anomalies.

g) *Others*

These included phthisis bulbi, orbital cellulitis and enucleated eye

#### 4.8.1 Presenting eye anomalies in the right eye

The most common presenting eye anomalies were conjunctival anomalies (30.5%), uncorrected refractive errors (27.8%) and lens anomalies (12.3%). A total of 12.0% participants did not have eye anomalies in the right eye. The distributions of eye anomalies in the right eye are shown in Figure 4.25 below.



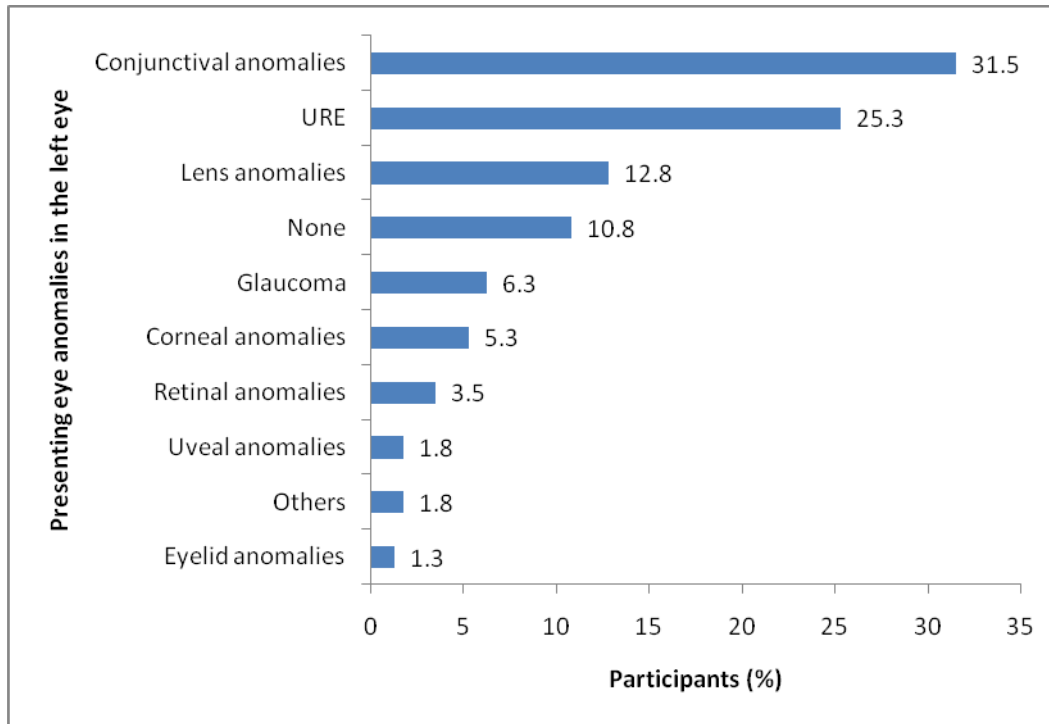
**Figure 4.25: Presenting eye anomalies in the right eye**

URE = uncorrected refractive errors.

Others included pthisis bulbi, orbital cellulits and enucleated eye

#### 4.8.2 Presenting eye anomalies in the left eye

Conjunctival anomalies accounted for highest (31.5%) of the presenting eye anomalies in the left eye. Uncorrected refractive errors (25.3%) and lens anomalies (12.8%) were the most presented eye anomalies in the left eye respectively. A total of 10.8% participants did not have eye anomalies in the left eye. The distributions of eye anomalies in the left eye are presented in Figure 4.26 below.



**Figure 4.26: Presenting eye anomalies in the left eye**

URE = uncorrected refractive errors

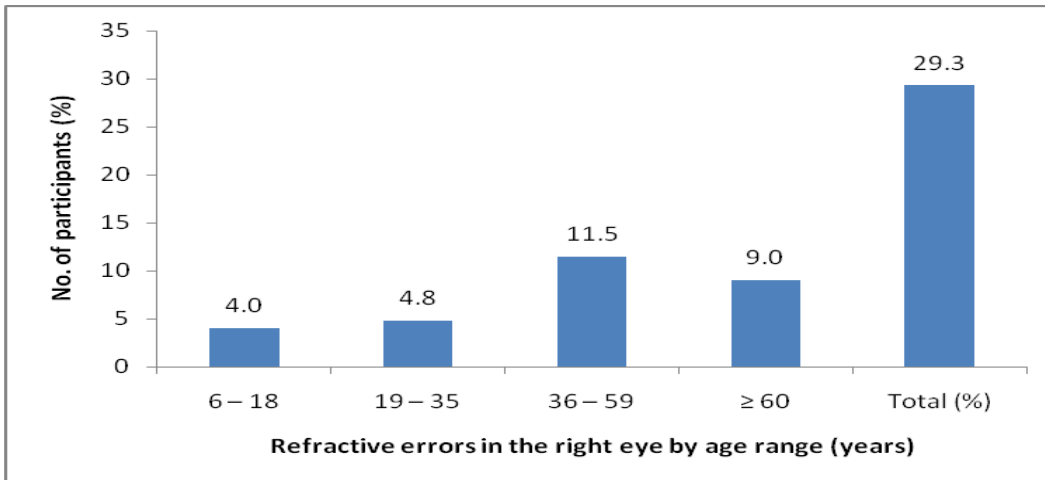
Others included pthisis bulbi, orbital cellulits and enucleated eye

## 4.9 Refractive errors

### 4.9.1 Refractive errors by age

#### a. *Refractive errors in the right eye*

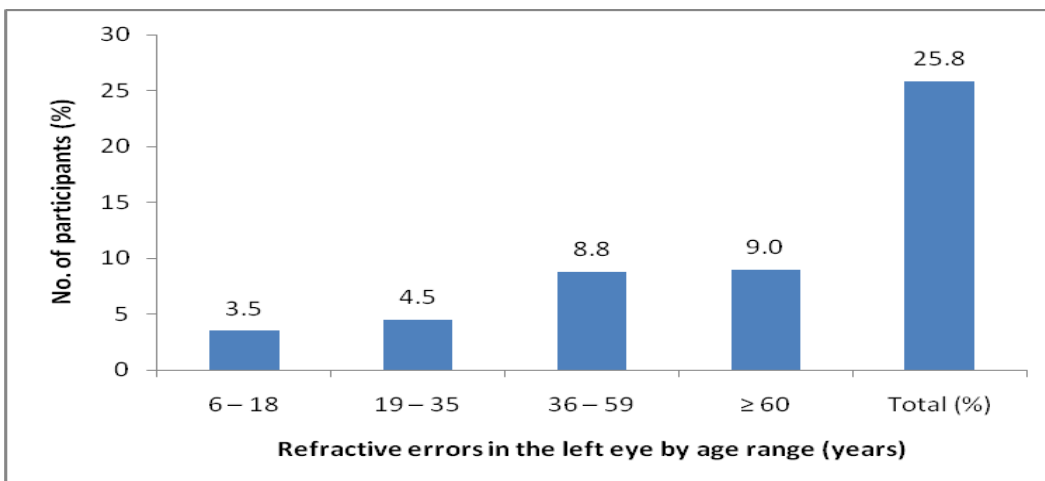
The distribution of refractive errors in the total population ( $N=400$ ) in the right eye was 29.3% with mean of  $1.71 \pm 0.46$ . The prevalence was highest among participants ( $N = 400$ ) aged 36 – 59 years old (11.5%) and lowest (4.0%) among those 6 – 18 years old (Figure 4.27). The prevalence was highest (46.0%) among participants aged 36 to 59 years old ( $N = 100$ ) and lowest (16.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age ( $\chi^2 = 29.32$ ;  $df = 3$ ;  $p = 0.00$ ) and refractive errors. The distribution of refractive errors in the right eye by age is shown in Figure 4.27 below.



**Figure 4.27: Refractive errors in the right eye by age**

*b. Refractive errors in the left eye*

The distribution of refractive errors in the total population ( $N=400$ ) in the left eye was 25.8% with mean of  $1.26 \pm 0.44$ . The prevalence was highest among participants ( $N = 400$ ) aged 60 years and older (9.0%) and lowest (3.5%) among those 6 – 18 years old (Figure 4.28). The prevalence was highest (36.0%) among participants aged 60 years and older ( $N = 100$ ) and lowest (14.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age ( $\chi^2 = 20.33$ ;  $df = 3$ ;  $p = 0.000$ ) and refractive errors. The distribution of refractive errors in the left eye by age is shown in Figure 4.28 below.



**Figure 4.28: Refractive errors in the left eye by age**

#### 4.9.2. Refractive errors by gender

Females ( $N = 239$ ) had higher prevalence of refractive errors in the right eye (33.5%) than males ( $N = 161$ ) accounting for 23.0% and among the total study sample ( $N = 400$ ); females had higher occurrence (20.0%) of refractive errors than males (9.3%). There was significant association between gender ( $\chi = 5.12$ ;  $df = 1$ ;  $p = 0.02$ ) and refractive errors in the right eye. In the left eye, females ( $N = 239$ ) had higher prevalence of refractive errors (32.2%) than males ( $N = 161$ ) accounting for 16.1% and among the total study sample ( $N = 400$ ); females had higher occurrence (19.3%) of blindness than males (6.5%). There was significant association between gender and refractive errors ( $\chi = 12.9$ ;  $df = 1$ ;  $p = 0.00$ ) in the left eye. The distributions of refractive errors by gender in the right and left eye are shown in Table 4.5 below.

**Table 4.5: Refractive errors by gender in the right and left eye**

Age range (years)	Right eye		Left eye	
	Male	Female	Male	Female
6 – 18	6.8	6.8	5.8	7.8
19 – 35	5.1	11.1	4.9	12.6
36 – 59	8.5	30.8	3.9	30.1
≥ 60	11.1	19.7	10.7	24.3
Total (%)	31.6	68.4	25.2	74.8

#### 4.9.3 Types Refractive errors

##### a. Types Refractive errors in the right eye

In the right eye, the prevalence of myopia in the total population ( $N = 400$ ) was 18.5%. Based on the spherical equivalent values, myopia ranged from -0.25 to -12.0 SEP with mean of  $1.82 \pm 0.39$ . There was no association between age ( $\chi = 7.50$ ;  $df = 3$ ;  $p = 0.06$ ) and myopia. The prevalence of hyperopia in the total population was 10.8%. Based on the spherical equivalent values, hyperopia ranged from +0.50 to +12.0 SEP with mean of  $1.89 \pm 0.31$ . There was significant association between age ( $\chi = 20.56$ ;  $df = 3$ ;  $p = 0.00$ ) and hyperopia. Table 4.6

below shows the percentage distribution of refractive status in the right eye within each age group ( $N=100$ ) and among the total population (in bracket).

**Table 4.6: Refractive status in the right eye by age**

Age (Years)	Refractive error type		
	Myopia	Hyperopia	None
6 – 18	13.0 (3.3)	3.0 (0.8)	84.0 (21.0)
19 – 35	14.0 (3.5)	5.0 (1.3)	81.0 (20.3)
36 – 59	26.0 (6.5)	20.0 (5.0)	54.0 (13.5)
≥ 60	21.0 (5.3)	15.0 (3.8)	64.0 (16.0)
Total (%)	74.0 (18.5)	43.0 (10.8)	283 (70.8)

$N = 400$

*b. Types Refractive errors in the left eye*

In the left eye, the prevalence of myopia in the total population ( $N = 400$ ) was 15.8%. Based on the spherical equivalent values, myopia ranged from -0.25 to -12.0 SEP with mean of  $1.84 \pm 0.37$ . There was no association between age ( $\chi^2 = 4.73$ ;  $df = 3$ ;  $p = 0.19$ ) and myopia. The prevalence of hyperopia in the total population was 9.8%. Based on the spherical equivalent values, hyperopia ranged from +0.50 to +12.0 SEP with mean of  $1.90 \pm 0.30$ . There was significant association between age ( $\chi^2 = 22.13$ ;  $df = 3$ ;  $p = 0.00$ ) and hyperopia. Table 4.7 below shows the percentage distribution of refractive status in the left eye within each age group ( $N = 100$ ) and among the total population (in bracket).

**Table 4.7: Refractive status in the left eye by age**

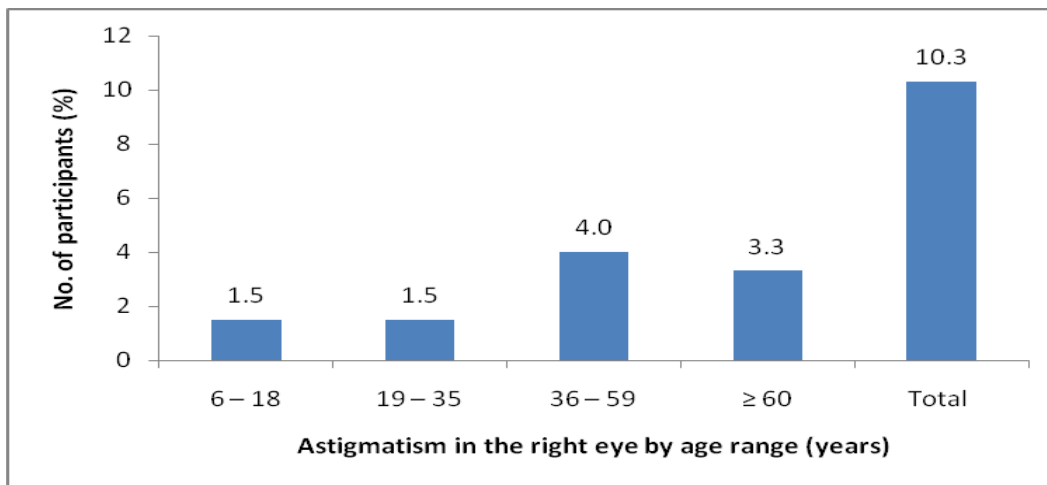
Age (Years)	Refractive error type		
	Left eye		
	Myopia	Hyperopia	None
6 – 18	11.0 (2.8)	3 (0.8)	86 (21.5)
19 – 35	15 (3.8)	3 (0.8)	82 (20.5)
36 – 59	15 (3.8)	19 (4.8)	66 (16.5)
≥ 60	22 (5.5)	14 (3.5)	64 (16.0)
Total (%)	63 (15.8)	39 (9.8)	298 (74.5)

$N= 400$

#### 4.9.4. Astigmatism among the sample population

##### a. *Astigmatism in the right eye*

The distribution of astigmatism in the total population ( $N=400$ ) in the right eye was 10.3%. The prevalence was highest among participants ( $N = 400$ ) aged 36 to 59 years older (4.0%) and lowest (1.5%) among those 6 – 18 years old and 19 to 35 years old (Figure 4.29). The prevalence was highest (16.0%) among participants aged 36 to 59 years old and lowest (6.0%) among those 6 – 18 years and 19 to 35 years old ( $N = 100$ ). Astigmatism ranged from -0.25 to -2.50DC with mean of  $1.14 \pm 0.37$ DC. There was association between age and astigmatism ( $\chi^2 = 8.34$ ;  $df = 3$ ;  $p = 0.04$ ). The distributions of astigmatism in the right eye by age are shown in Figure 4.29 below.

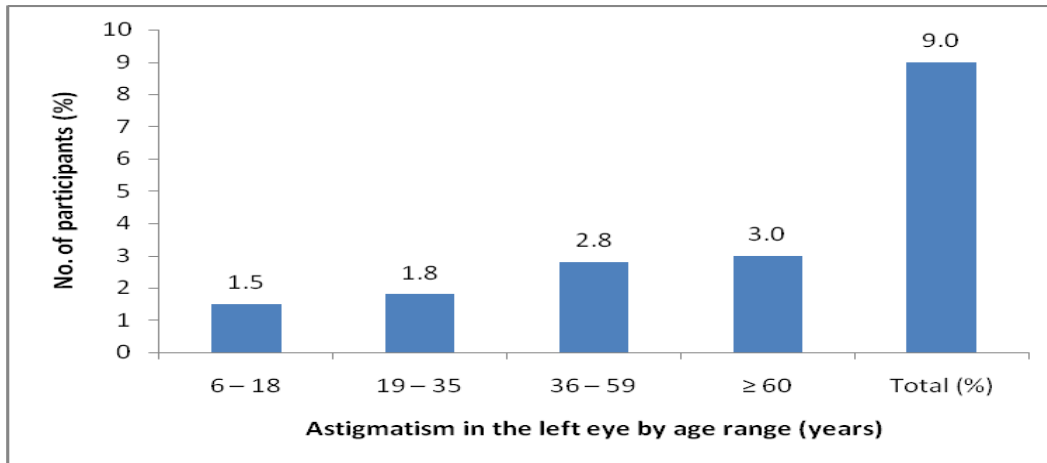


**Figure 4.29: Astigmatism in the right eye by age**

##### b. *Astigmatism in the left eye*

The distribution of astigmatism in the total population ( $N=400$ ) in the left eye was 9.0%. The prevalence was highest among participants ( $N = 400$ ) aged 60 years and older (3.0%) and lowest (1.5%) among those 6 – 18 years old (Figure 4.30). The prevalence was highest (12.0%) among participants aged 60 years and older and lowest (6.0%) among those 6 – 18 years old ( $N = 100$ ). Astigmatism ranged from -0.25 to -2.75DC with mean of  $1.91 \pm 0.29$ DC. There was no

association between age and astigmatism ( $\chi = 3.18$ ;  $df = 3$ ;  $p = 0.37$ ). The distributions of astigmatism in the left eye by age are shown in Figure 4.30 below.



**Figure 4.30: Astigmatism in the right eye by age**

#### 4.9.5 Refractive errors among the sample population by gender

##### a. Refractive errors in the right eye by gender

Females ( $N = 239$ ) had higher prevalence of myopia (20.5%) than males ( $N = 161$ ) accounting for 15.5% and among the total study sample ( $N = 400$ ); females had higher occurrence (12.3%) of myopia than males (6.3%). Also; females ( $N = 239$ ) had higher prevalence of hyperopia (13.0%) than males ( $N = 161$ ) accounting for 7.5% and among the total study sample ( $N = 400$ ); females had higher occurrence (7.8%) of hyperopia than males (3.0%). Females ( $N = 239$ ) had higher prevalence of astigmatism (10.5%) than males ( $N = 161$ ) accounting for 9.9% and among the total study sample ( $N = 400$ ); females had higher occurrence (6.3%) of astigmatism than males (4.0%). There was no association between myopia ( $\chi = 1.58$ ;  $df = 1$ ;  $p = 0.21$ ), hyperopia ( $\chi = 3.05$ ;  $df = 1$ ;  $p = 0.08$ ) and astigmatism ( $\chi = 0.03$ ;  $df = 1$ ;  $p = 0.87$ ) with gender in the right eye. The distributions of refractive errors status by gender in the right eye are shown in Table 4.8 below.



**Table 4.8: Refractive errors status by gender in the right eye**

Age (Years)	Refractive error type (%)					
	Myopia		Hyperopia		Astigmatism	
	Male	Female	Male	Female	Male	Female
6 – 18	6.8	10.8	7.0	0.0	4.9	9.8
19 – 35	6.8	12.2	2.3	9.3	4.9	9.8
36 – 59	9.5	25.7	7.0	39.5	12.2	26.8
≥ 60	10.8	17.6	11.6	23.3	17.1	14.6
Total (%)	33.8	66.2	27.9	72.1	39.0	61.0

*b. Refractive errors in the left eye by gender*

Females ( $N = 239$ ) had higher prevalence of myopia (19.2%) than males ( $N = 161$ ) accounting for 10.6% and among the total study sample ( $N = 400$ ); females had higher occurrence (11.5%) of myopia than males (4.3%). Also; females ( $N = 239$ ) had higher prevalence of hyperopia (12.6%) than males ( $N = 161$ ) accounting for 5.6% and among the total study sample ( $N = 400$ ); females had higher occurrence (7.5%) of hyperopia than males (2.3%). Females ( $N = 239$ ) had higher prevalence of astigmatism (10.0%) than males ( $N = 161$ ) accounting for 7.5% and among the total study sample ( $N = 400$ ); females had higher occurrence (6.0%) of astigmatism than males (3.0%). There was significant association between myopia ( $\text{Chi} = 5.47$ ;  $\text{df} = 1$ ;  $p = 0.02$ ) and hyperopia ( $\text{Chi} = 5.30$ ;  $\text{df} = 1$ ;  $p = 0.02$ ) with gender in the left eye. However, there was no association between astigmatism ( $\text{chi} = 0.79$ ;  $\text{df} = 1$ ;  $p = 0.38$ ) with gender in the left eye. The distributions of refractive errors status by gender in the left eye are shown in Table 4.9 below.

**Table 4.9: Refractive status by gender in the left eye**

Age (Years)	Refractive error type (%)					
	Myopia		Hyperopia		Astigmatism	
	Male	Female	Male	Female	Male	Female
6 – 18	6.3	11.1	5.1	2.6	5.6	11.1
19 – 35	6.3	17.5	2.6	5.1	5.6	13.9
36 – 59	1.6	22.2	7.7	41.0	8.3	22.2
≥ 60	12.7	22.2	7.7	28.2	13.9	19.4
Total (%)	27.0	73.0	23.1	76.9	33.3	66.7

#### 4.9.6. Axes of astigmatism

The axes of the correcting cylinders were grouped together as with-the-rule (WTR), against-the-rule (ATR) and oblique (OBL) as adapted from Raliavegwa and Oduntan (2000). With-the-rule astigmatism was defined as axis of the correcting cylinder located within 30 degrees of the horizontal (0 to 30 degrees or 150 to 180 degrees). Against-the-rule is when the axis of the correcting cylinders is within 30 degrees of the vertical meridian (60-90-120). All other meridians were included as oblique (Raliavegwa and Oduntan 2000).

##### 4.9.6.1 Axes of astigmatism by age

###### a. *Axes of astigmatism in the right eye*

Among participants with astigmatism, against- the- rule astigmatism was the most common axes of astigmatism among all age ranges ( $N= 100$ ) accounting for 4.0% among the 6 to 18 years old; 2.0% among participants aged 19 to 35 years; 9.0% among the 36 to 59 years old and 8.0% among the  $\geq 60$  years old. There was no association between age ( $\chi^2 = 9.61$ ;  $df = 9$  and  $p = 0.38$ ) and axes of astigmatism. The distribution of axes of astigmatism in the right eye among participants within each age group ( $N = 100$ ) and among the total population (in bracket) is shown in Table 4.10 below.

**Table 4.10: Axes of astigmatism by age range in the right eye**

Age range (Years)	Axes of astigmatism (%)				
	ATR	WTR	OBL	None	Total (%)
6 – 18	4.0 (1.0)	1.0 (0.3)	1.0 (0.3)	94.0 (23.5)	100.0 (25.0)
19 – 35	2.0 (0.5)	2.0 (0.5)	2.0 (0.5)	94.0 (23.5)	100.0 (25.0)
36 – 59	9.0 (2.3)	3.0 (0.8)	4.0 (1.0)	84.0 (21.0)	100.0 (25.0)
$\geq 60$	8.0 (2.0)	2.0 (0.5)	2.0 (0.5)	88.0 (22.0)	100.0 (25.0)
<b>Total (%)</b>	23.0 (5.8)	8.0 (2.0)	9.0 (2.3)	360.0 (90.0)	400.0 (100.0)

$N = 400$

b. *Axes of astigmatism in the left eye*

Among participants with astigmatism, against- the- rule astigmatism was the most common axes of astigmatism in the left eye among all age ranges ( $N=100$ ) accounting for 1.0% among the 6 to 18 years old; 3.0% among participants aged 19 to 35 years; 3.0% among the 36 to 59 years old and 5.0% among the  $\geq 60$  years old. There was no association between age ( $\chi^2 = 10.85$ ;  $df = 9$  and  $p = 0.29$ ) and axes of astigmatism. The distribution of axes of astigmatism in the left eye among participants within each age group ( $N = 100$ ) and among the total population (in bracket) is shown in Table 4.11 below.

**Table 4.11: Axes of astigmatism in the left eye by age**

Age range (Years)	Axes of astigmatism (%)				
	ATR	WTR	OBL	None	Total (%)
6 – 18	1.0 (0.3)	0.0 (0.0)	0.0 (0.0)	99.0 (24.8)	100.0 (25.0)
19 – 35	3.0 (0.8)	0.0 (0.0)	0.0 (0.0)	97.0 (24.3)	100.0 (25.0)
36 – 59	3.0 (0.8)	2.0 (0.5)	1.0 (0.3)	94.0 (23.5)	100.0 (25.0)
$\geq 60$	5.0 (1.3)	0.0 (0.0)	1.0 (0.3)	94.0 (23.5)	100.0 (25.0)
<b>Total (%)</b>	12.0 (3.0)	2.0 (0.5)	2.0 (0.5)	384.0 (96.0)	400.0 (100.0)

$N = 400$

4.9.6.2 Axes of astigmatism by gender

a. *Axes of astigmatism in the right and left eye by gender*

Females ( $N = 239$ ) had higher prevalence of ATR (5.9%) than males ( $N = 161$ ) accounting for 5.6% and among the total study sample ( $N = 400$ ); females had higher occurrence (3.5%) of ATR than males (2.3%). However; females ( $N = 239$ ) had lower prevalence of WTR (1.7%) than males ( $N = 161$ ) accounting for 2.5% in the right eye. There was no association between gender ( $\chi^2 = 0.51$ ;  $df = 3$  and  $p = 0.92$ ) and axes of astigmatism. In the left eye, males ( $N = 161$ ) had higher prevalence of ATR (3.1%) than females ( $N = 239$ ) accounting for 2.9%. However; females ( $N = 239$ ) had higher prevalence of WTR (0.8%) than males ( $N = 161$ ) accounting for 0.0%. Also, there was no association between age ( $\chi^2 = 1.44$ ;  $df = 3$  and  $p = 0.70$ ) and axes of

astigmatism in the left eye. The distribution of axes of astigmatism in the right and left eye among participants is shown in Table 4.12 below.

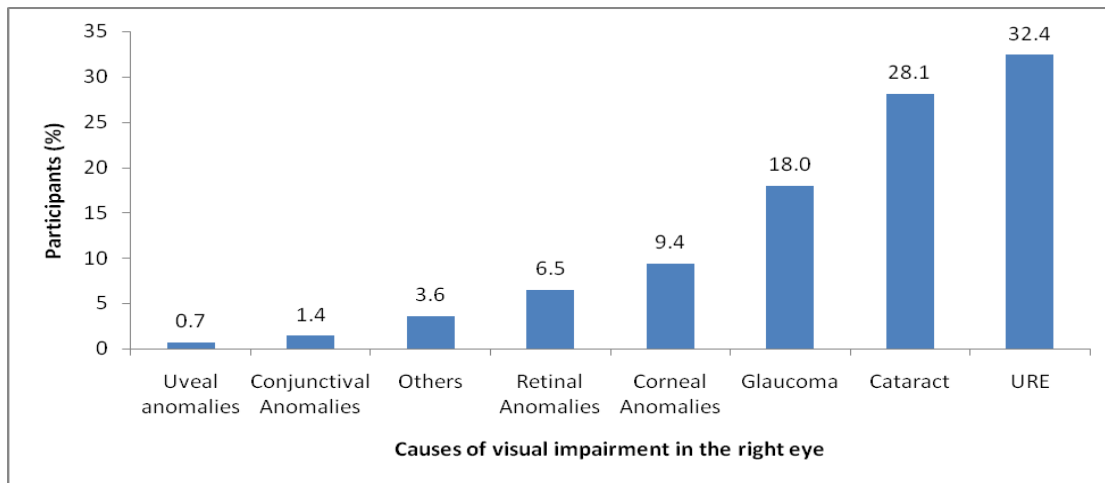
**Table 4.12: Axes of astigmatism in the right and left eye**

Axes of astigmatism	Right eye		Left eye	
	Male	Female	Male	Female
<b>ATR</b>	9.0 (22.0)	14.0 (34.1)	8.0 (22.2)	12.0 (33.3)
<b>WTR</b>	4.0 (9.8)	5.0 (12.2)	2.0 (5.6)	5.0 (13.9)
<b>OBL</b>	3.0 (7.3)	6.0 (14.6)	2.0 (5.6)	7.0 (19.4)
<b>Total (%)</b>	16.0 (39.0)	25.0 (61.0)	12.0 (33.3)	24.0 (66.7)

#### 4.10 Causes of visual impairment among participants

##### a. Causes of visual impairment in the right eye

The main causes of visual impairment in the right eye were uncorrected refractive errors (32.4%); cataract (28.1%) and glaucoma (18.0%). The distributions of causes of visual impairment in the right eye are shown in Figure 4.31 below.



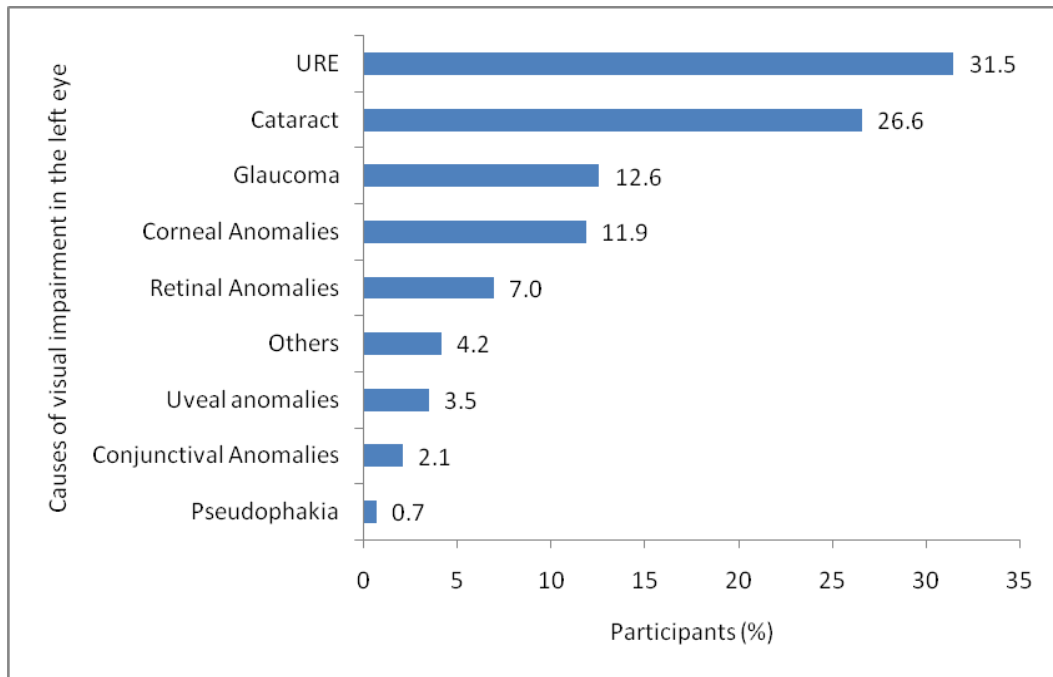
**Figure 4.31: Causes of visual impairment in the right eye**

URE = uncorrected refractive errors

Others included pthisis bulbi, orbital cellulitis and enucleated eye

b. *Causes of visual impairment in the left eye*

Uncorrected refractive errors and cataract were the leading causes of visual impairment in the left eye accounting for 31.5% and 26.6% respectively. Glaucoma and corneal anomalies accounted for 12.6% and 11.9% respectively. The distributions of causes of visual impairment in the left eye are shown in Figure 4.32 below.



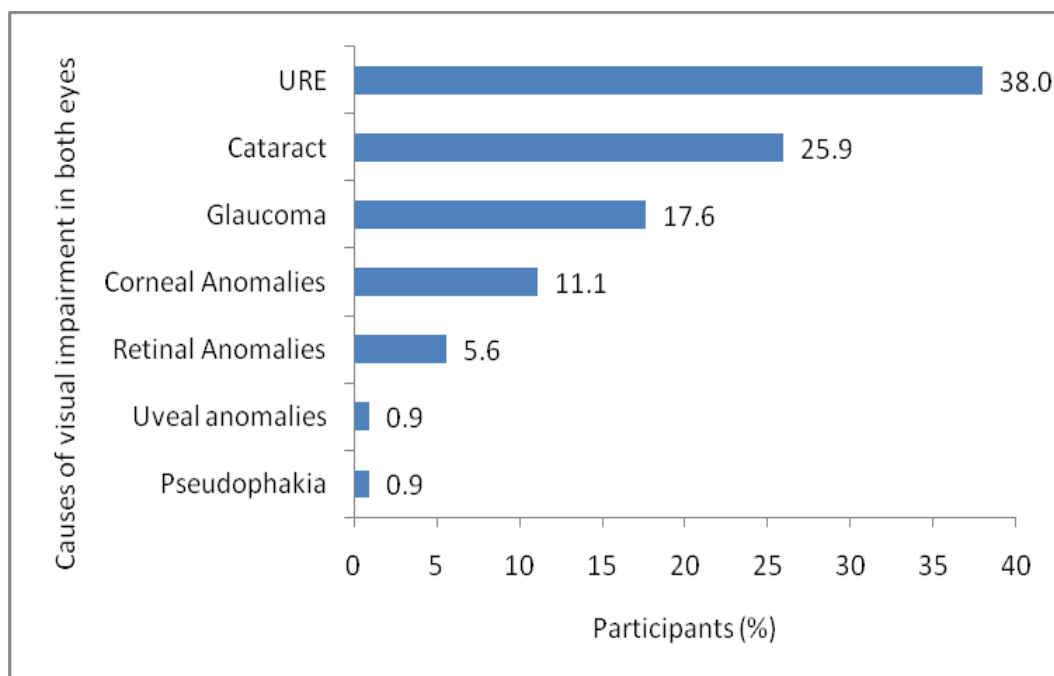
**Figure 4.32: Causes of visual impairment in the left eye**

URE = uncorrected refractive errors

Others included pthisis bulbi, orbital cellulitis and enucleated eye

c. *Causes of visual impairment in both eyes*

The main causes of visual impairment in both eyes were uncorrected refractive errors; cataract and glaucoma accounting for 38.0%; 25.9% and 17.6% respectively. The distributions of causes of visual impairment in both eyes are shown in Figure 4.33 below.



**Figure 4.33: Causes of visual impairment in both eyes**

URE = uncorrected refractive errors.

#### 4.10.1 Causes of visual impairment by age

##### a. Causes of visual impairment in the right eye

The main cause of visual impairment among participants aged 6 – 18 was uncorrected refractive errors (58.3%). Cataract and corneal anomalies accounted for 16.7% each. Among participants aged 19 – 35 years old the leading cause of VI was URE (31.8%), cataract, retinal anomalies and corneal anomalies accounted for 13.6% each. Among participants aged 36 to 59 years old, the main causes of visual impairment were URE (37.5%) and glaucoma (20.0%). Cataract and corneal anomalies accounted for 15.0% each. Among participants aged  $\geq 60$  years old, the main causes of visual impairment were cataract (43.1%), URE (24.6%) and glaucoma (23.1%). Table 4.13 below shows the percentage distribution of causes of visual impairment in the right eye within each age group and among the total population (in bracket).

**Table 4.13: Causes of visual impairment in the right eye by age**

Age (years)	Causes of visual impairment								Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival anomalies	Corneal anomalies	Uveal anomalies	Others	
6 – 18	16.7 (16.7)	58.3 (5.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	16.7 (.4)	8.3 (0.7)	0.0 (0.0)	100.0 (8.6)
19 – 35	13.6 (2.2)	31.8 (5.0)	9.1 (1.4)	13.6 (2.2)	9.1 (1.4)	13.6 (2.2)	0.0 (0.0)	9.1 (1.4)	100.0 (15.8)
36 – 59	15.0 (4.3)	37.5 (10.8)	20.0 (5.8)	7.5 (2.2)	0.0 (0.0)	15.0 (4.3)	0.0 (0.0)	5.0 (1.4)	100.0 (28.8)
≥ 60	43.1 (20.1)	24.6 (11.5)	23.1 (10.8)	4.6 (2.2)	0.0 (0.0)	3.1 (1.4)	0.0 (0.0)	1.5 (0.7)	100.0 (46.8)
<b>Total (%)</b>	28.1 (28.1)	32.4 (32.4)	18.0 (18.0)	6.5 (6.5)	1.4 (1.4)	9.4 (9.4)	0.7 (0.7)	3.6 (3.6)	100.0 (100.0)

N = 139

*b. Causes of visual impairment in the left eye*

The main causes of visual impairment in the left eye among participants aged 6 – 18 years old were uncorrected refractive errors (35.3%) and corneal anomalies (23.5%). Among the age range 19 – 35 years old, the leading causes of visual impairment were uncorrected refractive errors (28.0%) and corneal anomalies (24.0%). Uncorrected refractive errors (42.1%) and cataract (21.1%) were the main causes of visual impairment among the age range 35 – 59 years old. The leading causes among the age range ≥ 60 old were cataract (39.7%), uncorrected refractive errors (25.4%) and glaucoma (17.5%). Table 4.14 below shows the percentage distribution of causes of visual impairment in the left eye within each age group and among the total population (in bracket).

**Table 4.14: Causes of visual impairment by age in the left eye**

Age (years)	Causes of visual impairment									Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival anomalies	Pseudo phakia	Corneal anomalies	Uveal anomalies	Others	
6 – 18	11.8 (1.4)	35.3 (4.2)	0.0 (0.0)	11.8 (1.4)	5.9 (0.7)	0.0 (0.0)	23.5 (2.8)	11.8 (1.4)	0.0 (0.0)	100.0 (11.9)
19 – 35	12.0 (2.1)	28.0 (4.9)	8.0 (1.4)	12.0 (2.1)	4.0 (0.7)	0.0 (0.0)	24.0 (4.2)	4.0 (0.7)	8.0 (1.4)	100.0 (17.5)
36 – 59	21.1 (5.6)	42.1 (11.2)	13.2 (3.5)	5.3 (1.4)	2.6 (0.7)	0.0 (0.0)	7.9 (2.1)	2.6 (0.7)	5.3 (1.4)	100.0 (26.6)
≥ 60	39.7 (17.5)	25.4 (11.2)	17.5 (7.7)	4.8 (2.1)	0.0 (0.0)	1.6 (0.7)	6.3 (2.8)	1.6 (0.7)	3.2 (1.4)	100.0 (44.1)
<b>Total (%)</b>	26.6 (26.6)	31.5 (31.5)	12.6 (12.6)	7.0 (7.0)	2.1 (2.1)	0.7 (0.7)	11.9 (11.9)	3.5 (3.5)	4.2 (4.2)	100.0 (100.0)

N = 143

c. *Causes of visual impairment in both eyes*

The main causes of visual impairment in both eyes among participants aged 6 – 18 years old were uncorrected refractive errors (60.0%). Corneal anomalies and cataract accounted for 20.0% each. Among the age range 19 – 35 years old, the leading causes of visual impairment were uncorrected refractive errors (47.1%) and corneal anomalies (23.5%). Uncorrected refractive errors (53.6%) and glaucoma (17.9%) were the main causes of visual impairment among the age range 35 – 59 years old. The leading causes among the age range  $\geq 60$  old were cataract (39.6%), uncorrected refractive errors and glaucoma accounted for 22.6% each. Table 4.15 below shows the percentage distribution of causes of visual impairment in both eyes within each age group and among the total population (in bracket).

**Table 4.15: Causes of visual impairment in both eyes by age**

Age (years)	Causes of visual impairment							Total
	Cataract	URE	Glaucoma	Retinal anomalies	Pseudophakia	Corneal anomalies	Uveal anomalies	
6 – 18	20.0 (1.9)	60.0 (5.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	20.0 (1.9)	0.0 (0.0)	100.0 (9.3)
19 – 35	11.8 (1.9)	47.1 (7.4)	11.8 (1.9)	5.9 (0.9)	0.0 (0.0)	23.5 (3.7)	0.0 (0.0)	100.0 (15.7)
36 – 59	10.7 (2.8)	53.6 (13.9)	17.9 (4.6)	7.1 (1.9)	0.0 (0.0)	10.7 (2.8)	0.0 (0.0)	100.0 (25.9)
$\geq 60$	39.6 (19.4)	22.6 (11.1)	22.6 (11.1)	5.7 (2.8)	1.9 (0.9)	5.7 (2.8)	1.9 (0.9)	100.0 (49.1)
<b>Total (%)</b>	25.9 (25.9)	38.0 (38.0)	17.6 (17.6)	5.6 (5.6)	0.9 (0.9)	11.1 (11.1)	0.9 (0.9)	100.0 (100.0)

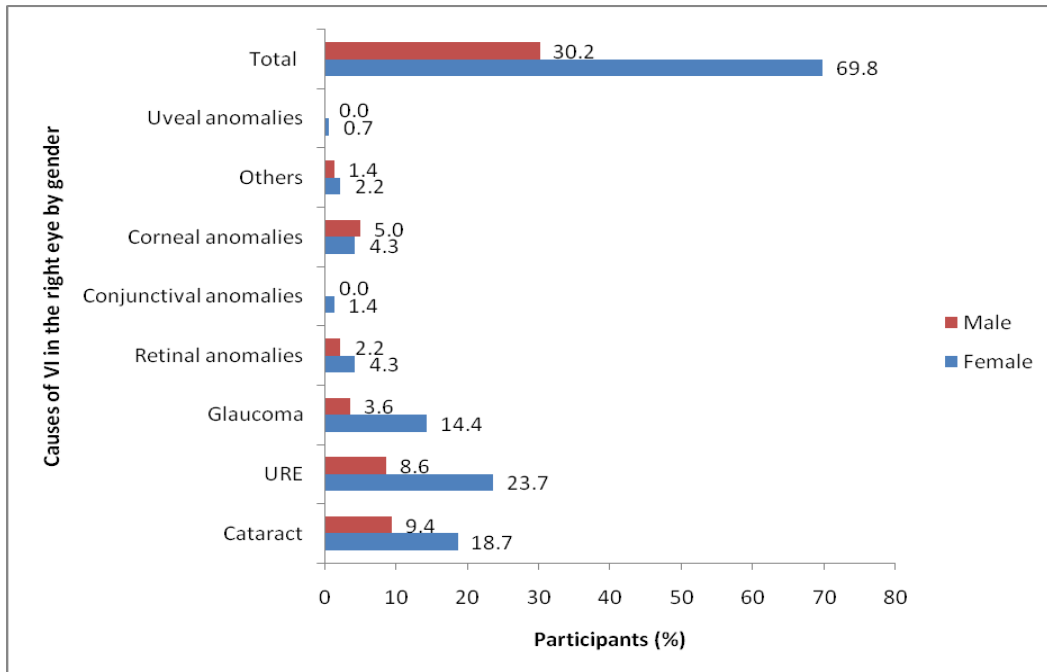
N = 108

4.10.2. Causes of visual impairment by gender

a. *Causes of visual impairment in the right eye*

The main causes of visual impairment in the right eye among females were uncorrected refractive errors (23.7%), cataract (18.7%) and glaucoma (14.4%); however among the males the main causes of visual impairment were cataract (9.4%), uncorrected refractive errors (8.6%) and corneal anomalies (5.0%). The distributions of causes of visual impairment in the right eye by gender are shown in Figure 4.34 below.





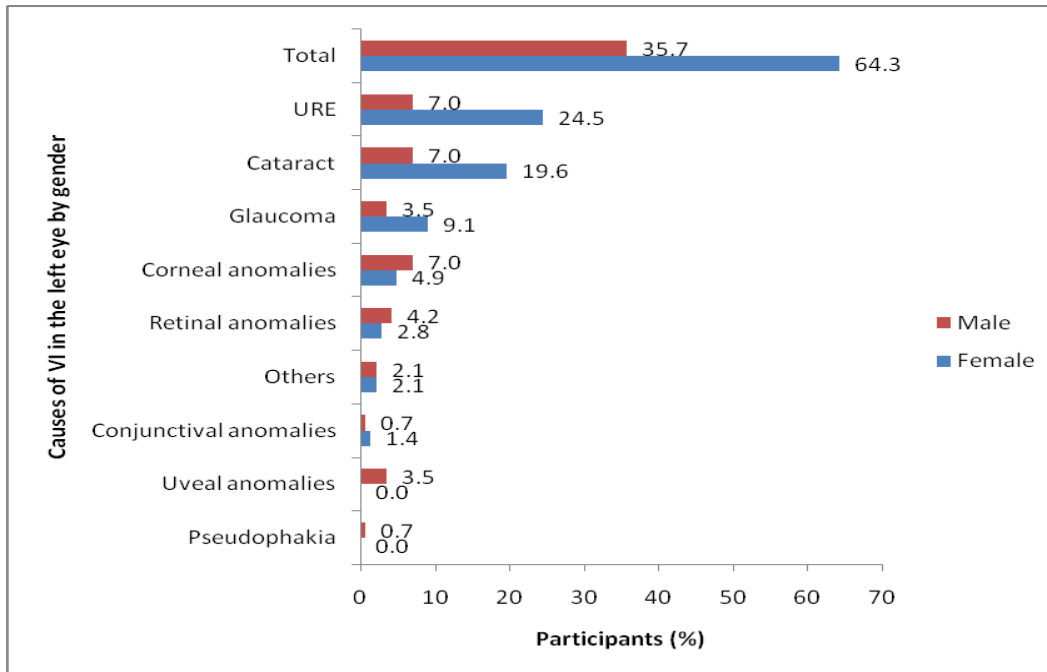
**Figure 4.34: Causes of visual impairment in the right eye by gender**

URE = uncorrected refractive errors.

Others included pthisis bulbi, orbital cellulits and enucleated eye

b. *Causes of visual impairment in the left eye*

The main causes of visual impairment in the left eye among the females were uncorrected refractive error (24.5%) and cataract (19.6%); whereas cataract, corneal anomalies and uncorrected refractive errors were the leading causes of visual impairment among males accounting for 7.0% each. The distribution of causes of visual impairment in the left eye by gender are shown in Figure 4.35 below.



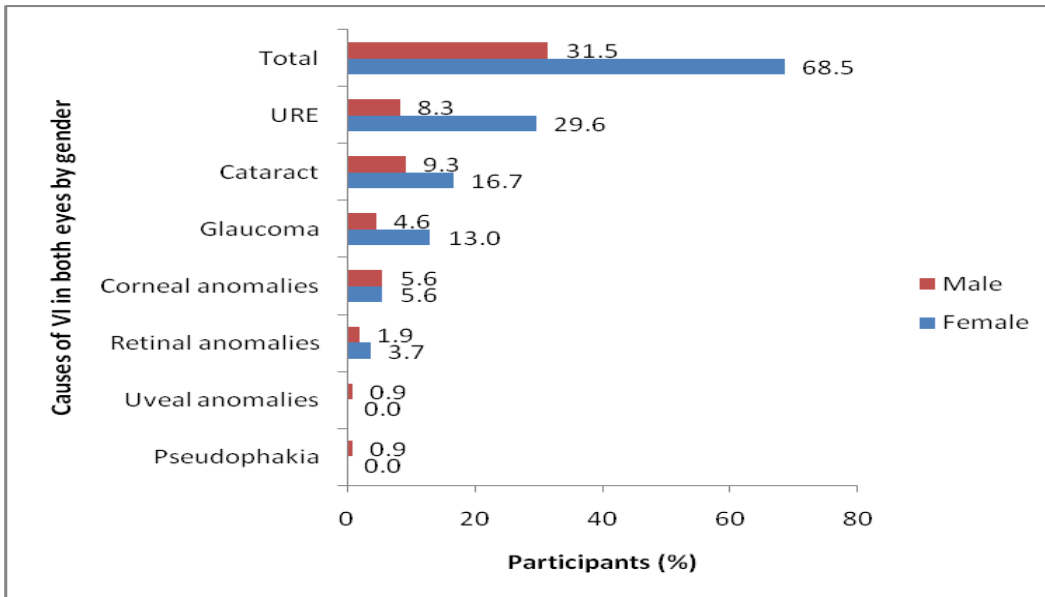
**Figure 4.35: Causes of visual impairment in the left eye by gender**

URE = uncorrected refractive errors.

Others included pthisis bulbi, orbital cellulits and enucleated eye

*c. Causes of visual impairment in both eyes*

The main causes of visual impairment in both eyes among the females were uncorrected refractive error (29.6%), cataract (16.7%) and glaucoma (13.0%). Among males, the main causes of visual impairment were cataract (9.3%), uncorrected refractive errors (8.3%) and corneal anomalies (5.6%). The distribution of causes of visual impairment in both eyes by gender are shown in Figure 4.36 below.



**Figure 4.36: Causes of visual impairment in both eyes by gender**

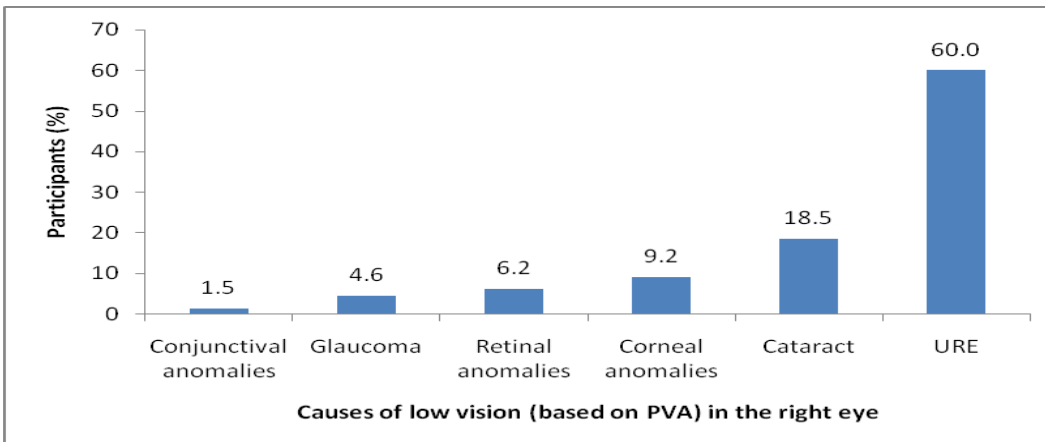
URE = uncorrected refractive errors.

Others included pthisis bulbi, orbital cellulits and enucleated eye

#### 4.11 Causes of low vision among participants

##### a. Causes of low vision in the right eye

The main causes of low vision in the right eye were uncorrected refractive errors (60.0%); cataract (18.5%) and corneal anomalies (9.2%). The distributions of causes of low vision in the right eye are shown in Figure 4.37 below.

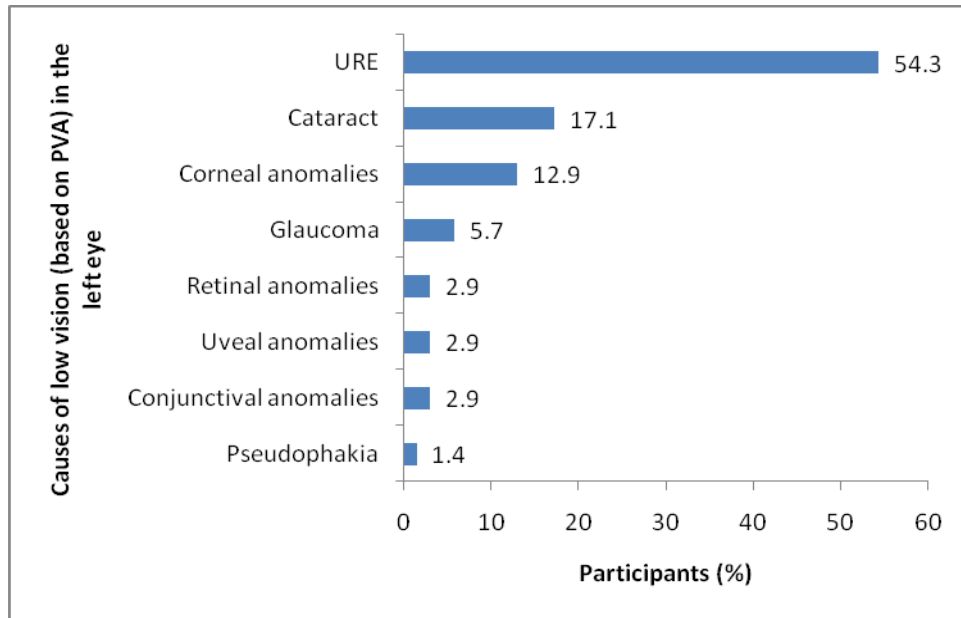


**Figure 4.37: Causes of low vision based in the right eye**

URE = uncorrected refractive errors, PVA = presenting visual acuity

b. *Causes of low vision in the left eye*

The main causes of low vision in the left eye were uncorrected refractive errors (54.3%); cataract (17.1%) and corneal anomalies (12.9%). The distributions of causes of low vision in the left eye are shown in Figure 4.38 below.



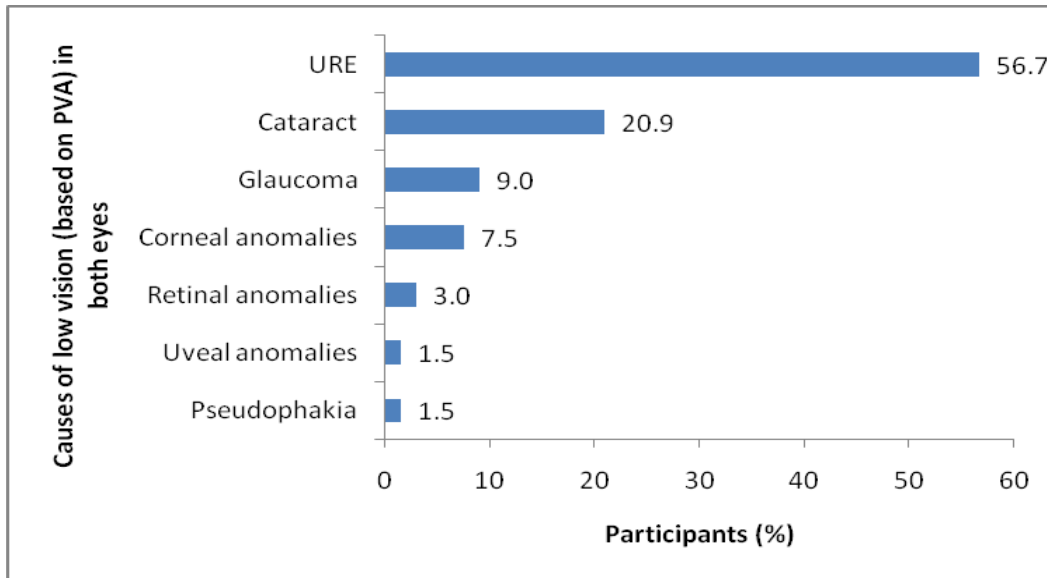
**Figure 4.38: Causes of low vision in the left eye.**

URE = uncorrected refractive errors

PVA = presenting visual acuity.

c. *Causes of low vision in both eyes*

The main causes of low vision in both eyes were uncorrected refractive errors (56.7%) and cataract (20.9%). The distributions of causes of low vision in both eyes are shown in Figure 4.39 below.



**Figure 4.39: Causes of low vision based in both eyes**

URE = uncorrected refractive errors. PVA = presenting visual acuity.

#### 4.11.1 Causes of low vision by age

##### a. Causes of low vision in the right eye

The main causes of low vision among participants aged 6 to 18 years old were uncorrected refractive errors (71.4%) and corneal anomalies (28.6%); whereas, among participants aged 19 to 35 years old, the main causes of low vision was uncorrected refractive errors (63.6%). Among participants aged 36 to 59 years old, the main causes of low vision were uncorrected refractive errors (70.6%) and corneal anomalies (23.5%). The main causes of low vision among participants aged  $\geq 60$  years old were uncorrected refractive errors (50.0%) and cataract (33.3%). Table 4.16 below shows the percentage distribution of causes of low vision in the right eye within each age group and among the total population (in bracket).

**Table 4.16: Causes of low vision in the right eye by age**

Age (years)	Causes of low vision						Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival anomalies	Corneal anomalies	
6 – 18	0.0 (0.0)	71.4 (7.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	28.6 (3.1)	100.0 (10.8)
19 – 35	9.1 (1.5)	63.6 (10.8)	9.1 (1.5)	9.1 (1.5)	9.1 (1.5)	0.0 (0.0)	100.0 (16.9)
36 – 59	5.9 (1.5)	70.6 (18.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	23.5 (6.2)	100.0 (26.2)
$\geq 60$	33.3 (15.4)	50.0 (23.1)	6.7 (3.1)	10.0 (4.6)	0.0 (0.0)	0.0 (0.0)	100.0 (46.2)
<b>Total (%)</b>	18.5 (18.5)	60.0 (60.0)	4.6 (4.6)	6.2 (6.2)	1.5 (1.5)	9.2 (9.2)	100.0 (100.0)

N= 65

b. *Causes of low vision in the left eye*

The main causes of low vision among participants aged 6 to 18 years old were uncorrected refractive errors (50.0%) and corneal anomalies (25.0%); whereas, among participants aged 19 to 35 years old, the main causes of visual impairment were uncorrected refractive errors (70.0%) and corneal anomalies (20.0%). Among participants aged 36 to 59 years old, the main cause of visual impairment was uncorrected refractive errors (65.0%). The main causes of visual impairment among participants aged  $\geq 60$  years old were uncorrected refractive errors (43.8%) and cataract (31.3%). Table 4.17 below shows the percentage distribution of causes of low vision in the left eye within each age group and among the total population (in bracket).

**Table 4.17: Causes of low vision in the left eye by age**

Age (years)	Causes of low vision								Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival anomalies	Pseudo phakia	Corneal anomalies	Uveal anomalies	
<b>6 – 18</b>	0.0 (0.0)	50.0 (5.7)	0.0 (0.0)	0.0 (0.0)	12.5 (1.4)	0.0 (0.0)	25.0 (2.9)	12.5 (1.4)	100.0 (11.4)
<b>19 – 35</b>	0.0 (0.0)	70.0 (10.0)	0.0 (0.0)	0.0 (0.0)	10.0 (1.4)	0.0 (0.0)	20.0 (2.9)	0.0 (0.0)	100.0 (14.3)
<b>36 – 59</b>	10.0 (2.9)	65.0 (18.8)	10.0 (2.9)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	10.0 (2.9)	5.0 (1.4)	100.0 (28.6)
<b><math>\geq 60</math></b>	31.3 (14.3)	43.8 (20.0)	6.3 (2.9)	6.3 (2.9)	0.0 (0.0)	3.1 (1.4)	9.4 (4.3)	0.0 (0.0)	100.0 (45.7)
<b>Total (%)</b>	17.1 (17.1)	54.3 (54.3)	5.7 (5.7)	2.9 (2.9)	2.9 (2.9)	1.4 (1.4)	12.9 (12.9)	2.9 (2.9)	100.0 (100.0)

*N* = 70

c. *Causes of low vision in both eyes*

The main cause of low vision based on presenting visual acuity among participants aged 6 – 18; 19 – 35 and 36 – 59 years old was uncorrected refractive errors accounting for 85.7%; 80.0% and 72.2% respectively. The main causes of low vision among the age range  $\geq 60$  years old were cataract (37.5%) and uncorrected refractive errors (34.4%). Table 4.18 below shows the percentage distribution of causes of low vision in both eyes within each age group and among the total population (in bracket).

**Table 4.18: Causes of low vision in both eyes by age**

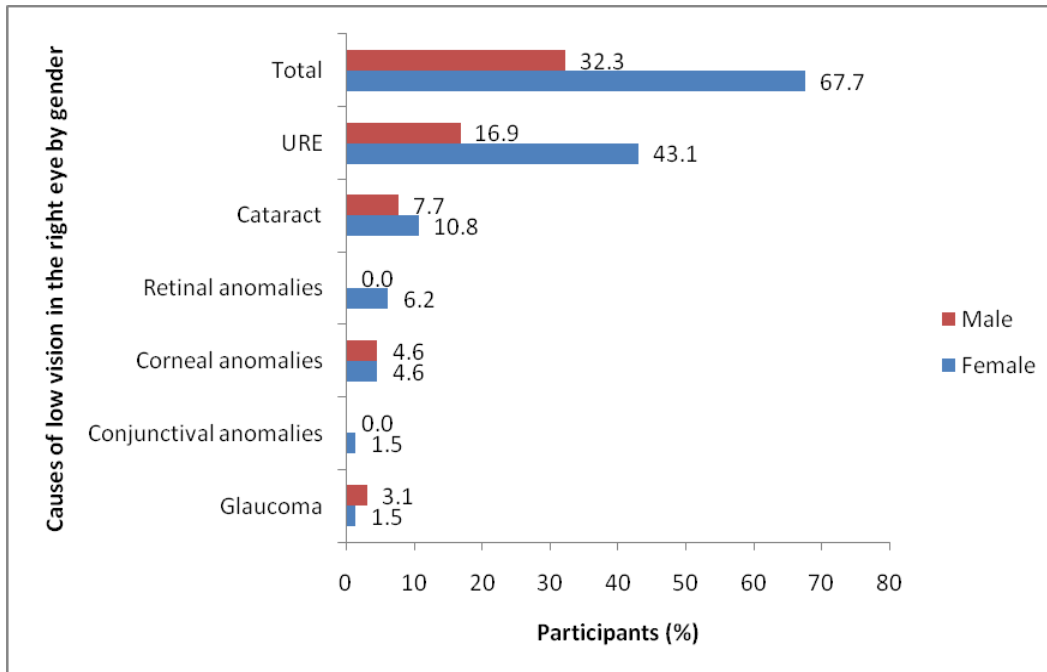
Age (years)	Causes of low vision							Total
	Cataract	URE	Glaucoma	Retinal anomalies	Pseudophakia	Corneal anomalies	Uveal anomalies	
<b>6 – 18</b>	0.0 (0.0)	85.7 (9.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	14.3 (1.5)	0.0 (0.0)	100.0 (10.4)
<b>19 – 35</b>	10.0 (1.5)	80.0 (11.9)	10.0 (13.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	100.0 (26.9)
<b>36 – 59</b>	5.6 (1.5)	72.2 (19.4)	11.1 (3.0)	0.0 (0.0)	0.0 (0.0)	11.1 (3.0)	0.0 (0.0)	100.0 (26.9)
<b>≥ 60</b>	37.5 (17.9)	34.4 (16.4)	9.4 (4.5)	6.3 (3.0)	3.1 (1.5)	6.3 (3.0)	3.1 (1.5)	100.0 (47.8)
<b>Total (%)</b>	20.9 (20.9)	56.7 (56.7)	9.0 (9.0)	3.0 (3.0)	1.5 (1.5)	7.5 (7.5)	1.5 (1.5)	100.0 (100.0)

*N* = 67

#### 4.11.2 Causes of low vision by gender

##### *a. Causes of low vision in the right eye*

The main causes of low vision among the females were uncorrected refractive errors (43.1%), cataract (10.8%) and retinal anomalies (6.2%). Among the males, the main causes of low vision were uncorrected refractive errors (16.9%), cataract (7.7%) and corneal anomalies (4.6%). The distributions of causes of low vision in the right eye by gender are shown in Figure 4.40 below.



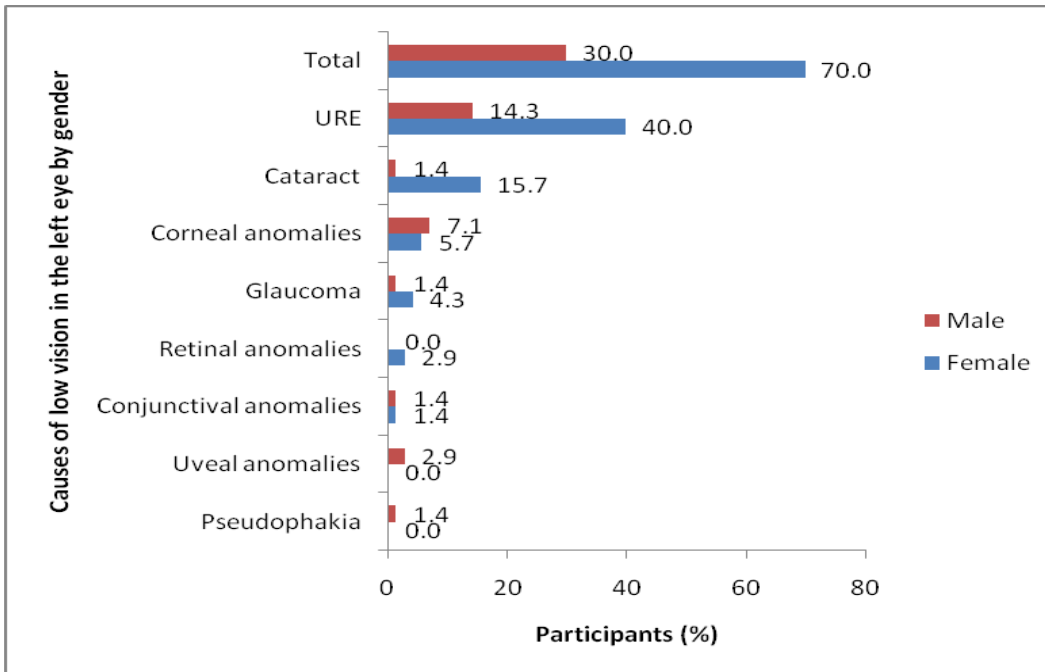
**Figure 4.40: Causes of low vision in the right eye by gender**

URE = uncorrected refractive errors

*b. Causes of low vision in the left eye*

The main causes of low vision among the females were uncorrected refractive errors (40.0%), cataract (15.7%) and corneal anomalies (5.7%). Among the males, the main causes of low vision were uncorrected refractive errors (14.3%) and corneal anomalies (7.1%). The distributions of causes of low vision in the left eye by gender are shown in Figure 4.41 below.



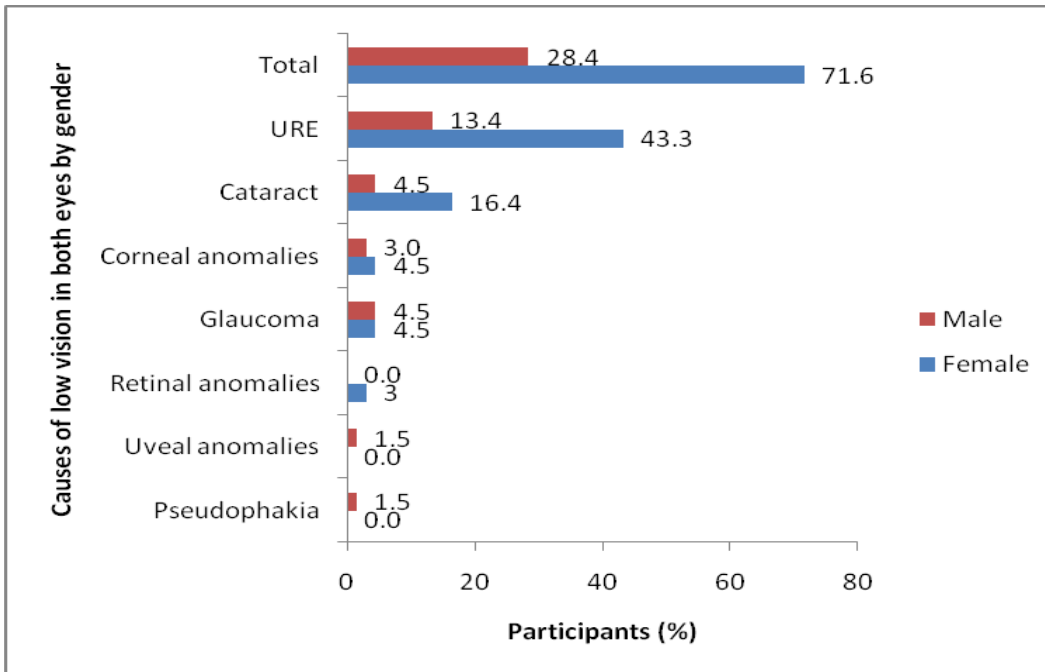


**Figure 4.41: Causes of low vision in the left eye by gender**

URE = uncorrected refractive errors

*c. Causes of low vision in both eyes*

The main causes of low vision among the females were uncorrected refractive errors (43.3%) and cataract (16.4%). Among the males, the main causes of low vision were uncorrected refractive errors (13.4%); cataract and glaucoma accounted for 4.5% each. The distributions of causes of low vision in both eyes by gender are shown in Figure 4.42 below.



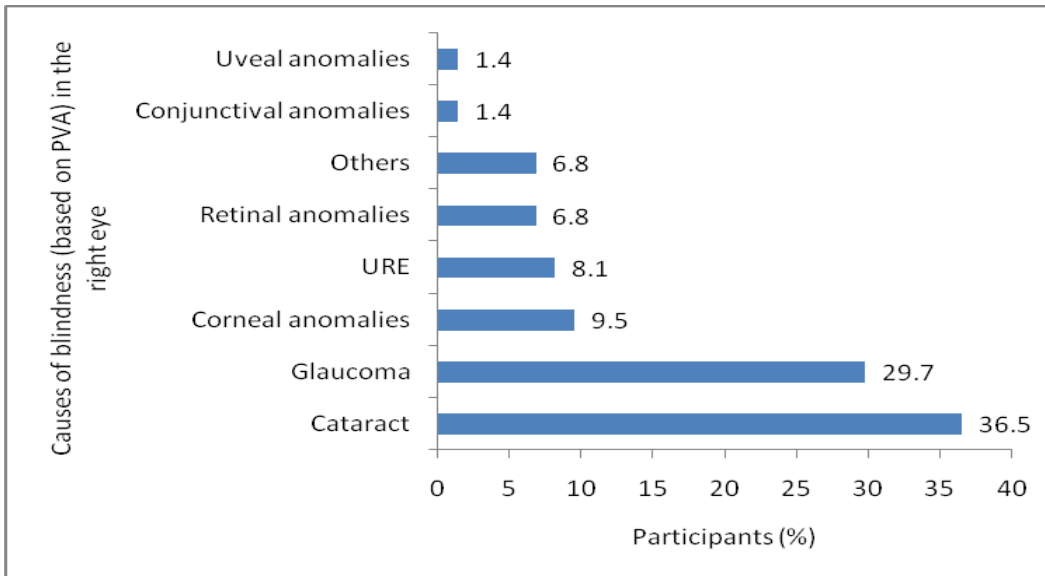
**Figure 4.42: Causes of low vision in both eyes by gender**

URE = uncorrected refractive errors

## 4.12 Causes of blindness among participants

### a. Causes of blindness in the right eye

The main causes of blindness in the right eye were cataract (36.5%) and glaucoma (29.7%). Corneal anomalies and uncorrected refractive errors accounted for 9.5% and 8.1% respectively. The distributions of causes of blindness in the right eye are shown in Figure 4.43 below.

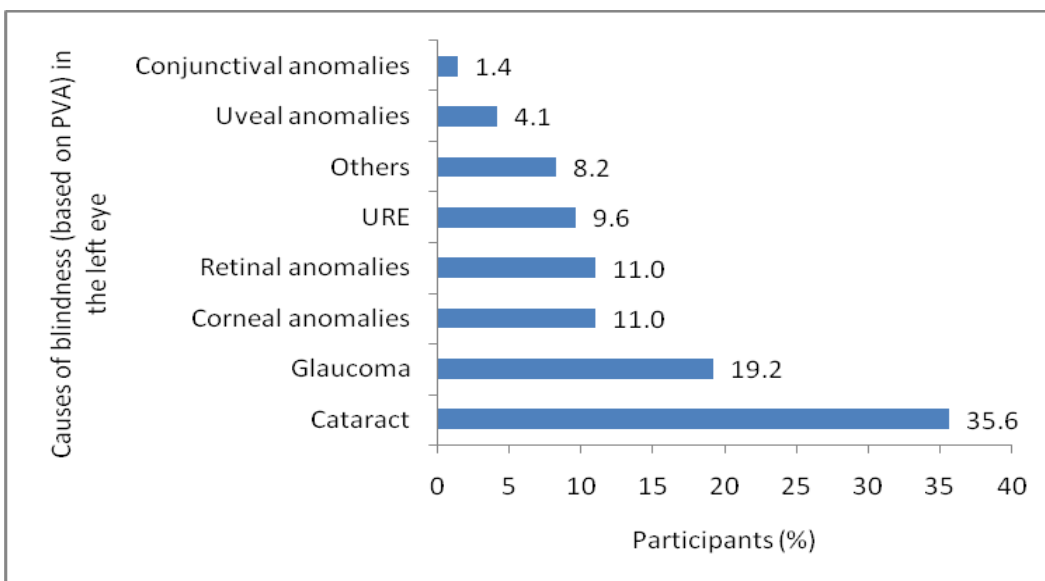


**Figure 4.43: Causes of blindness in the right eye**

URE = uncorrected refractive errors

*b. Causes of blindness in the left eye*

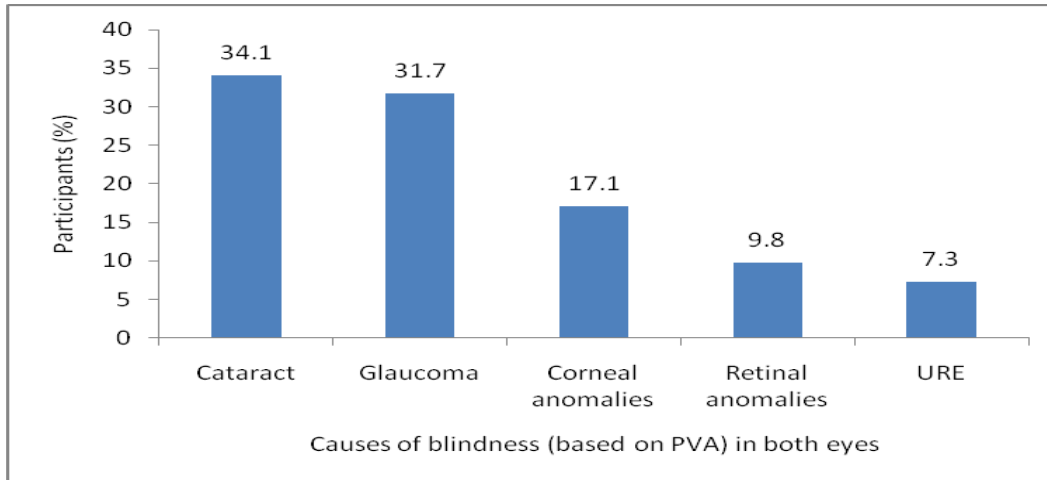
The main causes of blindness in the left eye were cataract (35.6%) and glaucoma (19.2%). Corneal anomalies and retinal anomalies accounted for 11.0% each. The distributions of causes of blindness in the left eye are shown in Figure 4.44 below.



**Figure 4.44: Causes of blindness in the left eye**

c. *Causes of blindness in both eyes*

The main causes of blindness in both eyes were cataract (34.1%) and glaucoma (31.7%). The distributions of causes of blindness in both eyes are shown in Figure 4.45 below.



**Figure 4.45: Causes of blindness in both eyes**

URE = uncorrected refractive errors

4.12.1 Causes of blindness by age

a. *Causes of blindness in the right eye*

The main causes of blindness among participants aged 6 to 18 years old were cataract (40.0%) and uncorrected refractive errors (40.0%); however, among participants aged 19 to 35 years old, the main causes of blindness were corneal anomalies (27.3%). Cataract, retinal anomalies and others (enuleated eye and pthisis bulbi) accounted for 18.2% each. Among participants aged 36 to 59 years old, the main causes of blindness were uncorrected refractive errors (34.8%) and cataract (21.7%). The main causes of blindness among participants aged  $\geq 60$  years old were cataract (51.4%) and glaucoma (37.1%). Table 4.19 below shows the percentage distribution of causes of blindness in the right eye within each age group and among the total population (in bracket).

**Table 4.19: Causes of blindness in the right eye**

Age (years)	Causes of blindness								Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival Anomalies	Corneal anomalies	Uveal anomalies	Others	
6 – 18	40.0 (2.7)	40.0 (2.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	20.0 (1.4)	0.0 (0.0)	100.0 (6.8)
19 – 35	18.2 (2.7)	0.0 (0.0)	9.1 (1.4)	18.2 (2.7)	9.1 (1.4)	27.3 (4.1)	0.0 (0.0)	18.2 (2.7)	100.0 (14.9)
36 – 59	21.7 (6.8)	13.0 (4.1)	34.8 (10.8)	13.0 (4.1)	0.0 (0.0)	8.7 (2.7)	0.0 (0.0)	8.7 (2.7)	100.0 (31.1)
≥ 60	51.4 (24.3)	2.9 (1.4)	37.1 (17.6)	0.0 (0.0)	0.0 (0.0)	5.7 (2.7)	0.0 (0.0)	2.9 (1.4)	100.0 (47.3)
<b>Total (%)</b>	36.5 (36.5)	8.1 (8.1)	29.7 (29.7)	6.8 (6.8)	1.4 (1.4)	9.5 (9.5)	1.4 (1.4)	6.8 (6.8)	100.0 (100.0)

N = 74 URE = uncorrected refractive errors

*b. Causes of blindness in the left eye*

The main causes of blindness among participants aged 6 to 18 years old were cataract, uncorrected refractive errors, retinal anomalies and corneal anomalies accounting for 22.2% each. Among participants aged 19 to 35 years old, the main causes of blindness were corneal anomalies (26.7%). Cataract and retinal anomalies accounted for 20.0% each. Among participants aged 36 to 59 years old, the main causes of blindness were cataract (33.3%). Uncorrected refractive errors and glaucoma accounted for 16.7% each. The main causes of blindness among participants aged ≥ 60 years old were cataract (48.4%) and glaucoma (29.0%). Table 4.20 below shows the percentage distribution of causes of blindness in the left eye within each age group and among the total population (in bracket).

**Table 4.20: Causes of blindness in the left eye by age**

Age (years)	Causes of blindness								Total
	Cataract	URE	Glaucoma	Retinal anomalies	Conjunctival Anomalies	Corneal anomalies	Uveal anomalies	Others	
6 – 18	22.2 (2.7)	22.2 (2.7)	0.0 (0.0)	22.2 (2.7)	0.0 (0.0)	22.2 (2.7)	11.1 (1.4)	0.0 (0.0)	100.0 (12.3)
19 – 35	20.0 (4.1)	0.0 (0.0)	13.3 (2.7)	20.0 (4.1)	0.0 (0.0)	26.7 (5.5)	6.7 (1.4)	13.3 (2.7)	100.0 (20.5)
36 – 59	33.3 (8.2)	16.7 (4.1)	16.7 (4.1)	11.1 (2.7)	5.6 (1.4)	5.6 (1.4)	0.0 (0.0)	11.1 (2.7)	100.0 (24.7)
≥ 60	48.4 (20.5)	6.5 (2.7)	29.0 (12.3)	3.2 (1.4)	0.0 (0.0)	3.2 (1.4)	3.2 (1.4)	6.5 (2.7)	100.0 (42.5)
<b>Total (%)</b>	35.6 (35.6)	9.6 (9.6)	19.2 (19.2)	11.0 (11.0)	1.4 (1.4)	11.0 (11.0)	4.1 (4.1)	8.2 (8.2)	100.0 (100.0)

N = 73 URE = uncorrected refractive errors

*c. Causes of blindness in both eyes*

The leading cause of blindness in both eyes among the age range 6 – 18 years old were cataract (66.7%) and corneal anomalies (33.3%). Among the age range 19 – 35 years old, the leading cause of blindness was corneal anomalies (57.1%). Glaucoma (30.0%), cataract (20.0%), URE (20.0%) and retinal anomalies (20.0%) were the main causes of blindness among the age range 36 – 59 years old. The main causes of blindness among the age range  $\geq 60$  years old were cataract and glaucoma accounting for 42.9% each. Table 4.21 below shows the percentage distribution of causes of blindness in both eyes within each age group and among the total population (in bracket).

**Table 4.21: Causes of blindness in both eyes by age**

Age (year)	Causes of blindness					Total
	Cataract	URE	Glaucoma	Retinal anomalies	Corneal anomalies	
<b>6 – 18</b>	66.7 (4.9)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	33.3 (2.4)	100.0 (7.3)
<b>19 – 35</b>	14.3 (2.4)	0.0 (0.0)	14.3 (2.4)	14.3 (2.4)	57.1 (9.8)	100.0 (17.1)
<b>36 – 59</b>	20.0 (4.9)	20.0 (4.9)	30.0 (7.3)	20.0 (4.9)	10.0 (2.4)	100.0 (24.4)
<b><math>\geq 60</math></b>	42.9 (22.0)	4.8 (2.4)	42.9 (22.0)	4.8 (2.4)	4.8 (2.4)	100.0 (51.2)
<b>Total (%)</b>	34.1 (34.1)	7.3 (7.3)	31.7 (31.7)	9.8 (9.8)	17.1 (17.1)	100.0 (100.0)

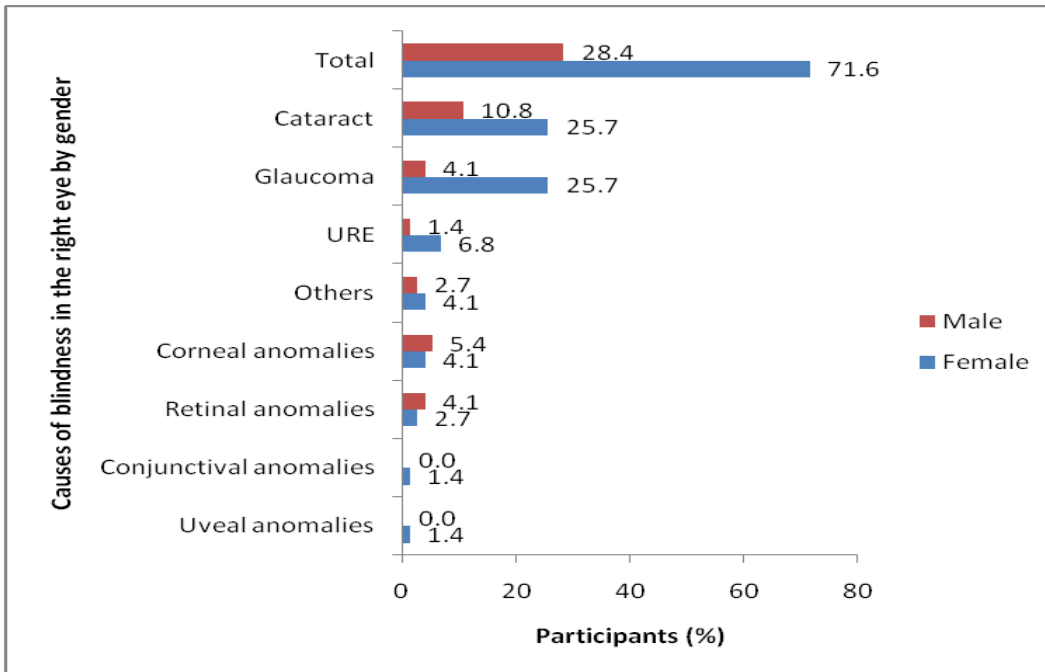
$N = 41$

URE = uncorrected refractive errors

4.12.2 Causes of blindness by gender

*a. Causes of blindness in the right eye*

The main causes of blindness among the females were cataract and glaucoma accounting for 25.7% each. Among the males, the main causes of blindness were cataract (10.8%) and corneal anomalies (5.4%). The distributions of causes of blindness in the right eye by gender are shown in Figure 4.46 below.



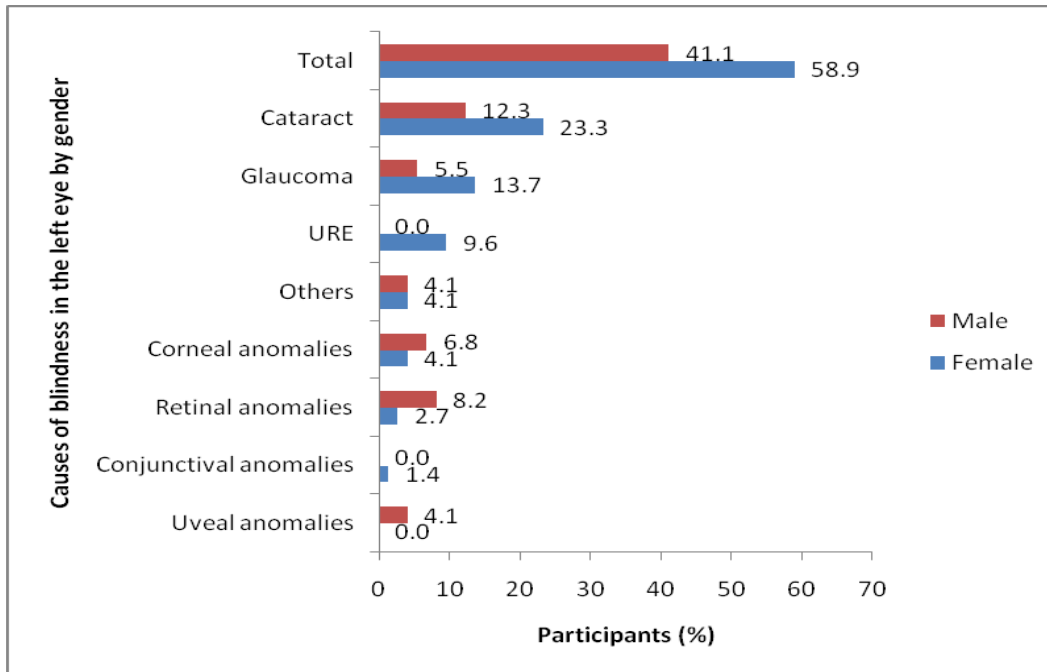
**Figure 4.46: Causes of blindness in the right eye by gender**

URE = uncorrected refractive errors

Others included pthisis bulbi, orbital cellulits and enucleated eye

*b. Causes of blindness in the left eye*

The main causes of blindness among the females were cataract (23.3%) and glaucoma (13.7%). Among the males, the main causes of blindness were cataract (12.3%) and corneal anomalies (6.8%). The distributions of causes of blindness in the left eye by gender are shown in Figure 4.47 below.



**Figure 4.47: Causes of blindness in the left eye by gender**

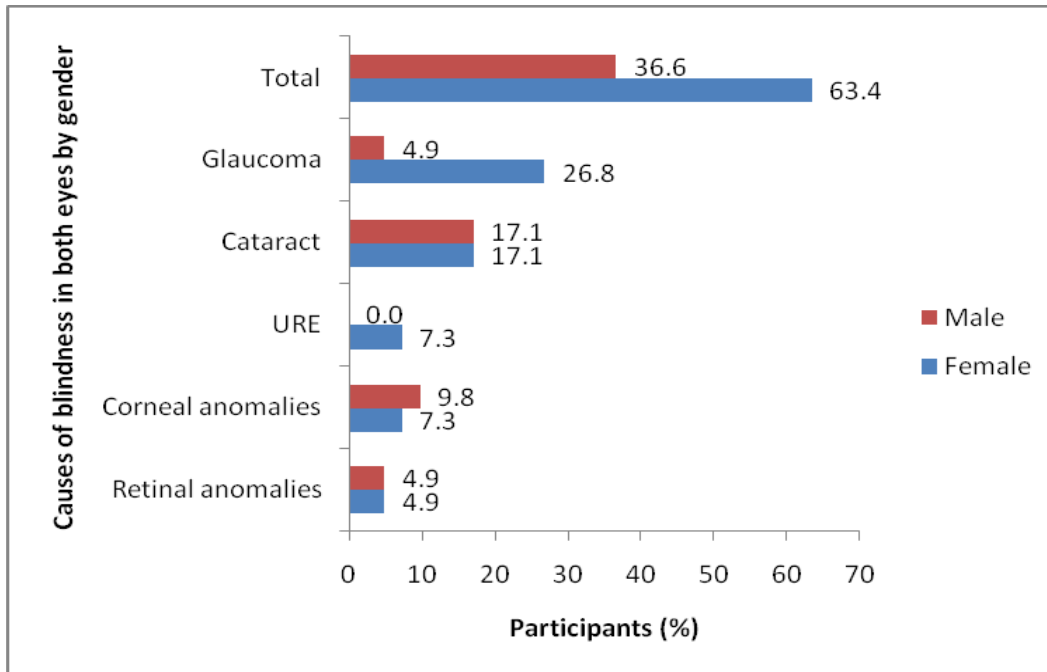
URE = uncorrected refractive errors

Others included pthisis bulbi, orbital cellulitis and enucleated eye

*c. Causes of blindness in both eyes*

The main causes of blindness among the females were glaucoma (26.8%) and cataract (17.1%). Among the males, the main causes of blindness were cataract (17.1%) and corneal anomalies (9.8%). The distributions of causes of blindness in both eyes by gender are shown in Figure 4.48 below.





**Figure 4.48: Causes of blindness in both eyes by gender**

URE = uncorrected refractive errors

### 4.13 Refractive status in relation to visual impairment

#### 4.13.1 Refractive status by age

##### a. Refractive status in the right eye

Of those participants who were visual impairment in the right eye due to uncorrected refractive errors, myopia was highest accounting for 71.1% than hyperopia (28.9%). Among participants aged 6 to 18 years old and 19 to 35 years old, myopia accounted for 100.0% of refractive errors each. The prevalence of hyperopia was higher among the age range 36 – 59 years accounting for 53.3% than myopia (46.7%). Myopia accounted for 68.8% among participants aged  $\geq 60$  years old and the prevalence of myopia was highest among all age groups accounting for 24.4%. Table 4.22 below shows the percentage distribution of refractive status among the visually impaired participants in the right eye within each age group and among the total population (in bracket).

**Table 4.22: Refractive status in the right eye by age among participants who were visually impaired due to uncorrected refractive errors**

Age (years)	Type of refractive error		Total
	Myopia	Hyperopia	
<b>6 – 18</b>	100.0 (15.6)	0.0 (0.0)	100.0 (15.6)
<b>19 – 35</b>	100.0 (15.6)	0.0 (0.0)	100.0 (15.6)
<b>36 – 59</b>	46.7 (15.6)	53.3 (17.8)	100.0 (33.3)
<b>≥ 60</b>	68.8 (24.4)	31.3 (11.1)	100.0 (35.6)
<b>Total (%)</b>	71.1 (71.1)	28.9 (28.9)	100.0 (100.0)

*N* = 45

*b. Refractive status in the left eye*

Among participants who were visual impairment in the left eye due to uncorrected refractive errors, the prevalence of myopia was higher than hyperopia accounting for 64.4% and 35.6% respectively. Myopia was the main cause of refractive errors among participants aged 6 to 18 and 19 to 35 years old accounting for 100.0% and 85.7% respectively. Among participants aged 36 to 59 years old, hyperopia was the main cause of refractive error accounting for 56.3%. Among participants aged 60 years and older, myopia was the main cause of refractive error accounting for 62.5%. Table 4.23 below shows the percentage distribution of refractive status among the visually impaired participants in the left eye within each age group and among the total population (in bracket).

**Table 4.23: Refractive status in the left eye by age among participants who were visually impaired due to uncorrected refractive errors**

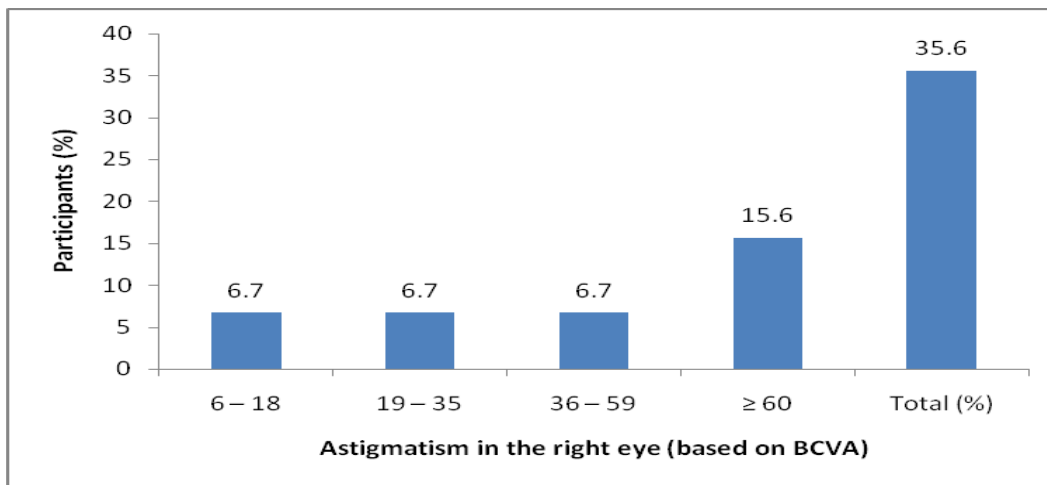
Age (years)	Type of refractive error		Total
	Myopia	Hyperopia	
<b>6 – 18</b>	100.0 (13.3)	0.0 (0.0)	100.0 (13.3)
<b>19 – 35</b>	85.7 (13.3)	14.3 (2.2)	100.0 (15.6)
<b>36 – 59</b>	43.8 (15.6)	56.3 (20.0)	100.0 (35.6)
<b>≥ 60</b>	62.5 (22.2)	37.5 (13.3)	100.0 (35.6)
<b>Total (%)</b>	64.4 (64.4)	35.6 (35.6)	100.0 (100.0)

*N* = 45

#### 4.13.2 Astigmatism and visual impairment

##### a. Astigmatism in the right eye by age

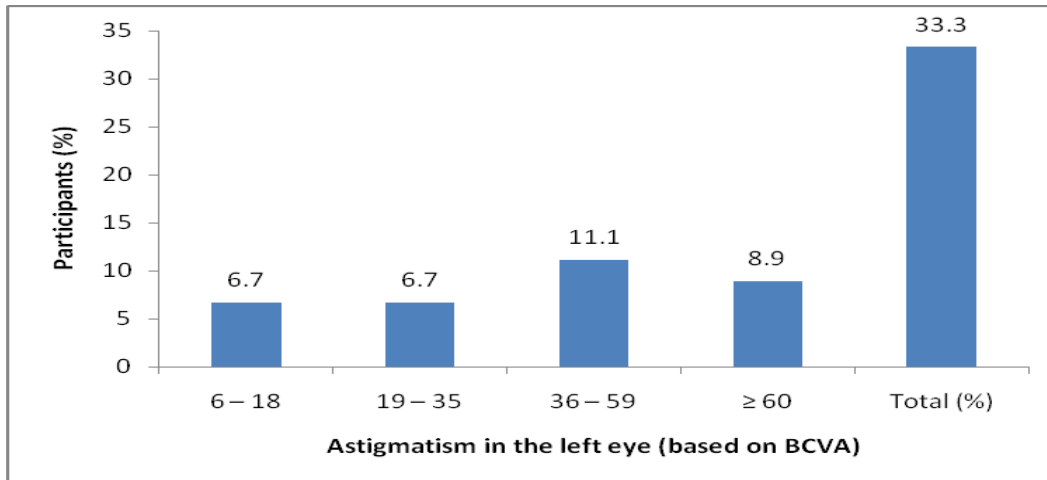
The prevalence of astigmatism in the right eye was 35.6%. The prevalence ( $N = 400$ ) of astigmatism was highest (15.6%) among participants aged  $\geq 60$  years old. The prevalence was highest (43.8%) among those  $\geq 60$  years and older and lowest (20.0%) among those 36 to 59 years old ( $N = 100$ ). Distributions of astigmatism in the right eye are shown in Figure 4.49 below.



**Figure 4.49: Astigmatism in the right eye by age**

##### b. Astigmatism in the left eye

The prevalence of astigmatism in the left eye was 33.3%. The prevalence of astigmatism was highest (11.1%) among participants aged 36 to 59 years old ( $N = 400$ ). The prevalence was highest (50.0%) among those 6 to 18 years old and lowest (25.0%) among those 60 years and older ( $N = 100$ ). Distributions of astigmatism in the left eye are shown in Figure 4.50 below.



**Figure 4.50: Astigmatism in the left eye by age**

#### 4.13.3 Refractive status by gender

##### a. Refractive status by gender in the right eye

Females had higher prevalence of myopia (68.8%) and hyperopia (84.6%) than males accounting for 31.3% and 15.4% respectively. Astigmatism accounted for 50.0% among both males and females. The distributions of refractive status by gender in the right eye among participants who were visually impaired due to uncorrected refractive errors are shown in Table 4.24 below.

**Table 4.24: Refractive status by gender in the right eye**

Age (Years)	Refractive error type (%)					
	Myopia		Hyperopia		Astigmatism	
	Male	Female	Male	Female	Male	Female
6 – 18	3.1	18.8	0.0	0.0	0.0	18.8
19 – 35	9.4	12.5	0.0	0.0	12.5	6.3
36 – 59	0.0	21.9	0.0	61.5	0.0	18.8
≥ 60	18.8	15.6	15.4	23.1	37.5	6.3
Total (%)	31.3	68.8	15.4	84.6	50.0	50.0

b. *Refractive status by gender in the left eye*

Females had higher prevalence of myopia (72.4%), hyperopia (87.5%) and astigmatism (60.0%) than males accounting for myopia (27.6%), hyperopia (12.5%) and astigmatism (40.0%) respectively. The distributions of refractive errors by gender in the left eye among participants who were visually impaired due to uncorrected refractive errors are shown in Table 4.25 below.

**Table 4.25: Refractive status by gender in the left eye**

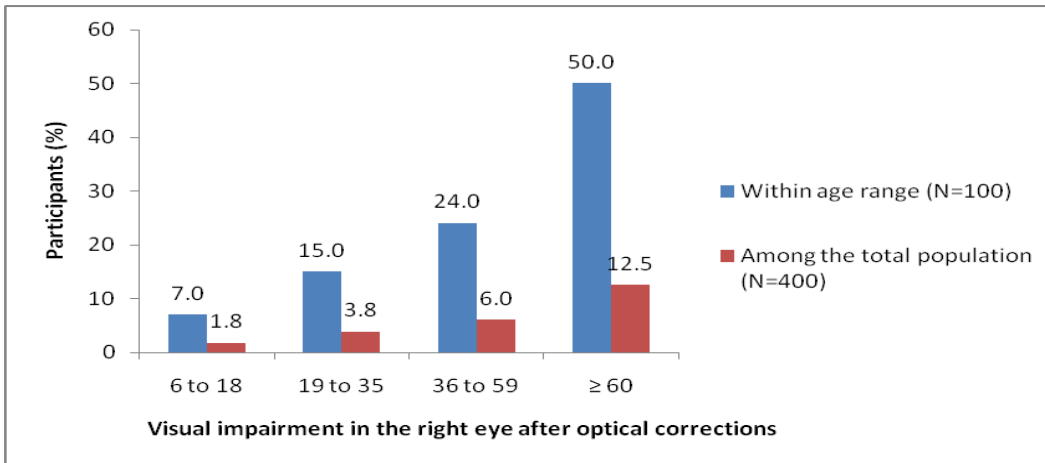
Age (Years)	Refractive error type (%)					
	Myopia		Hyperopia		Astigmatism	
	Male	Female	Male	Female	Male	Female
6 – 18	3.4	17.2	0.0	0.0	0.0	20.0
19 – 35	6.9	13.8	0.0	6.3	6.7	13.3
36 – 59	3.4	20.7	6.3	50.0	13.3	20.0
≥ 60	13.8	20.7	6.3	31.3	20.0	6.7
Total (%)	27.6	72.4	12.5	87.5	40.0	60.0

#### 4.14 Visual impairment after optical correction

##### 4.14.1 Visual impairment after optical corrections by age

a. *Visual impairment in the right eye*

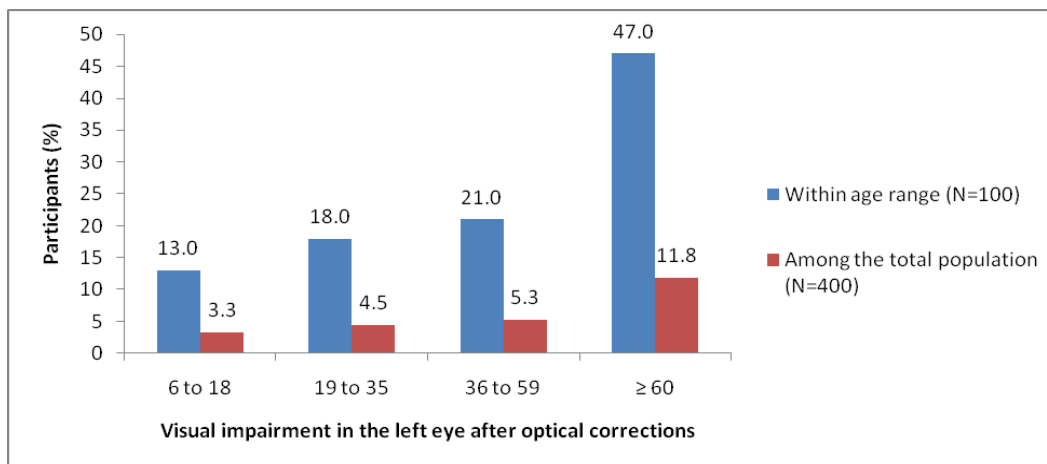
The prevalence of visual impairment in the right eye after optical corrections was 24.0%. The prevalence of visual impairment was highest (12.5%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and least (1.8%) among participants aged 6 to 18 years old (Figure 4.50). The prevalence was highest (50.0%) among participants aged 60 years and older and lowest (7.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age ( $\chi^2 = 57.35$ ;  $df = 3$  and  $p = 0.00$ ) and visual impairment in the right eye, however, there was no association between gender ( $\chi^2 = 3.33$ ;  $df = 1$  and  $p = 0.07$ ) and visual impairment. The distributions of visual impairment after optical compensation in the right eye are shown in Figure 4.51 below.



**Figure 4.51: Visual impairment in the right eye after optical corrections**

*b. Visual impairment in the left eye*

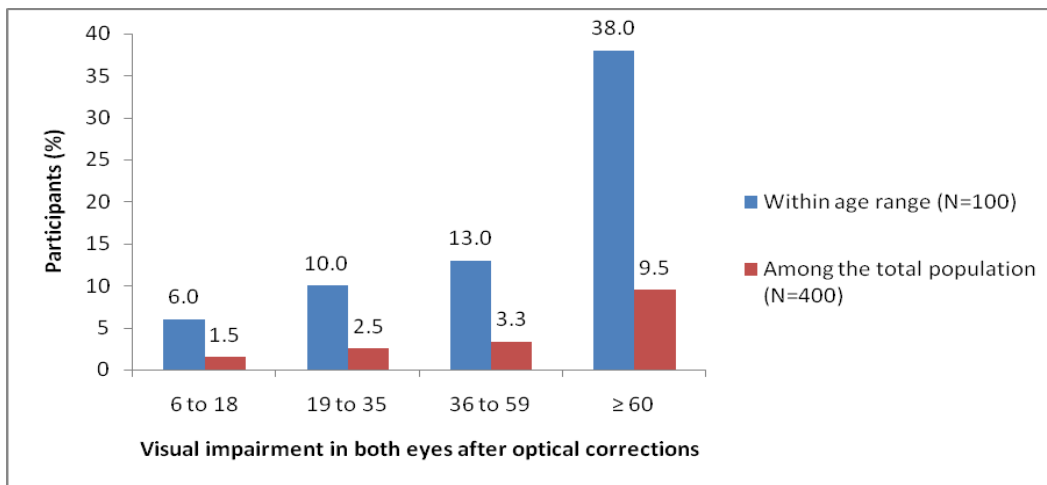
The prevalence of visual impairment in the left eye after optical corrections was 24.8%. The prevalence of visual impairment was highest (11.8%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and least (3.3%) among participants aged 6 to 18 years old (Figure 4.51). The prevalence was highest (47.0%) among participants aged 60 years and older and lowest (13.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age ( $\chi^2 = 37.20$ ;  $df = 3$  and  $p = 0.00$ ) and visual impairment in the left eye, however, there was no association between gender ( $\chi^2 = 0.26$ ;  $df = 1$  and  $p = 0.61$ ) and visual impairment. The distributions of visual impairment after optical compensation in the left eye are shown in Figure 4.52 below.



**Figure 4.52: Visual impairment in the left eye after optical corrections**

c. *Visual impairment in both eyes*

The prevalence of visual impairment in both eyes after optical corrections was 16.8%. The prevalence of visual impairment was highest (9.5%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and least (1.5%) among participants aged 6 to 18 years old (Figure 4.52). The prevalence was highest (38.0%) among participants aged 60 years and older and lowest (6.0%) among those 6 – 18 years old ( $N = 100$ ). There was significant association between age ( $\chi^2 = 44.94$ ;  $df = 3$  and  $p = 0.00$ ) and visual impairment in both eyes, however, there was no association between gender ( $\chi^2 = 0.29$ ;  $df = 1$  and  $p = 0.59$ ) and visual impairment. The distributions of visual impairment after optical compensation in both eyes are shown in Figure 4.53 below.

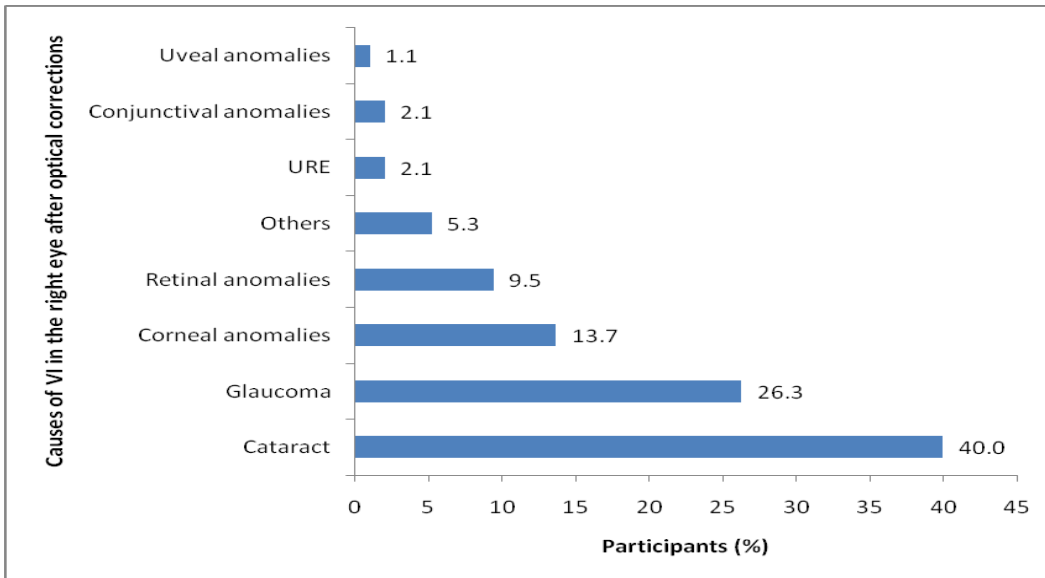


**Figure 4.53: Visual impairment in both eyes after optical corrections**

4.14.2 Causes of visual impairment after optical corrections

a. *Causes of visual impairment in the right eye*

The main causes of visual impairment in the right eye after optical corrections were cataract (40.0%), glaucoma (26.3%) and corneal anomalies (13.7%). The distributions of causes of visual impairment in the right eye after optical corrections are shown in Figure 4.54 below.

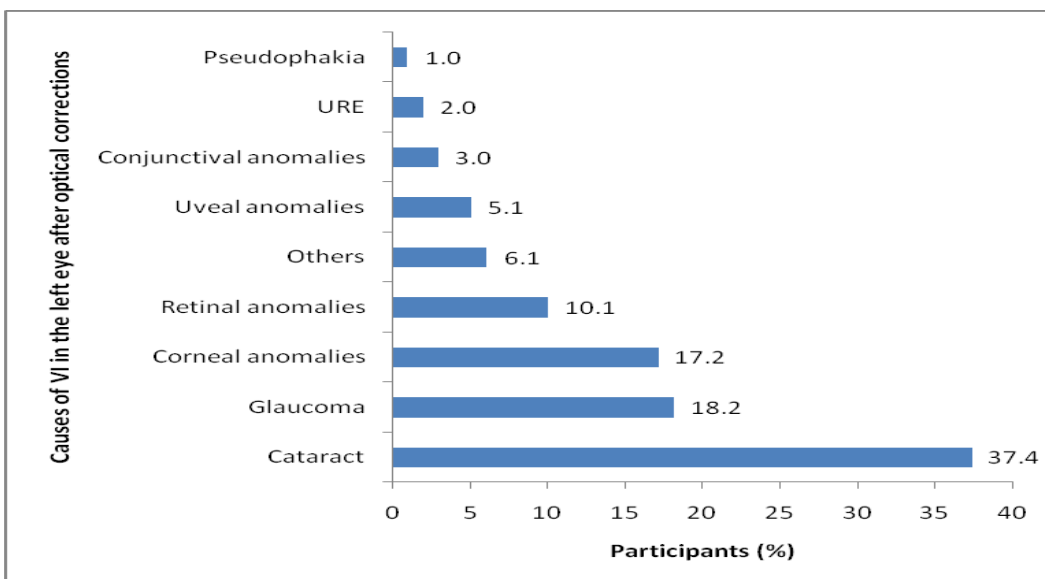


**Figure 4.54: Causes of visual impairment in the right eye.**

URE = uncorrected refractive errors

*b. Causes of visual impairment in the left eye*

The main causes of visual impairment in the left eye after optical corrections were cataract (37.4%), glaucoma (18.2%) and corneal anomalies (17.2%). The distributions of causes of visual impairment in the left eye after optical corrections are shown in Figure 4.55 below.

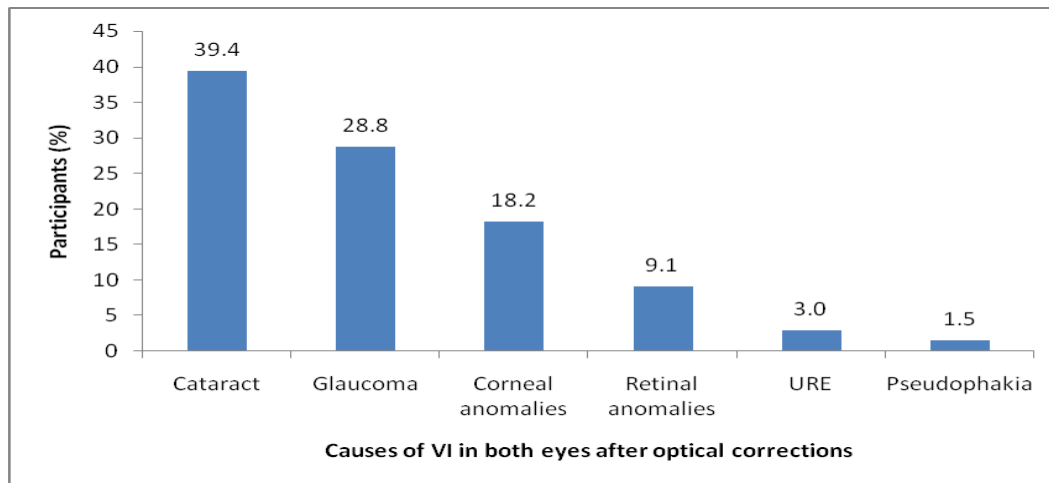


**Figure 4.55: Causes of visual impairment in the left eye**



c. Causes of visual impairment in both eyes

The main causes of visual impairment in both eyes after optical corrections were cataract (39.4%), glaucoma (28.8%) and corneal anomalies (18.2%). The distributions of causes of visual impairment in both eyes after optical corrections are shown in Figure 4.56 below.



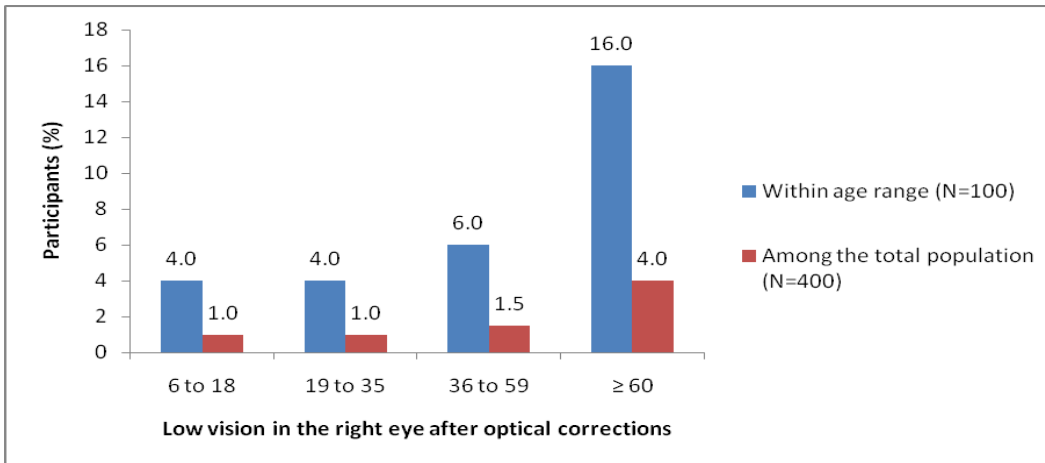
**Figure 4.56: Causes of visual impairment in both eyes**

URE = uncorrected refractive errors

4.14.3 Low vision after optical corrections

a. *Low vision in the right eye*

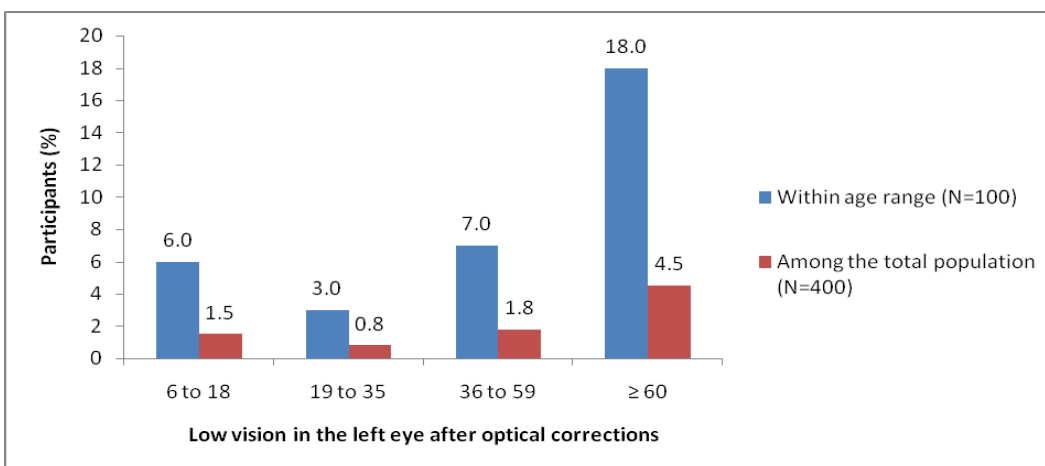
The prevalence of low vision in the right eye after optical corrections was 7.5%. The prevalence of low vision was highest (4.0%) among participants ( $N = 400$ ) aged  $\geq 60$  years old (Figure 4.56). The prevalence was highest (16.0%) among participants ( $N = 100$ ) aged 60 years and older and lowest (4.0%) among those 6 – 18 years and 19 to 35 years old. There was an association between age ( $\chi = 14.27$ ;  $df = 3$  and  $p = 0.00$ ) and low vision in the right eye, however, there was no association between gender ( $\chi = 0.00$ ;  $df = 1$  and  $p = 0.98$ ) and low vision. The distributions of low vision after optical correction in the right eye are shown in Figure 4.57 below.



**Figure 4.57: Low vision in the right eye**

b. *Low vision in the left eye*

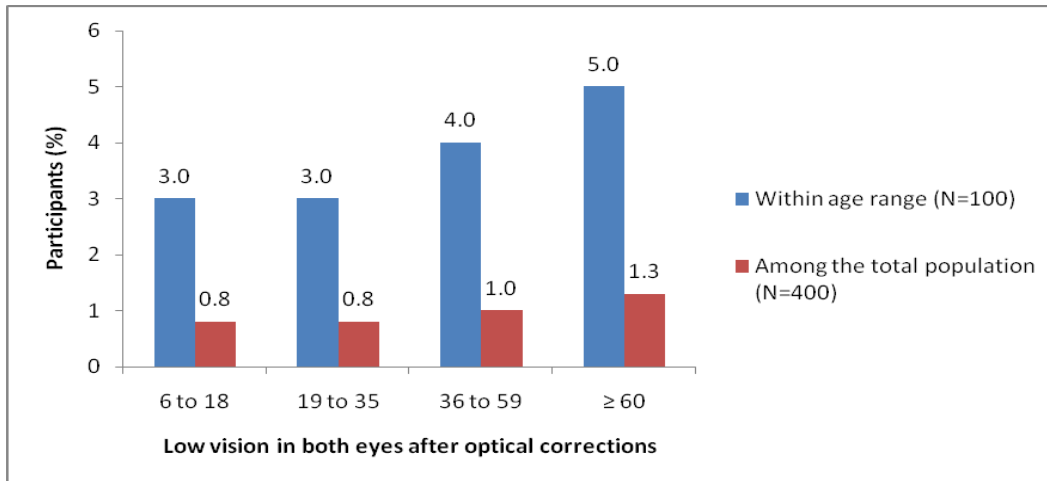
The prevalence of low vision in the left eye after optical corrections was 8.5%. The prevalence of low vision was highest (4.5%) among participants (N= 400) aged  $\geq 60$  years old and least (0.8%) among participants aged 19 to 35 years old (Figure 4.57). The prevalence was highest (18.0%) among participants (N = 100) aged 60 years and older and lowest (3.0%) among those 19 to 35 years old. There was an association between age (chi = 16.59; df = 3 and  $p = 0.00$ ) and low vision in the left eye, however, there was no association between gender (chi = 0.38; df = 1 and  $p = 0.54$ ) and low vision. The distributions of low vision after optical corrections in the left eye are shown in Figure 4.58 below.



**Figure 4.58: Low vision in the left eye**

c. *Low vision in both eyes*

The prevalence of low vision in the both eyes after optical corrections was 3.8%. The prevalence of low vision was highest (1.3%) among participants ( $N = 400$ ) aged  $\geq 60$  years old (Figure 4.58). The prevalence was highest (5.0%) among participants ( $N = 100$ ) aged 60 years and older and lowest (3.0%) among those 6 to 18 years and 19 to 35 years old. There was significant no association between age ( $\chi^2 = 0.76$ ;  $df = 3$  and  $p = 0.86$ ) and gender ( $\chi^2 = 0.00$ ;  $df = 1$  and  $p = 0.98$ ) and low vision. The distributions of low vision after optical corrections in both eyes are shown in Figure 4.59 below.

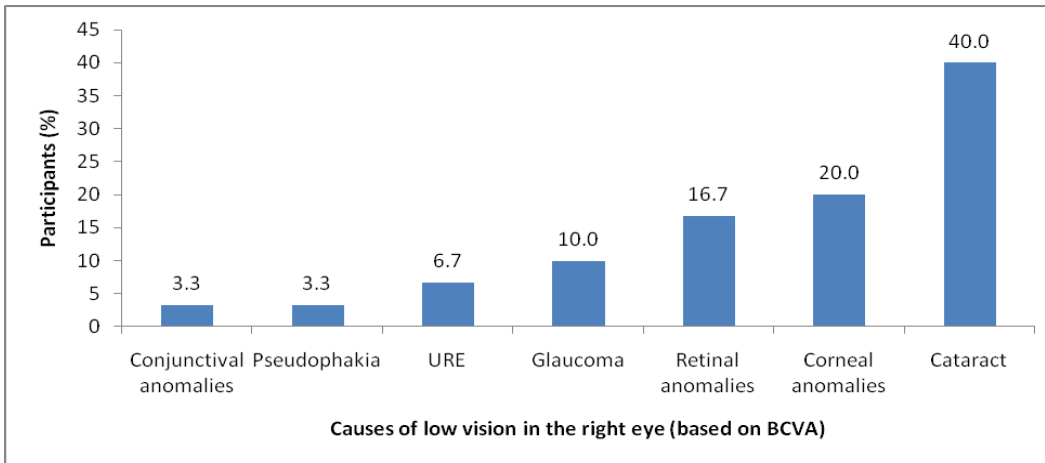


**Figure 4.59: Low vision in both eyes**

4.14.4 Causes of low vision after optical corrections

a. *Causes of low vision in the right eye*

The leading causes of low vision in the right eye after optical corrections were cataract (40.0%), corneal anomalies (20.0%) and retinal anomalies (16.7%). The distribution of causes of low vision in the right eye are shown in Figure 4.60 below.

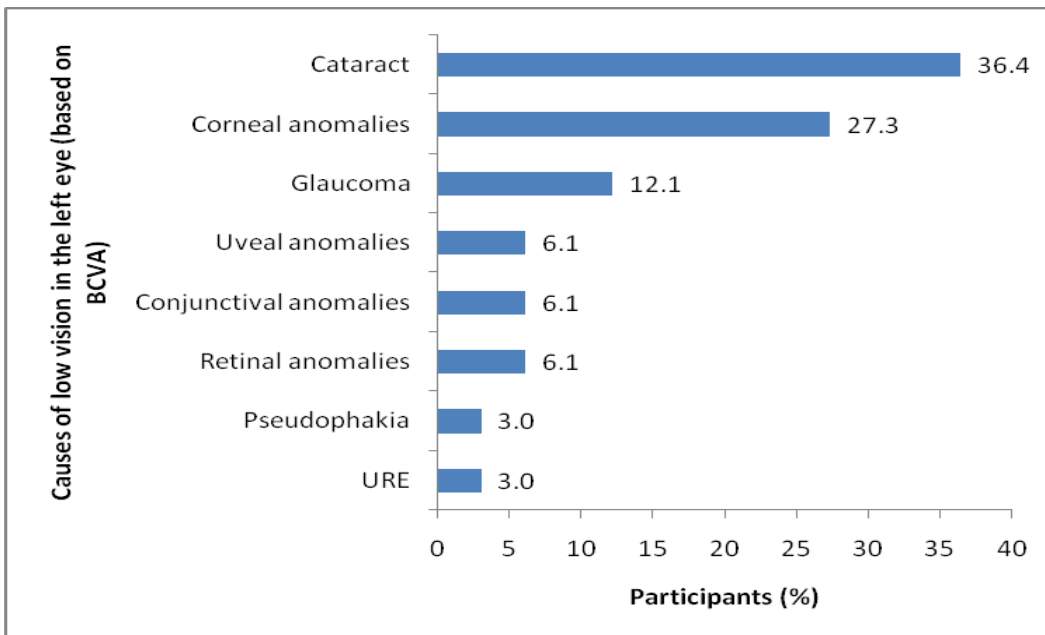


**Figure 4.60: Causes of low vision in the right eye**

URE = uncorrected refractive errors

*b. Causes of low vision in the left eye*

The leading causes of low vision in the left eye after optical corrections were cataract (36.4%), corneal anomalies (27.3%) and glaucoma (12.1%). The distribution of causes of low vision in the left eye are shown in Figure 4.61 below.

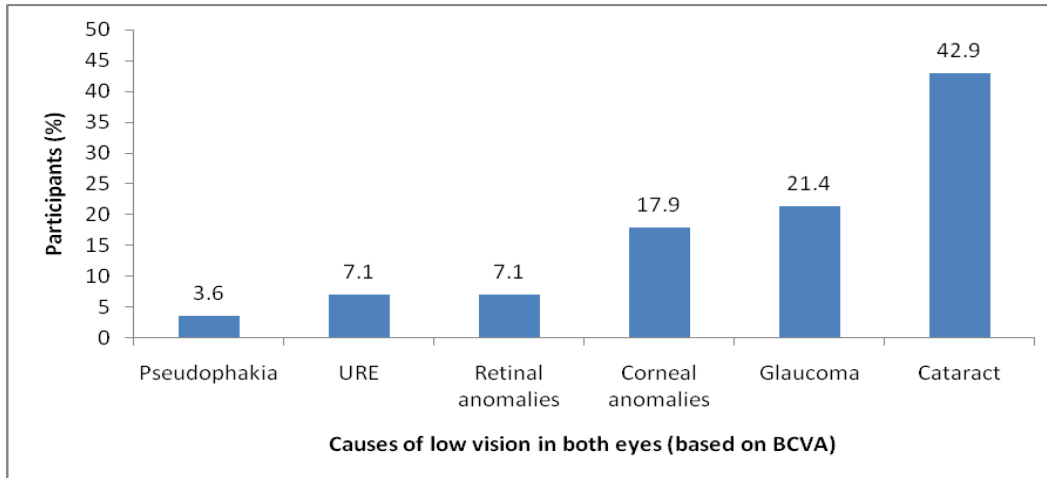


**Figure 4.61: Causes of low vision in the left eye**

URE = uncorrected refractive errors

c. *Causes of low vision in both eyes*

The leading causes of low vision in both eyes after optical corrections were cataract (42.9%), glaucoma (21.4%) and corneal anomalies (17.9%). The distribution of causes of low vision in both eyes are shown in Figure 4.62 below.



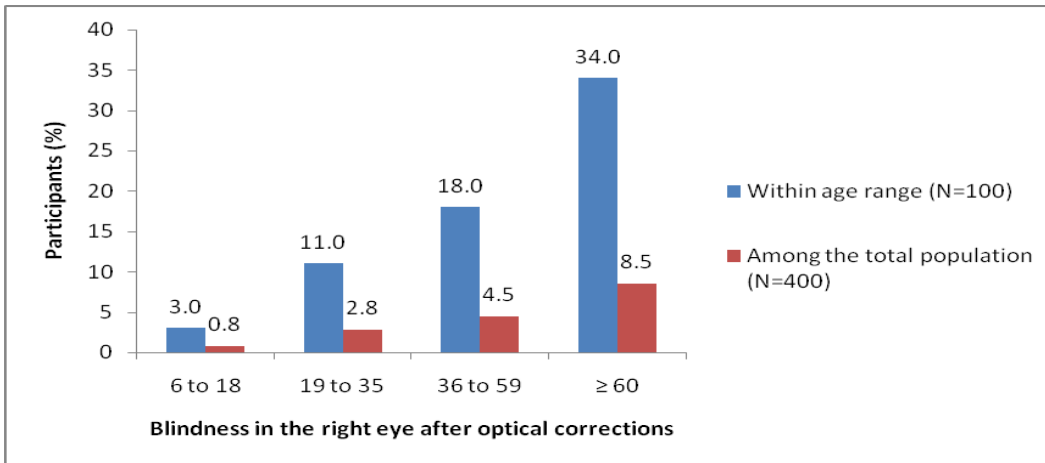
**Figure 4.62: Causes of low vision in both eyes**

URE = uncorrected refractive errors

4.14.5 Blindness based after optical corrections

a. *Blindness in the right eye*

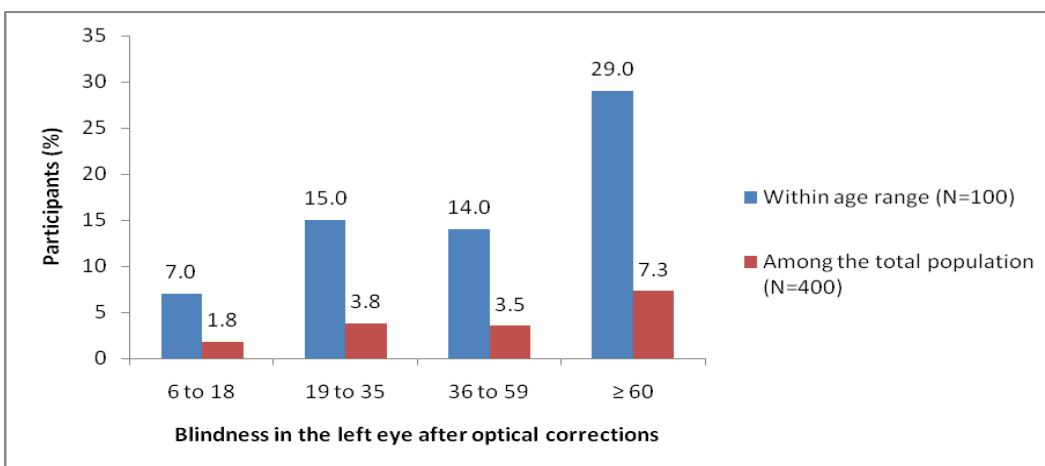
The prevalence of blindness in the right eye after optical corrections was 16.5%. The distributions of blindness was highest (8.5%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and lowest (0.8) among those aged 6 to 18 years old (Figure 4.62). The prevalence was highest (34.0%) among participants ( $N = 100$ ) aged 60 years and older and lowest (3.0%) among those 6 to 18 years old. There was a significant association between age ( $\text{Chi} = 37.81$ ;  $\text{df} = 3$ ;  $p = 0.00$ ) and gender ( $\text{Chi} = 4.32$ ;  $\text{df} = 1$ ;  $p = 0.04$ ) with blindness. The prevalence of blindness in the right eye after optical corrections is shown in Figure 4.63 below.



**Figure 4.63: Blindness in the right eye**

*b. Blindness in the left eye*

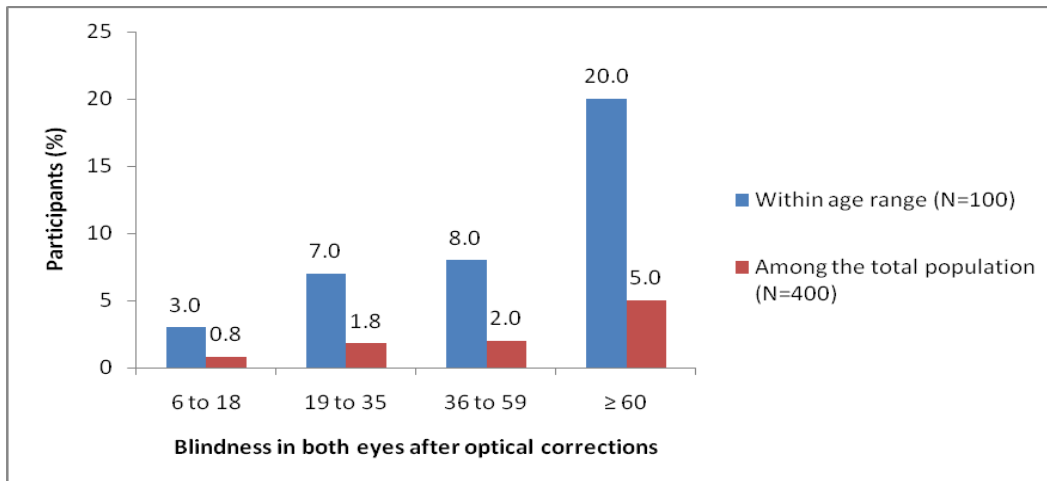
The prevalence of blindness in the left eye after optical corrections was 16.3%. The distributions of blindness was highest (7.3%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and lowest (1.8) among those aged 6 to 18 years old (Figure 4.63). The prevalence was highest (29.0%) among participants ( $N = 100$ ) aged 60 years and older and lowest (7.0%) among those 6 to 18 years old. There was a significant association between age ( $\text{Chi} = 18.72$ ;  $\text{df} = 3$ ;  $p = 0.00$ ) and blindness; however, there was no association between blindness and gender ( $\text{Chi} = 1.13$ ;  $\text{df} = 1$ ;  $p = 0.29$ ) in the left eye. The prevalence of blindness in the left eye after optical corrections is shown in Figure 4.64 below.



**Figure 4.64: Blindness in the left eye**

c. *Blindness in both eyes*

The prevalence of blindness in both eyes after optical corrections was 9.5%. The distributions of blindness was highest (5.0%) among participants ( $N = 400$ ) aged  $\geq 60$  years old and lowest (0.8) among those aged 6 to 18 years old (Figure 4.64). The prevalence was highest (20.0%) among participants ( $N = 100$ ) aged 60 years and older and lowest (3.0%) among those 6 to 18 years old. There was a significant association between age (Chi = 18.73; df =3;  $p = 0.00$ ) and blindness; however, there was no association between blindness and gender (Chi = 0.01; df =1;  $p = 0.92$ ) in both eyes. The prevalence of blindness in both eyes after optical corrections is shown in Figure 4.65 below.

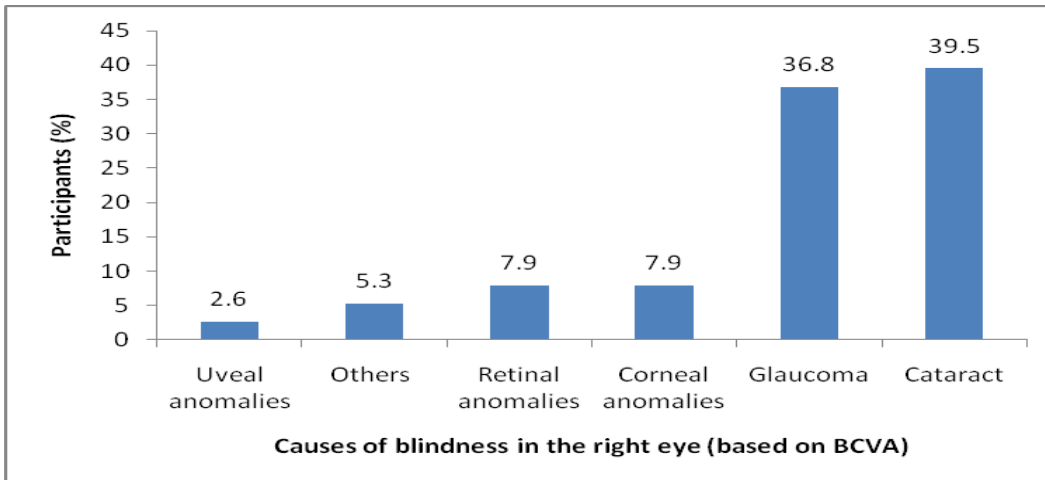


**Figure 4.65: Blindness in both eyes**

4.14.6 Causes of blindness after optical corrections

a. *Causes of blindness in the right eye*

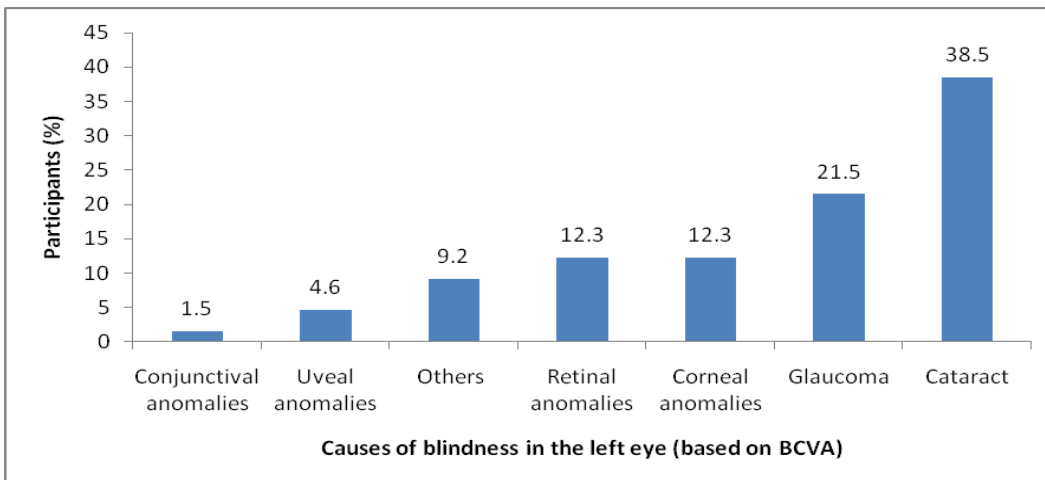
The most common causes of blindness based on best corrected visual acuity were cataract (39.5%), glaucoma (36.8%). The distribution of causes of blindness in the right eye after optical corrections is shown in figure 4.66 below.



**Figure 4.66: Causes of blindness in the right eye**

*b. Causes of blindness in the left eye*

The most common causes of blindness in the left eye after optical corrections were cataract (38.5%) and glaucoma (21.5%). The distribution of causes of blindness in the left eye after optical corrections is shown in figure 4.67 below.

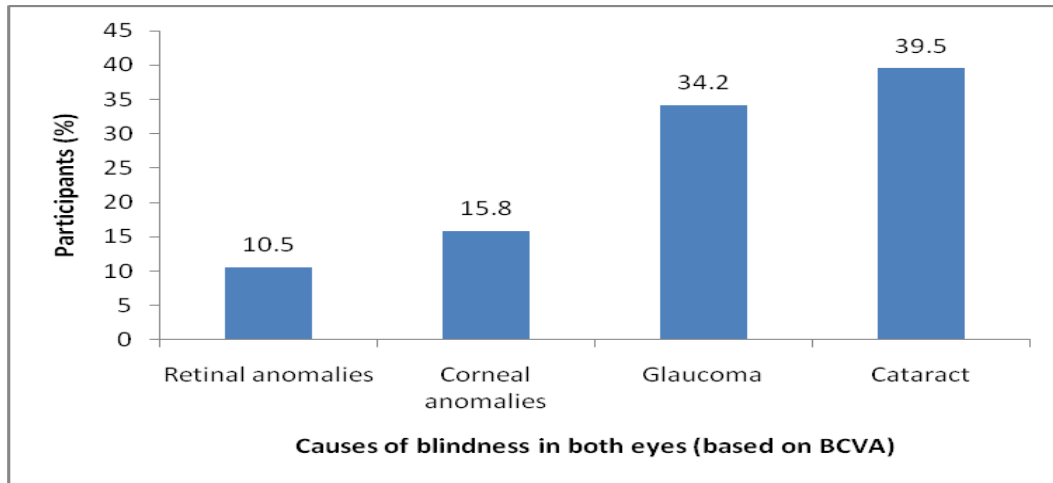


**Figure 4.67: Causes of blindness in the left eye**



*c. Causes of blindness in both eyes*

The most common causes of blindness in both eyes after optical corrections were cataract (39.5%) and glaucoma (34.2%). The distribution of causes of blindness in both eyes after optical corrections is shown in figure 4.68 below.



**Figure 4.68: Causes of blindness in both eyes**

## **CHAPTER 5**

### **5. DISCUSSION**

#### **5.1 Classifications**

Visual impairment is an important public health issue since it impairs the quality of life and considering its impact on career choices/ job opportunities and the socioeconomic burden on society. In this study, visual impairment was categorised according to the International Classification of Diseases 10<sup>th</sup> revision (ICD-10) that defines visual impairment based on presenting visual acuity (WHO, 2008) in order to compare the results with other previous studies. The criteria permit assessment of visual impairment due to refractive errors as highlighted by Dandona and Dandona (2001) and Resnikoff et al. (2008).

The classification used for visual impairment in this study was visual acuity  $<0.52$  logMAR (equivalent to  $< 6/18$  Snellen acuity) to 4.0 logMAR (equivalent to no light perception) as defined by WHO (2008). According to this definition, moderate visual impairment combined with severe visual impairment are grouped under the term low vision. Low vision with blindness represents all visual impairment (WHO 2014). The results are presented in logMAR acuity based on presenting and best corrected visual acuity in order to determine the extent of visual impairment due to uncorrected refractive errors. Resnioff et al. (2004) found visual impairment to be uniquely distributed across age groups. Therefore, participants in this study were stratified by age in order to determine the distribution and causes of visual impairment across age strata, and by gender. However, one of the limitations of this study is that it was conducted at hospital base, therefore the findings cannot be generalised to the entire district or province.

## **5.2 Visual impairment**

### **5.2.1 Prevalence of visual impairment**

Overall, the prevalence of visual impairment in both eyes found in this study population (27.0%) is higher than 21.8% reported in a Timor-Leste study among people aged  $\geq 40$  years old (Ramke et al. 2007) but lower than the 33.1% reported in Papua New Guinea among the elderly people aged  $\geq 50$  years old (Garap et al. 2006) respectively. Also, the prevalence in this study was higher than 7.4% reported from Botucatu, Brazil among children and adults aged 1 to 91 years old (Schellini et al. 2009), 13.0% among the adult population aged  $\geq 20$  years old in Aligarh, India (Haq et al. 2009); 1.3% in Khuzestan province of Iran among people aged 3 months to 87 years old (Fegghi et al. 2009) and 15.3% in Bangladesh among people aged  $\geq 30$  years old (Dineen et al. 2003). These various differences may be attributed to differences in study sites e.g. Botucatu eye study in Brazil reported by Schellini et al. (2009) was a population based survey, environmental differences, age range of participants, gender differences and sample sizes.

The prevalence of low vision in both eyes based on presenting visual acuity in the study population (17.5%) is similar to 17.7% in Timor-Leste (Ramke et al. 2007) but lower than 29.2% reported in Papua New Guinea (Garap et al. 2006). The prevalence of low vision is higher

than 13.8% reported in a Bangladesh study (Dineen et al. 2003); 5.2% reported from Brazil (Schellini et al. 2009), 7.8% in Aligarh (Haq et al. 2009), 6.2% in Nairobi among people  $\geq 2$  years old in Kibera slums (Ndegwa et al. 2006) and 6.8% among people  $\geq 1$  month in Bioko, Equatorial Guinea (Moser et al. 2002).

The prevalence of blindness in both eyes based on presenting visual acuity (10.3%) is higher than 6.8% reported in Bioko, Equatorial Guinea (Moser et al. 2002) and 1.3% reported in Khuzestan (Fegghi et al. 2009); 0.39% in Tehran (Fotouhi et al. 2004) and 1.22% in Ogun State, Nigeria among people aged zero year and older (Fasina et al. 2003). However, the difference in findings in these studies might be attributed to study sample population and that this study was conducted among people who are based in rural areas of South Africa which the national department of health confirmed that 80% of blind people in the country live in the rural areas (Department of Health 2002). The prevalence of blindness based on best corrected visual acuity was 9.5%.

Following optical compensation in those with refractive error, the prevalence of low vision based on best corrected visual acuity was determined in order to establish those who need low vision services (WHO 2008). The prevalence of visual impairment based on best corrected visual acuity was 16.8%. The prevalence of low vision based on best corrected visual acuity (3.8%) found in this study is similar to 3.1% reported in Liwan district of Guangzhou, China among adults aged  $\geq 50$  years (Haung et al. 2009) but higher than 2.6% in Khuzestan (Fegghi et al. 2009); 1.11% reported in Tehran among people aged  $\geq 1$  year old (Fotouhi et al. 2004) and 1.3% in Brazil among people aged 1 to 91 years old (Schellini et al. 2009) respectively. The prevalence of blindness was 9.5%.

### 5.2.2 Age and visual impairment

Consistent with other studies Schellini et al. (2009), Fegghi et al. (2009), Fotouhi et al. (2004), Khandekar et al. (2002), WHO (2007) and Resnikoff et al. (2004), there was significant association between age and visual impairment (Chi = 54.1; df =3;  $p = 0.00$ ). The risk of visual

impairment increases with age due to chronic eye diseases (e.g. retinopathies and cataract) and ageing processes (WHO 2014). In an ageing eye, many optical and pathological changes take place and produce progressive reduction in visual performance e.g. with age, the lens changes shape, size, mass, its protein contents clumps. All these changes diminish the lens ability to vary shape and reduce light transmissions (Atchison 2014).

### 5.2.3 Gender and visual impairment

There was a significant association between gender and visual impairment ( $\chi^2 = 4.7$ ;  $df = 1$ ;  $p = 0.03$ ). This is consistent with other studies by WHO (2007), Resnikoff et al. (2004), Abdull et al. (2009), Schellini et al. (2009) and Khandekar et al. (2002). However, Fegghi et al. (2009) and Ramke et al. (2007) did not find association between gender and visual impairment and contrarily, blindness was reported to be more common in men (Fasina et al. 2003). The attributing factor for females being at risk of being visual impaired than males is mostly because of their longer life expectancy and in poorer societies, because of their lack of access to services (WHO 2007).

### 5.3 Causes of visual impairment, low vision and blindness

The overall causes of visual impairment based on presenting visual acuity among all participants were uncorrected refractive errors (38.0%), cataract (25.9%) and glaucoma (17.6%). Cataract as the second leading cause of visual impairment is comparable to 25.4% reported in Terhan among participants aged 1 year and older (Fotouhi et al. 2004); however, uncorrected refractive errors (33.6%) and glaucoma prevalence of 2.2% in Terhan were lower than found in this study. In Khuzestan province in Iran among participants aged 3 months to 87 years old, refractive errors (31.4%), cataract (29.1%) and corneal anomalies (9.9%) were the leading causes of visual impairment (Fegghi et al. 2009).

Among all participants, the leading causes of low vision based on presenting visual acuity in this study were uncorrected refractive errors (56.7%), cataract (20.9%) and glaucoma (9.0%). Uncorrected refractive errors as the main causes of low vision is comparable to 57.1% in Nigeria among people aged  $\geq 40$  years old (Abdull et al. 2009) and 58.1% in Nairobi (Ndegwa et al. 2006). Uncorrected refractive errors as the main cause of visual impairment are lower than 72.3% reported in Brazil (Schellini et al. 2009); however, higher than that reported by Garap et al. (2006).

The main causes of blindness in both eyes were cataract (34.1%), glaucoma (31.7%) and corneal anomalies (17.1%). This is higher than findings reported in the previous study Khandekar et al. (2002). Cataract being the leading cause of blindness is lower than findings reported in Nigeria (43.0%) by Abdull et al. and 61.3% in Bioko by Moser et al. (2002). Other causes of blindness included retinal anomalies (9.8%) and uncorrected refractive errors (7.3%).

#### **5.4 Causes of visual impairment, low vision and blindness after optical corrections**

The main causes of visual impairment after optical corrections were cataract (39.4%), glaucoma (28.8%) and corneal anomalies (18.2%). These findings were higher than cataract (36.0%), glaucoma (2.7%) and corneal anomalies including corneal opacities and keratoconus (9.4%) reported in Terhan (Fotouhi et al. 2004). The main causes of low vision based on best corrected visual acuity were cataract (42.9%), glaucoma (21.4%) and corneal anomalies (17.9%).

The main causes of blindness based on best corrected visual acuity were cataract (39.5%), glaucoma (34.2%) and corneal anomalies (15.8%).

#### **5.5 Causes of visual impairment by age**

The main cause of visual impairment by age range was uncorrected refractive errors (60.0%) among participants aged 6 – 18 years. Cataract and corneal anomalies accounted for 20.0% each. Among participants aged 19 – 35 years old, uncorrected refractive errors and corneal anomalies

were the leading causes of visual impairment accounting 47.1% and 23.5% respectively. Among participants aged 36 – 59 years old, uncorrected refractive errors (53.6%) and glaucoma (17.9%) were the main causes of visual impairment, however, among participants aged  $\geq 60$  years old; cataract (39.6%), glaucoma (22.6%) and URE (22.6%) were the main causes of visual impairment. These findings were lower than those reported in Brazil (Schellini et al. 2009).

Based on presenting visual acuity, uncorrected refractive errors were the main causes of low vision among participants aged 6 – 18; 19 – 35 and 36 – 59 years old accounting for 85.7%, 80.0% and 72.2% respectively. Cataract (37.5%) and uncorrected refractive errors (34.4%) were the leading causes of low vision among participants aged 60 years and older.

The main causes of blindness were cataract (66.7%) and corneal anomalies (33.3%) among participants aged 6 – 18 years; corneal anomalies (57.1%) among participants aged 19 – 35 years and glaucoma (30.0%) among the 36 – 59 years old. Both cataract and glaucoma accounted for 42.9% each among participants aged  $\geq 60$  years old. The higher cataract prevalence as a cause of blindness among participants aged 6 – 18 years is similar to the findings reported in the national guideline for the prevention of blindness in South Africa, noting cataract to be on the increase and leading cause of childhood (aged 0 – 15 years) blindness (Department of Health 2002). The common causes of corneal anomalies (of which majority was corneal opacities) were corneal injuries among participants aged 19 – 35 years. The main non-modifiable risk factors for cataract among participants aged 60 years and older are chronic diseases and ageing (WHO 2014). Age-related cataract develops in various formations and is due to clumping of the protein in the crystalline lens which matures with age. Loss of transparency is thus explained on the basis of disorganization of the fiber membranes at a microscopical level, or of the lens proteins at a molecular level. These processes may occur separately or together in the various morphological types of cataract. Age-related nuclear cataracts lose transparency by the formation of white scatter or of brunescence. White scatter is accounted for by protein aggregates. Brunescence is accounted for by the accumulation of a yellow brown insoluble protein pigment, which causes loss of transparency by light absorption and is also responsible for scatter. In age-related cortical cataract, and in subcapsular cataract, there is loss of transparency due to both molecular and to membrane changes, whereas in nuclear cataract the changes are limited to the molecular (Brown

2001). Other risk factors are injuries and metabolic diseases; however among children cataract is mainly due to genetic disorders (WHO 2007) and eye injuries. Systemic diseases such as diabetes result in osmotic overhydration of the lens which leads to cataract formation (Kanski 2000).

## **5.6 Causes of visual impairment by gender**

The main causes of visual impairment among the females were URE (29.6%), cataract (16.7%) and glaucoma (13.0%). Among the males, the main causes of visual impairment were cataract (9.3%), URE (8.3%) and corneal anomalies (5.6%). The main causes of low vision based on presenting visual acuity by gender were uncorrected refractive errors (43.3%) and cataract (16.4%) among the females however among the males the main causes of low vision was uncorrected refractive errors (13.4%). These findings are lower than those reported in Timor-Leste among people aged  $\geq 40$  years (Ramke et al. 2007). The main causes of blindness by gender were glaucoma (26.8%) and cataract (17.1%) among the females whereas among the males, the main causes of blindness were cataract (17.1%) and corneal anomalies (9.8%). Although the findings in this study are lower than those reported in Timor-Leste; there is a similarity in the prevalence of corneal anomalies among males (Ramke et al. 2007).

## **5.7 Prevalence of refractive errors**

Only the right eye results in this study are discussed because of the high correlation between the right and left eye spherical equivalent refractive error values (Pearson ' $r = 0.73$ ;  $p = 0.00$ ). This is consistent with the presentation used by other authors (Schellini et al. 2009 and Wu et al. 1999). The overall prevalence of refractive errors (29.3%) found in this study was lower than 33.0% reported in an Air Force hospital in Nigeria among patients aged 8 days to 95 years old (Adenuga and Samuel 2012) and 54.28% reported in an eye clinic of the Niger-Delta University Teaching hospital, Okolobiri among people aged 5 – 86 years old (Koroye-Egbe et al. 2010). The

prevalence of refractive errors was higher than 25.0% reported among the adult population aged  $\geq 20$  years old in Aligarh, India (Haq et al. 2009).

The prevalence of myopia found in this study (18.5%) was similar to 17.4% reported in Cape town, South Africa among participants aged 16 to 74 years old (Otutu et al. 2012) but significantly lower than 57.8% reported from out-patient department of ophthalmology, Hamdard University hospital in Karachi among patients of all age groups (Qureshi et al. 2012); 36.5% reported from the adult Pakistani population aged  $\geq 30$  years of age (Shah et al. 2008); 31.83% reported in an eye clinic of the Niger-Delta University Teaching hospital, Okolobiri among people aged 5 – 86 years old (Koroye-Egbe et al. 2010) and 48.15% reported from University of the North in South African among black population aged 4 to 110 years old (Raliavhengwa et al. 2000). The prevalence of myopia was higher than 11.5% reported among the adult population aged  $\geq 20$  years old in Aligarh, India (Haq et al. 2009).

The prevalence of hyperopia (10.8%) found in this study was similar to 9.8% reported among the adult population aged  $\geq 20$  years old in Aligarh, India (Haq et al. 2009). However, lower than 13.4% reported from Cape Town in South Africa among participants aged 16 to 74 years old (Otutu et al. 2012); 18.7% reported from out-patient department of ophthalmology, Hamdard University hospital in Karachi among patients of all age groups (Qureshi et al. 2012) and significantly lower than 27.1% reported among the adult Pakistani population aged  $\geq 30$  years of age (Shah et al. 2008); 35.67% reported from University of the North in South African among black population aged 4 to 110 years old (Raliavhengwa et al. 2000); 22.54% reported in an eye clinic of the Niger-Delta University Teaching hospital, Okolobiri among people aged 5 – 86 years old (Koroye-Egbe et al. 2010); 28.4% reported from Singapore among adult Chinese aged 40 – 79 years old (Tien et al. 2000) and 35.67% reported from University of the North in South African among black population aged 4 to 110 years old (Raliavhengwa et al. 2000).

Astigmatism (10.3%) found in this study was lower to 18.5% reported from adults aged  $\geq 21$  years old in Sumatra, Indonesia (Saw et al. 2002); 21.3% reported from out-patient department of ophthalmology, Hamdard University hospital in Karachi among patients of all age groups (Qureshi et al. 2012); 37.0% reported among the adult Pakistani population aged  $\geq 30$  years of



age (Shah et al. 2008) and 60.0% reported from Cape Town in South Africa among participants aged 16 to 74 years old (Otutu et al. 2012). The prevalence of astigmatism was higher than 3.7% reported among the adult population aged  $\geq 20$  years old in Aligarh, India (Haq et al. 2009).

Astigmatism may be acquired as a result of altering the curvature of the cornea. This may be due to dysplasia, e.g. keratoconus, or abnormal growth of tissue on the cornea e.g. pterygium. Infection of the cornea, either bacterial or viral (typically herpetic) may induce astigmatism during the infection, or from resultant scarring. Scarring may also result from lacerating or penetrating trauma or chemical/thermal injury. Ocular surgery involving the cornea, e.g. cataract surgery, corneal grafting or excimer laser, may all directly cause astigmatism. Other forms of ocular surgery such as retinal surgery or squint surgery may also induce astigmatism as noted by Johnstone (2008).

The prevalence of myopia, hyperopia and astigmatism found among the age range 6 to 18 years in this study was lower than reported from school children aged 11 to 18 years in Agona Swedru in Ghana (Ovenseri-Ogbomo et al. 2010); from children aged 5 – 19 years in the Cape Coast municipality in Ghana (Ovenseri-Ogbomo et al. 2010) and from children aged 7 – 15 years in the city of Qazvin Northeastern Iran (Khalaj et al. 2009).

Comparison of other published refractive error data studies is limited since different authors use different definitions of refractive errors (e.g., myopia defined as sphere power  $\leq -0.50D$  and hyperopia as  $\geq +0.75D$  and the use of spherical equivalent power), methods of measuring refractive errors (e.g., different autorefractors, cycloplegic and non cycloplegic refraction, subjective refraction), age groups and other environmental factors (e.g. improper lighting conditions of computer workstations may contribute to ocular discomfort) as noted by Shah et al. (2008) and Johnstone (2008). Also, several epidemiological studies have identified higher rates of myopia and progression amongst university students and length of time studying as reported by Kinye et al. (2000) and Johnstone (2008). Occupations requiring intense close work (microscopists, textilers) have also been associated with the development and progression of myopia. Metabolic changes that alter the osmolality of the lens such as hypoglycaemia in diabetes may induce a fluctuation in refractive error (Johnstone 2008).

### 5.7.1 Relationship between gender and age with refractive errors

There was significant association between gender ( $\chi^2 = 5.12$ ;  $df = 1$ ;  $p = 0.02$ ) and age ( $\chi^2 = 29.32$ ;  $df = 3$ ;  $p = 0.000$ ) with refractive errors. Association between age and refractive errors is consistent with study by Ayanniyi et al. (2010) but the findings are contrary for gender. There was no association between gender and myopia ( $\chi^2 = 1.58$ ;  $df = 1$ ;  $p = 0.21$ ); gender and hyperopia ( $\chi^2 = 3.05$ ;  $df = 1$ ;  $p = 0.08$ ) and gender and astigmatism ( $\chi^2 = 0.03$ ;  $df = 1$ ;  $p = 0.87$ ). This is consistent with studies by (Schellini et al. 2009) and Otutu *et al*, 2012. Also, there was no association between myopia and age ( $\chi^2 = 7.50$ ;  $df = 3$ ;  $p = 0.06$ ) and this is contrary to the findings by (Schellini et al. 2009). However, there was significant association between hyperopia with age ( $\chi^2 = 20.56$ ;  $df = 3$ ;  $p = 0.00$ ) and age with astigmatism ( $\chi^2 = 8.34$ ;  $df = 3$ ;  $p = 0.04$ ) which is consistent with Schellini et al. (2009). There was no association between age ( $\chi^2 = 9.61$ ;  $df = 9$  and  $p = 0.38$ ) and axes of astigmatism. There was no association between gender ( $\chi^2 = 0.51$ ;  $df = 3$  and  $p = 0.92$ ) and axes of astigmatism. Myopia occurs in childhood between the ages of 8 and 14 as noted by Johnstone (2008). In adulthood, with the natural onset of presbyopia, there may be some unmasking of hyperopia that was previously overcome by accommodation. Refractive changes in adults over the age of 40, over a 10 year period, are small ( $<0.5D$ ) and dependant on age (mild hypermetropia in 40s, mild myopia in 70s.). This may also be dependent on the presence of cataract, which may induce a myopic shift in refraction (Johnstone 2008).

### 5.8 Visual impairment and uncorrected refractive errors

In visually impaired participants as a result of uncorrected refractive errors, myopia; hyperopia and astigmatism accounted for 71.1%, 28.9% and 35.6% respectively. Myopia accounted for 100.0% among participants aged 6 to 18 year and 19 to 35 years old within age group. Among those 36 to 59 years old, hyperopia accounted for 53.3% within age group. The prevalence of myopia was 68.8% among participants aged  $\geq 60$  years old. Refractive errors are relatively stable between the ages of 20 to 40 years of age; thereafter there is a shift in the hypermetropic

direction (Atchison 2014). The high myopia prevalence among participants aged  $\geq 60$  years old could be because of “index myopia” (myopia induced by development of nuclear cataract) as noted by Dandona and Dandona (2001).

Despite that refractive errors can be simply corrected by a pair of spectacles, majority of people still remain visually impaired due to uncorrected refractive errors. Some contributing factors to this could be because people with refractive errors tend to cope with the refractive errors and do not proactively seek care, poor awareness amongst those requiring care and low priority for eye care in life choices. Uncorrected refractive errors were the common cause of visual impairment across all age strata and this is mostly because uncorrected refractive errors affect persons of all ages and ethnic groups (WHO 2007). Dandona and Dandona (2001) indicated that a person becoming blind due to refractive errors at a younger age, and which is not corrected, would suffer many more years of blindness than a person being blind from cataract in old age and would place a grater socioeconomic burden on society if the impact of blindness due to refractive errors is considered in terms of blind-person-years since blindness due to uncorrected or inadequately corrected refractive errors starts at a younger age than cataract, which manifest itself in old age.

### **5.9 Limitations of this study**

1. Limited number of participants.
2. Subjects from only one hospital; therefore findings cannot be generalised to the district, province or country.
3. Use of confrontation method to measure visual fields.

### **5.10 Conclusion**

The findings in this study indicate that the overall prevalence of visual impairment, low vision and blindness among patients attending the Nkhensani hospital eye clinic were 27.0%, 17.5%

and 10.3% respectively. The main causes of visual impairment, low vision and blindness were uncorrected refractive errors, cataract and glaucoma. A focus on the optical correction of refractive errors and surgical intervention in the case of cataract would lead to a significant reduction in the burden of visual impairment among patients who utilise Nkhensani hospital for eye care services. Also, early detection and appropriate management of glaucoma will reduce the burden of this ocular morbidity. A significant proportion of these prevailing ocular morbidities are avoidable and with appropriate management, visual impairment is preventable.

### **5.11 Recommendations**

Sustainable programs towards correction of refractive errors and cataract surgery to further reduce the burden of visual impairment need to be intensified within the hospital and sub-district municipality. Strengthening awareness programmes and screening campaigns (with appropriate screening equipments) will provide an opportunity for identifying potentially blinding conditions (such as glaucoma and retinopathies) before they cause visual loss.

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# APPENDIX 1

**UNIVERSITY OF LIMPOPO**  
Medunsa Campus



## **MEDUNSA RESEARCH & ETHICS COMMITTEE**

### **CLEARANCE CERTIFICATE**

**MEETING:** 03/2012  
**PROJECT NUMBER:** MREC/HS/63/2012: PG

**PROJECT :**


**Title:** The prevalence and causes of visual impairment among clients at Nkhensane Hospital, Limpopo Province, South Africa

**Researcher:** Mrs. MM Maake  
**Supervisor:** Prof OA Oduntan  
**Co-supervisor:** Dr. MBL Mpolokeng  
**Department:** Public Health  
**School:** Health Sciences  
**Degree:** MPH

**DECISION OF THE COMMITTEE:**

MREC approved the project.

**DATE:** 12 April 2012

  
**PROF GA OGUNBANJO**  
**CHAIRPERSON MREC**

The Medunsa Research Ethics Committee (MREC) for Health Research is registered with the US Department of Health and Human Services as an International Organisation (IORG0004319), as an Institutional Review Board (IRB00005122), and functions under a Federal Wide Assurance (FWA00009419)  
Expiry date: 11 October 2016

**Note:**

- i) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.
- ii) The budget for the research will be considered separately from the protocol. PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

*Finding Solutions for Africa*



**APPENDIX 2: DATA COLLECTION TOOL**

S/N	Age	Gender	P VA	VI (Y/N)	PH VA	Refractive Findings	BC VA	VI (Y/N)
			OD: OS: OU:		OD: OS:	OD: OS:	OD: OS: OU:	
			OD: OS: OU:		OD: OS:	OD: OS:	OD: OS: OU:	
			OD: OS: OU:		OD: OS:	OD: OS:	OD: OS: OU:	
			OD: OS: OU:		OD: OS:	OD: OS:	OD: OS: OU:	
			OD: OS: OU:		OD: OS:	OD: OS:	OD: OS: OU:	

**APPENDIX 2 continues**

<b>Ophthalmoscope Findings</b>	<b>Other test (specify)/ REMARK</b>	<b>Diagnosis/ Cause of VI</b>	<b>Low vision (Y/N)</b>	<b>Cause of Low vision</b>
OD: OS:				
OD: OS:				
OD: OS:				
OD: OS:				
OD: OS:				
OD: OS:				
OD: OS:				
OD: OS:				

P VA = Presenting visual acuity, PH VA = Pinhole visual acuity, OD = Right eye, BC VA = Best corrected visual acuity,  
 OS = Left eye, S/N = Serial number, OU = Both eyes, Y/N = Yes/ No and VI = visual impairment



## APPENDIX 3 (a)

### APPENDIX 3

P O Box 569  
Polokwane, 0700  
18 August, 2011

The Manager: Research and Quality improvement  
Human Resource Development  
Department of Health (Limpopo Province)  
Private Bag X 9302  
POLOKWANE

Dear Sir / Madam

**Re: APPLICATION FOR APPROVAL TO CONDUCT A STUDY.**

I hereby request permission to use the health facility (Nkhensani hospital) as a base for data collection for a research study. I am currently studying for Master of Public Health with University of Limpopo and am expected to conduct a research study as a fulfillment of the qualification.

The purpose of the study is to determine the prevalence and causes of visual impairment among clients who are attending at Nkhensani Hospital and are 6 years and older. The study has been given ethical clearance and approval by the University of Limpopo. The participants will consent before participating in the study.

Attached please find the study proposal and the ethical clearance letter.

Thanking you in advance.

Yours truly

  
.....

Maake M M (Researcher) Cell no.: 073 011 3999

Co-supervisor: Dr MBL Mpolokeng

  
.....

## APPENDIX 3 (b)



**LIMPOPO**  
PROVINCIAL GOVERNMENT  
REPUBLIC OF SOUTH AFRICA

### DEPARTMENT OF HEALTH

Enquiries: Selamolela Donald

Ref:4/2/2

Maake MM  
University of Limpopo  
Sovenga  
0727

Dear Mrs Maake

**Re: Permission to conduct the study titled: The prevalence and causes of visual impairment among clients at Nkhensani hospital, Limpopo Province, South Africa.**

1. The above matter refers.
2. Permission to conduct the above mentioned study is hereby granted.
3. Kindly be informed that:-
  - Further arrangement should be made with the targeted institutions.
  - In the course of your study there should be no action that disrupts the services.
  - After completion of the study, a copy 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.

Your cooperation will be highly appreciated.

Head of Department

2018/05/23

Date

18 College Street, Polokwane, 0700, Private Bag x9302, POLOLKWANE, 0700  
Tel: (015) 293 6000, Fax: (015) 293 6211/20 Website: <http://www.limpopo.gov.za>

*The heartland of Southern Africa – development is about people*

## APPENDIX 4 (a)

### APPENDIX 4

P O Box 569  
Polokwane, 0700  
18 August, 2011

The Manager: Human Resource Development  
Department of Health and Social Development (Mopani District)  
Private Bag X 628  
GIYANI

Dear Sir / Madam

Re: **APPLICATION FOR APPROVAL TO CONDUCT A STUDY.**

I hereby request permission to conduct a research study at Nkhensani hospital in the district. I am currently studying for Master of Public Health with University of Limpopo and am expected to conduct a research study as a fulfillment of the qualification.

The purpose of the study is to determine the prevalence and causes of visual impairment among clients who are attending at Nkhensani Hospital and are 6 years and older. The study has been given ethical clearance and approval by the University of Limpopo Ethics committee and the Department of Health (Limpopo Provincial office). The participants will consent before participating in the study.

Attached please find the study proposal, the ethical clearance letter from the University and approval letter from Limpopo Provincial Department of Health.

Yours truly

.....  
Maake M M (Researcher) Cell no.: 073 011 3999

Work Tel: 015 811 7354

Co-supervisor: Dr MBL Mpolokeng

**APPENDIX 4 (b)**



**LIMPOPO**  
PROVINCIAL GOVERNMENT  
REPUBLIC OF SOUTH AFRICA

**DEPARTMENT OF HEALTH AND SOCIAL DEVELOPMENT  
MOPANI DISTRICT**

Ref: S5/4/1

Enq: Mogale D.I

TO: MAAKE M.M (Mrs)  
University Of Limpopo  
Sovenga  
0727

**PERMISSION TO CONDUCT THE STUDY TITLED: THE PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG CLIENTS AT NKHENSANI HOSPITAL, LIMPOPO, SOUTH AFRICA**

1. The above matter refers.
2. Permission to conduct the above mentioned study is hereby granted.
3. Note the following:
  - further arrangement should be made with the management of Nkhensane hospital
  - In the course of your study there should be no action that disrupts the service.
  - After completion of the study, a copy should be submitted to the Department to serve as a resource.
  - You should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
4. We hope that you will find this arrangement in order.

**DISTRICT EXECUTIVE MANAGER**

DATE: 2012/06/12

The heartland of Southern Africa - *development is about people*

**APPENDIX 5 (a)**

**APPENDIX 5**

P O Box 569  
Polokwane, 0700  
18 August, 2011

The Chief Executive Officer  
Nkhensani Hospital  
Private Bag X 9581  
GIYANI  
0826

Dear Sir / Madam

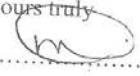
**RE: APPLICATION FOR PERMISSION TO CONDUCT A STUDY.**

I hereby request permission to conduct a study at Nkhensani hospital. I am currently studying for Master of Public Health with University of Limpopo and am expected to conduct a research study as a fulfillment of the qualification.

The purpose of the study is to determine the prevalence and causes of visual impairment among clients who are attending at Nkhensani Hospital and are 6 years and older. The study has been given ethical clearance and approval by the University of Limpopo, the Department of Health (Limpopo Provincial office) and the Mopani district Health office. The participants will consent before participating in the study.

Attached please find the study proposal, the ethical clearance letter and the approval from University of Limpopo, Department of Health Limpopo Provincial office and Mopani district health office.

Yours truly

  
.....  
Maake M M (Researcher) Cell no.: 073 011 3999

Co-supervisor: Dr MBL Mpolokeng

  
.....

**APPENDIX 5 (b)**



**Department of Health and Social Development**

**NKHENSANI HOSPITAL**

TEL: 015 811 7300

P/Bag x9581

FAX: 015 812 1451

Giyani, 0826

Enq : Mbedzi IK  
Tel : 015 811 7303  
Date : 19<sup>th</sup> June 2012

To : Maake MM  
From : Office of the CEO

**RE: APPLICATION FOR PERMISSION TO CONDUCT STUDY**

1. Permission is hereby granted to conduct study titled. The Prevalence and Causes of Visual Impairment amongst Clients at Nkhensani Hospital, Limpopo South Africa
2. Please take note of the following:
  - 2.1 There should be no disruption of services.
  - 2.2 After completion of the study, a copy should be submitted to the hospital to serve as a resource.
3. Wishing you luck for completion of the study and your master's degree.

Kind Regards,

  
.....  
ACTING CHIEF EXECUTIVE OFFICER

  
.....  
DATE

**HOSPITAL MOTTO: QUALITY CARE IS OUR PRIDE AND PRIORITY**

APPENDIX 6 (a)

UNIVERSITY OF LIMPOPO (Medunsa Campus) ENGLISH CONSENT FORM

Statement concerning participation in a Clinical Trial/Research Project\*

Name of Project / Study / Trial\*

**THE PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG EYE CLINIC PATIENTS AT NKHENSANI HOSPITAL, LIMPOPO PROVINCE, SOUTH AFRICA**

I have read the information on \*/heard the aims and objectives of\* the proposed study and was provided the opportunity to ask questions and given adequate time to rethink the issue. The aim and objectives of the study are sufficiently clear to me. I have not been pressurized to participate in any way.

I am aware that this material may be used in scientific publications which will be electronically available throughout the world. I consent to this provided that my name / and hospital number\* is / are\* not revealed.

I understand that participation in this Clinical Trial / Study / Project\* is completely voluntary and that I may withdraw from it at any time and without supplying reasons. This will have no influence on the regular treatment that holds for my condition neither will it influence the care that I receive from my regular doctor.

I know that this Trial / Study / Project\* has been approved by the Medunsa Research Ethics Committee (MREC), University of Limpopo (Medunsa Campus) / Dr George Mukhari Hospital. I am fully aware that the results of this results of this Trial / Study / Project\* will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed.

I hereby give consent to participate in this Trial / Study / Project

-----	-----	
Name of patient/volunteer	Signature of patient or guardian.	
-----	-----	
Place.	Date	Witness

**Statement by the Researcher**

I provided verbal and/or written\* information regarding this Trial / Study / Project\*  
I agree to answer any future questions concerning the Trial / Study / Project\* as best as I am able.  
I will adhere to the approved protocol.

-----	-----	-----	-----
Name of Researcher	Signature	Date	Place

APPENDIX 6 (b)

UNIVERSITY OF LIMPOPO (Medunsa Campus) XITSONGA CONSENT FORM

Xitatimenthe mayelana na ku nghenelela eka Ndzavisiso.

Vito ra Ndzavisiso

**THE PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG CLIENTS AT NKHENSANI HOSPITAL, LIMPOPO PROVINCE, SOUTH AFRICA**

Ndzi hlayile/ twile swikongomelo swa ndzavisiso lowu kunguhatiweke na swona ndzi nyikiwile nkarhi wo vutisa swivutiso na ku tlhela ndzi nyikiwa nkarhi wo ringanela ku ehleketa hi mhaka leyi. Swikongomelo swa ndzavisiso lowu swa twisiseka swinene eka mina. A ndzi si sindzisiwangi ku nghenela eka ndzavisiso lowu.

Ndza swi lemuka leswaku vuxokoxoko lebyi byi nga ta tirhisiwa eka matsalwa ya xisaense lawa ya nga kumekaka misava hinkwayo. Ndza pfumela eka leswi ntsena vito ra mina/ nomboro ya le xibedhele a swi paluxiwa.

Ndza swi twisisa leswaku ku nghenela eka ndzavisiso lowu swi le ku tsakeleni ka mina naswona ndzi nga tihumisa eka wona nkarhi wun'wana na wun'wana handle ka ku nyika swivangelo. Leswi swi nge vi na nkucetelo eka matshungulelo ya mina ya ntolovelo mayelana na xiyimo xa mina, hambu vutshunguri lebyi ndzi byi kumaka eka dokodela wa mina.

Ndza swi tiva leswaku ndzavisiso lowu wu pasisiwile hi komiti ya milawu ya ndzavisiso ya le Yunivesiti ya Limpopo (khampasi ya le MEDUNSA)/ xibedhele xa Dr George Mukhari. Ndzi swi tiva kahle leswaku mbuyelo wa ndzavisiso lowu wu nga ha tirhisiwa mayelana na swikongomelo swa xisaense na swona wu nga ha kandziyiswa loko vuhundla bya mina byi nga paluxiwi.

Ndzi nyika mpfumelelo wa mina ku nghenelela eka ndzavisiso lowu.

-----  
Vito ra muvabyi/ mutinyiketi

-----  
Nsayina wa muvabyi/ muhlayisi.

-----  
Ndhawu

-----  
Siku

-----  
Mbhoni

**Xitatimenthe hi Mulavisisi**

Ndzi nyikile vuxokoxoko bya nomo/ byo tsariwa mayelana na ndzavisiso lowu.

Ndza pfumela ku hlamula eka swivutiso eka nkarhi lowu taka mayelana na ndzavisiso hi laha ndzi nga kotaka ha kona.

Ndzi ta landzelela eka milawu ya mafambiselo lama pasisiweke.

-----  
Vito ra Mulavisisi

-----  
Nsayino

-----  
Siku

-----  
Ndhawu



Appendix 6 (c)

UNIVERSITY OF LIMPOPO (Medunsa Campus) SEPEDI CONSENT FORM

Setatamente mabapi le go tšea karolo ka go Protšeke ya Dinyakišišo tša Teko ya Klinikhale \*.

**THE PREVALENCE AND CAUSES OF VISUAL IMPAIRMENT AMONG CLIENTS AT NKHENSANI HOSPITAL, LIMPOPO PROVINCE, SOUTH AFRICA**

Ke badile/ke kwele ka ga tshedimošo mabapi le \*maikemišetšo le morero wa\* dinyakišišo tšeo di šišintšwego gomme ke ile ka fiwa monyetla wa go botšiša dipotšišo gomme ka fiwa nako yeo e lekanego gore ke naganišiše ka ga taba ye. Ke tloga ke kwešiša maikemišetšo le morero wa dinyakišišo tše gabotse. Ga se ka gapeletšwa go kgatha tema ka tsela efe goba efe.

Ke a kwešiša gore go kgatha tema Protšekeng/Dinyakišišong tše tša Teko ya Klinikhale\* ke ga boithaopo gomme nka tlogela go kgatha tema nakong efe goba efe ntle le gore ke fe mabaka. Se se ka se be le khuetšo efe goba efe go kalafo yaka ya ka mehla ya maemo a ka gape e ka se huetše le ge e ka ba tlhokomelo yeo ke e humanago go ngaka yaka ya ka mehla.

Ke a tseba gore Teko/Protšeke/Dinyakišišo tše\* di dumeletšwe ke Medunsa Research Ethics Committee (MREC), Yunibesithi ya Limpopo (Khamphase ya Medunsa) / Dr George Mukhari Hospital. Ke tseba gabotse gore dipelo tša Teko/Dinyakišišo/ Protšeke tše \* di tla dirišetšwa merero ya saense gomme di ka phatlalatšwa. Ke dumelelana le se, ge fela bosephiri bja ka bo ka tlišetšwa.

Mo ke fa tumelelo ya go kgatha tema Tekong/Dinyakišišong/ Protšekeng \*.

-----  
Leina la molwetši/ moithaopi

-----  
Mosaeno wa molwetši goba mohlokamedi.

-----  
Lefelo.

-----  
Letšatšikgwedi

-----  
Tlhatse

**Setatamente ka Monyakišiši**

Ke fana ka tshedimošo ka molomo le/goba yeo e ngwadilwego \* mabapi le Teko/Dinyakišišo/ Protšeke ye.\*

Ke dumela go araba dipotšišo dife goba dife tša ka moso mabapi le Teko/Dinyakišišo/ / Protšeke ka bokgoni ka moo nka kgonago ka gona.

Ke tla latela melao yeo e dumeletšwego.

-----  
Leina la Monyakišiši

-----  
Mosaeno

-----  
Letšatšikgwedi

-----  
Lefelo