

**THE MAGNITUDE AND PATTERN OF PRESBYOPIA  
AMONG PATIENTS SEEN ON OUTREACH WITH LIONS  
SIGHTFIRST EYE HOSPITAL, LORESHO**

**DR. MUKIRI MUKURIA**  
2009

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**A DISSERTATION SUBMITTED IN PART FULFILMENT FOR THE DEGREE OF  
MASTERS OF MEDICINE (OPHTHALMOLOGY), UNIVERSITY OF NAIROBI.**

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# DECLARATION

This dissertation is my original work and has not been presented for a degree in any other University.

Signed:  \_\_\_\_\_

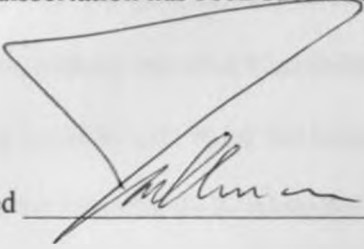
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**Dr Mukiri Mukuria**

# APPROVAL

This dissertation has been submitted with our approval as University supervisors.

Signed



Date

22/06/09

**Dr Martin Kollmann**

MBChB, MD (GOETTINGEN), DTM Parasitol (Hamburg)

M.MED Ophthalmology (Munich), FEACO, MBA- Healthcare (Durban)

Senior Lecturer, Department of Ophthalmology

University of Nairobi

Signed



Date

22/06/09

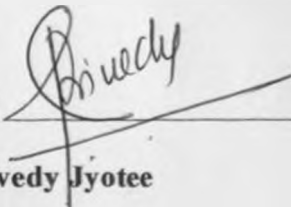
**Dr M. M. Kariuki- Wanyoike**

MBChB, M.MED Ophthalmology (Nairobi), FEACO

Lecturer, Department of Ophthalmology

University of Nairobi

Signed



Date

29/06/2009

**Dr Trivedy Jyotee**

MBChB, M.MED Ophthalmology (Nairobi), FEACO

Senior Ophthalmologist, Cataract and Refractive Surgeon

Lions SightFirst Eye Hospital, Loresho, Nairobi.

## **DEDICATION**

To my dear parents, for their dedication and all the sacrifices they have made throughout my life, making me what I am today.

To my beloved wife Njeri, for helping me realise life has a sweet side to it.

And most importantly to Almighty God, through him all things are possible.

## **ACKNOWLEDGEMENTS**

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## **LIST OF ABBREVIATIONS**

1. BCVA - Best Corrected Visual Acuity
2. CI - Confidence Interval
3. D - Dioptre
4. IOL - Intraocular lens
5. LE - Left Eye
6. N - Near (Vision)
7. OR - Odds Ratio
8. RE - Right Eye
9. SPSS - Statistical Package of Social Scientists
10. V - Visual acuity
11. WHO - World Health Organisation



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## ABSTRACT

**Objective:** To determine the magnitude and pattern of presbyopia among patients aged 35 years and above as seen on outreach with Lions Sightfirst Eye Hospital.

**Method:** Cross sectional outreach camp based study of presbyopia at various centres visited by Lions sightfirst eye hospital was carried out on patients 35 years old above. Those with prior intraocular surgery, unclear ocular media or BCVA for distance of less than 6/60 were excluded. The BCVA for distance was determined after refracting using appropriate plus or minus lenses and illiterate E distance chart at 6m before assessing presence and severity of presbyopia with an illiterate E near chart and plus lenses. Data was collected using a questionnaire and input and analysed using SPSS version 11.5 and Epi info version 3.4.1.

A case was a patient aged 35 years and above found to improve by at least 1 line on the near chart with addition with plus lenses.

**Results:** A total of 442 patients were examined of which 177 (40%) were male and 265 (60%) female. Males were found to be older than females  $p < 0.001$ . Refractive errors were found in 16.1% of those examined. Presbyopia was found in 388 (87.8%) of those examined, males = 151 (85.3%) and females = 237 (89.4%). No significant difference in frequency of presbyopia by sex  $p = 0.195$  but males required a higher presbyopia correction  $p = 0.001$ . Females had significant earlier presentation of presbyopia  $p = 0.008$ . Those with less education were found to have more severe presbyopia by age  $p = 0.004$ . Overall presbyopia was found to start at an earlier age and have a more gradual incline in

seventy then plateau at a later age (65 years) compared to studies carried out in Caucasians. The power used to correct the presbyopia was also less for age-matched individuals compared to Caucasians.

Spectacle coverage was found to be 33%. 44% of those with presbyopia were not aware their condition could be corrected with spectacles. 20% of spectacles made available and examined during the study were found to be of incorrect power. Males were more likely to have spectacle correction  $p=0.01$ . Spectacle uptake was not significantly influenced by education status or distance travelled to the outreach centre.

**Conclusion:** Prevalence of presbyopia was found in 87.8% in patients aged 35 years and above attending outreach camps. Females had an earlier presentation while less education and increasing age were associated with more severe presbyopia. Spectacle coverage was 33% while 20% of spectacles examined had incorrect power.

**Recommendation:** Awareness needs to be done in the communities about presbyopia showing that it can easily be corrected with spectacles. Health workers need heightened awareness to detect and treat those patients in their mid-thirties who are not symptomatic. Follow-up of previously treated patients is essential for change of prescription. Policy makers should incorporate presbyopia detection and management in the national eye health care plan. More studies to support above findings as well as design a protocol for presbyopia correction appropriate for our setup.

# 1. LITERATURE REVIEW

## 1.1 Introduction

The human eye is an optical system which is able to focus on objects at different distances within the visual field<sup>1</sup>. The ability to change focus from a far object to a near one is achieved mainly by increasing the curvature and thickness of the crystalline lens in a process called accommodation<sup>2</sup>. However accommodation reduces with advancing age due to decreasing elasticity of the crystalline lens, effectively causing blurring of near vision and eyestrain with near work, a phenomenon known as presbyopia<sup>2, 4, 5</sup>.

## 1.2 Historical Background

Speculation has been rife for centuries on how accommodation comes about. Scientists and philosophers alike have postulated and theorized on likely mechanisms but till this day no single theory explains all the findings associated with accommodation and by extension presbyopia.

Kepler in 1611 postulated that the lens moves forwards and backwards to focus images while Scheiner, a Jesuit priest, in 1619, proved experimentally that accommodation was achieved by change in the optical power of the eye and obeyed the laws of optics. Another philosopher Descartes (1677) suggested that the lens changes shape while in 1742 Lobe postulated it is the shape of the cornea that changed to bring about accommodation. Others like Sturm and Listing believed the eye elongated.

In 1801, Thomas Young disputed the earlier belief of accommodation was due to change in the shape of the cornea or elongation of the eyeball and proved experimentally that it was actually due to the change in shape or position of the crystalline lens. He also demonstrated

that accommodation did not occur in aphakic individuals. He went on to demonstrate that spherical aberrations reduced with accommodation and concluded that change in the shape of the lens is induced by a muscular mechanism within the lens. Purkinje (1823) noted reflected images from the anterior and posterior crystalline lens surfaces (Purkinje images). Langenback in 1849 observed the Purkinje images, under magnification, on the anterior lens surface become smaller on accommodation and concluded that the anterior lens surface becomes more convex during accommodation and this is due to ciliary muscle squeezing the crystalline lens. In 1851, Cramer improved on Langenback discovery and incorporated a telescopic device to make accurate observations during accommodations and noticed the anterior surface becomes more convex while posterior surface did not change.

In 1855 Helmholtz incorporated crossed plates between patients' eyes and the telescope so as to double the images. This helped him observe both the anterior and posterior surfaces of the lens become more convex and the lens thicker. He postulated that the ciliary muscle relaxes during accommodation with the lens becoming more spherical due to its own elasticity. Finally he postulated presbyopia is due to lens sclerosis. Donders (1864) studied change in amplitude of accommodation and noted it declined in a linear fashion with age. This decline is universal and predictable. He also noted that presbyopia was associated with hyperopia. In 1901, Tschering studied the anterior surface of the lens using the Purkinje images of four candles - two peripheral and two central - and observed the changes during accommodation. He noticed the two central ones moved closer while the peripheral one moved further apart and concluded that the central part becomes more convex while there is peripheral flattening - consistent with Young's observation that aberrations reduced during accommodation. Gullstrand (1911) and Fincham (1937) extended Helmholtz theory of zonule relaxation for accommodation and further added ciliary muscle atrophy and stiffening of lens attachments

Optical Coherence Tomography (OCT), where on-screen contraction and relaxation of the ciliary muscle as well as changes in the size and shape of the crystalline lens can be observed with accommodation.

### **1.3 Pathophysiology of presbyopia**

Presbyopia (literally, old eye) is the most common ocular affliction in the world. It comes about due to the progressive decline in the accommodative amplitude hence effectively pushing away the near point towards the far point. The rate of decline occurs with very little inter-individual variability even in different populations and is considered a reliable biomarker for human age.

The pathophysiology of presbyopia is poorly understood and alterations of every component of the accommodative mechanism have been proposed.

1.3.1 LENS: Most researchers attribute presbyopia to changes occurring in the crystalline lens. One theory suggests that despite lenticular rounding and thickening there is associated reduced refractive index with accompanied aggregation of insoluble proteins. This translates to reduced number of lens proteins contributing to refractive power of the lens. Ageing is also associated with reduced curvature of the lens surface and therefore reduced convergence of light rays. Lenticular sclerosis is another theory where reduced elasticity of lens capsule and hardening of lens substance leads to ineffective action of accommodative action.

1.3.2 CILIARY MUSCLE: Researchers have dismissed the unlikelihood of ciliary muscle contributing much to presbyopia. Reduced accommodative amplitude is noted to start as early

as second decade yet the ciliary muscle is still at its peak both physiologically and histologically at this age<sup>4</sup>.

#### **1.4 Clinical presentation**

The most common symptom of uncorrected presbyopia is difficulty reading at near. Early presbyopia is characterized by patient complaining of requiring more light to read or being able to read better in the morning hours compared to night, difficulty reading fine print and their eyes taking too long to focus on near point. This is accompanied by aesthenopia because of straining to accommodate the whole day. The onset of presbyopia is approximately between 40 and 45 years of age however there is some inter-individual variation. Presbyopia may present younger in under-corrected hyperopes and older in under-corrected myopes<sup>20</sup>.

#### **1.5 Management**

Spectacles are the simplest and most inexpensive way to correct refractive errors.<sup>11</sup> Emmetropic presbyopic patients will require readers to enable clear near vision. However, those with refractive error [myopia, hypermetropia or astigmatism] in addition to presbyopia will need bifocals or trifocals the design of which will depend on the nature of his/her work.

Surgical methods are also used but not as popular as spectacles. The methods used include the use of multi-focal IOLs (for those undergoing cataract surgery) Laser surgery of the cornea and lately a new technique called 'surgical reversal of presbyopia'.

Surgical management of presbyopia has been attempted but is still considered to be in the experimental stages. In the 1980's surgical reversal of presbyopia was introduced. This entailed making linear sclerotomies above the ciliary muscle. The theory behind this is that accommodation is due to ciliary muscle contraction causing increased zonular tension onto the equatorial zone of the crystalline lens.



However with increasing age the equatorial diameter of the lens also increases therefore the distance between the lens equator and the ciliary muscle reduces. The zonules become lax and can no longer apply tension onto the lens, effectively reducing accommodation in the same linear manner. Sclerotomies cause areas of weakness in the wall of the globe causing expansion. This effectively causes extra leverage for the zonules to pull on the lens equator during ciliary muscle contraction. A modification of sclerotomies was introduced in the 1990's and popularised by Schachar by using a scleral band to expand the sclera. The band is sutured into the sclera. Preliminary studies have shown increased accommodation of between 1.3 and 7 Dioptres (mean 3.8D).

Refractive surgery is an evolving technique introduced in the 1990's now being applied to the management of presbyopia. It has allowed a lot of creativity and flexibility to the ophthalmologist in managing refractive errors and presbyopia. One technique is the use of LASIK (laser-assisted insitu keratomileusis) where a flap is created from the cornea surface unveiling the cornea stroma. Laser is used to ablate micrometers of the stroma in a process called remodelling then the flap is returned. Differential application of laser to both eyes whereby one eye is 'refracted' for near and the other for far is called monovision. Other variations of this are conductive keratoplasty and laser thermal keratoplasty where ablation of collagen in the peripheral cornea steepens the cornea centrally thereby improving near vision. Multifocal LASIK similar to the multifocal IOLs or multifocal lenses is also applied to the cornea to create different refractive surfaces for far and near.

The latest treatment for presbyopia involves the insertion of cornea outlays (subepithelial) and inlays (stromal). It was introduced in 2006 and is still undergoing trials. It entails insertion of a biocompatible collagen device within the cornea which remodels its shape. Any additional refractive changes are done to the inlay or outlay therefore sparing the cornea from additional manipulation.

**Table 1: Choice of presbyopia ADD correction used in clinical evaluation<sup>22</sup>**

<b>Age (Years)</b>	<b>Typical Add (power of convex lens to assist near vision)</b>
45	+1.00 D to +1.25 D
50	+1.50 D to +1.75 D
55	+2.00 D to +2.25 D
60	+2.50 D to +3.00 D

The power of the presbyopic correction is generally related to the person's age. This is because there is a fairly uniform age-related decline in accommodative amplitude.

**Table 2: Comparison between Average accommodative amplitude and age<sup>2</sup>**

Age	Average accommodative amplitude
8	14.0(+/-2D)
12	13.0(+/-2D)
16	12.0(+/-2D)
20	11.0(+/-2D)
24	10.0(+/-2D)
28	9.0(+/-2D)
32	8.0(+/-2D)
36	7.0(+/-2D)
40	6.0(+/-2D)
44	4.5(+/-1.5D)
48	3.0(+/-1.5D)
52	2.5(+/-1.5D)
56	2.0(+/-1.0D)
60	1.5(+/-1.0D)
64	1.0(+/-0.5D)
68	0.5(+/-0.5D)

Based on this, it is possible within a certain range to predict the average presbyopic correction a person will require given his/her age.<sup>20</sup>

### 1.6 Prevalence

Globally, hundreds of millions of people suffer from severe near vision impairment due to uncorrected presbyopia<sup>6</sup>. No definite data is available from WHO, partly because there is no

universally accepted definition of presbyopia and no standard technique to measure it e.g. the near point and distance at which near vision is tested.

In population based studies, the prevalence of presbyopia in people aged 30 years and above was found to be 55.3% by Nirmalan et al in South India<sup>7</sup> while in Brazil, Duarte et al found the prevalence to be 54.7% in the same age group.<sup>8</sup> Another study done in rural Tanzania by Patel et al found the prevalence to be 61.7% among those 40 years and above.<sup>9</sup> In Rift Valley Province, Kenya, Sherwin et al found the prevalence to be 85.4% among those 50 years and older.<sup>10</sup> In an outreach clinic based study by Kamali et al, the prevalence of presbyopia was found to be 48%.<sup>25</sup>

No hospital based studies on presbyopia have recorded in literature.

### **1.7 Variables**

Various variables are associated with either earlier onset or increased severity of presbyopia. Higher prevalence of presbyopia is associated with increasing age, female sex, higher educational background and residence in town<sup>9</sup>. Of the above factors, female sex is associated with more severe presbyopia while education background is less likely to affect the severity of presbyopia. Other factors include alcohol consumption, lens nuclear opacities and hyperopia.<sup>7</sup>

**Table 3: ONSET OF PRESBYOPIA IN DIFFERENT REGIONS**

Age (years)	Place	Latitude	Author	Year published
47	England	51-54	Ayrshire	1964
43	England	51-54	Turner	1958
45	New York	41-45	Duane	1912
50	Cleveland	38-42	Allen	1961
45	Japan	36-44	Kajiura	1965
43	Japan	36-44	Fukuda	1965
42	Japan	36-44	Ishihara	1919
43	California	32-44	Hamasaki	1956
45	Texas	26-36	Fitch	1971
41	Israel	32	Raphael	1961
40	South Africa	26-29	Coates	1955
37	India	10-30	Rambo	1960
39	Puerto Rico	18-18.5	Miranda	1977

Geographical variations, specifically latitude, have also been noted to influence onset of presbyopia. Residents of areas closer to the equator experience earlier onset of presbyopia.<sup>11</sup>

Another variable is average annual ambient temperature whereby those residents of warmer and usually tropical areas experience earlier onset of presbyopia, some as early as mid-30s rather than in their 40s.<sup>11</sup>

Also related to temperature is the faster decline in accommodative power even when the age of the onset is the same.<sup>11</sup>

## 1.8 Impact of presbyopia

Presbyopia greatly affects the quality of life. In highly literate societies where reading and writing are main tasks this appears straight forward. However, in low income populations with lower educational levels, presbyopia may matter equally much as essential and vital near vision tasks such as winnowing grain, sorting rice, weeding, cooking food, dressing children and lighting and adjusting lamps become increasingly affected.<sup>6</sup>

Among the elderly (>55years), uncorrected refractive errors, including presbyopia, is associated with poorer quality of life, more depressive symptoms<sup>12</sup> and unnecessary dependency on other family members or society.<sup>6</sup>

## 1.9 Interventions

Spectacles represent an effective and economic option to correct refractive errors particularly for low and middle income countries<sup>6</sup>. Despite this there is a high unmet need for spectacles among these populations. In Tehran, Fotouhi et al found spectacle coverage of 66% (for all refractive errors) with increasing unmet need with increasing age<sup>17</sup>. In Tanzania, Patel et al found 94% of presbyopes did not have spectacle correction<sup>6</sup>. In India, Nirmalan et al found that two-thirds of presbyopes did not wear spectacle correction with over 95% having moderate to severe difficulty of reading fine print or recognizing small objects.<sup>7</sup>

Dandona et al<sup>18</sup> found in south India increased spectacle uptake associated with higher educational status, residence in town and in those who are aphakic or pseudophakic. Reasons for not buying or wearing spectacles include feeling the prescription is wrong, uncomfortable spectacles and cost. Another study done in Cambodia showed that willingness to pay for spectacle correction was less in those less than 60 years, not income earner in the household or those with low monthly income. However willingness did not depend on occupation, lack of transport or previous spectacle wear.<sup>21</sup>

Globally, it is estimated that US \$ 1500 million would be needed to give 300 million people access to an eye exam and a pair of spectacles, so as to eliminate direct loss of opportunity and productivity due to uncorrected refractive error.<sup>6</sup>

### **1.10 Future of presbyopia**

Presbyopia poses a serious public health challenge. With more people getting older the numbers are expected to increase in an ageing population.<sup>6</sup> This has been recognized by WHO and specific aims, objectives and strategies under 'Refractive Errors' have been incorporated into the 'VISION 2020: global initiative for the elimination of avoidable blindness, action plan 2006-2011.'<sup>19</sup>

## **2. RATIONALE**

Few studies have been done and therefore gaps in information exist regarding the prevalence and pattern of presbyopia in Kenya. Studies done in developing countries have shown a high prevalence of presbyopia as well as a high unmet need for presbyopic spectacle correction. With an ageing population and increasing urbanisation, the demand for presbyopia services will increase hence baseline data is essential to establish the need and plan for future services.



### **3.0 STUDY OBJECTIVES**

#### **3.1 Main objective**

To study the magnitude and pattern of presbyopia in patients aged 35 years and above as seen on outreach camps with Lions Sightfirst eye hospital

#### **3.2 Specific objectives**

1. To determine the prevalence of presbyopia in patients aged 35 years and above
  
2. To determine how:-
  - 2.1. increasing age;
  - 2.2. literacy levels;
  - 2.3. sex distribution;affects presbyopia in patients aged 35 years and above.
  
3. To determine spectacle coverage and reasons for not using spectacle correction for those with presbyopia.

## **4. RESEARCH METHODOLOGY**

### **4.1 Research design**

Cross-sectional outreach camp based study.

### **4.2 Study Area**

Various areas visited on outreach by Lions club Loresho through regular Lions Sight First Eye Hospital outreach.

Lions Sightfirst Eye Hospital organises in regular outreach programs visiting particular areas on a monthly basis. These are areas both within and outside Nairobi, the furthest being about 300km away. The areas visited on monthly basis are Kangundo, Njambini, Nyahururu, Rumuruti, Matuu, Kerugoya, Murang'a, Gachika, Naivasha, Kandara, Sultan Hamud, Kinamba, Tawa, Runyenjes, Kitui and Makuyu. Other areas are visited on request or on a two- to three monthly basis such as Marigat, Matiri, Kiserian, and Nyeri.

**Figure 1: Map of Kenya identifying some towns visited on outreach programs by Lions**

**Sightfirst eye Hospital<sup>24</sup>**



○ = some of the towns visited on outreach

◻ = approximate area under which the outreach visits cover

### 4.3 Study population

Patients who attended the various camps aged 35 years and above

### 4.4 Study period

19<sup>th</sup> February 2009 to 23<sup>rd</sup> March 2009

### 4.5 Sample size

The sample size was determined by using of the following formulae to achieve an adequate sample to accurately estimate the prevalence of presbyopia in the study population.

$$n = \frac{Z_{\alpha/2}^2 * P (1-P)}{D^2}$$

Where n = required sample size

P = prevalence of (61.7%), based on the estimated prevalence from a similar study by Patel et al<sup>7</sup>.

D = Precision with which to measure prevalence of the study, set at plus or minus 5%.

The  $Z_{\alpha/2}$  was the cut off points along the x-axis of the standard normal probability distribution that represents probability matching the 95% confidence interval (1.96).

Substituting the above in the formulae we got;

$$n \approx 363.12 = \underline{\underline{363 \text{ patients}}}$$

Presbyopia is a condition of the aged and therefore the higher the cut-off age the higher the prevalence of the condition. This entailed a higher or larger sample size (as per the above formula). A lowered cut-off age from 40 years to 35 years has a reduced prevalence and hence a smaller sample size was required. The above sample size was calculated based on

results from a study using 40 years as the cut-off age. Therefore the sample size was considered adequate for our own cut-off age of 35 years.

#### **4.6 Case definition**

A person was defined as having presbyopia if addition of plus lenses to his/her best corrected distance correction, improved near vision by at least one line on the near visual acuity chart.

#### **4.7 Sampling method**

Systematic sampling method was used. All patients arriving at the site of the camp were registered. This is the norm at every outreach done by Lions Sight First Eye Hospital Loresho. From this registration list, all patients aged 35 years and above were identified. Consecutive patients were examined until sample size was obtained provided they met the inclusion criteria and were not excluded.

#### **4.8 Inclusion criteria**

All patients aged 35 years and above, who agreed to be examined by signing consent, and showed none of the below exclusion criteria (Appendix B)

#### **4.9 Exclusion criteria**

Those patients below 35 years old, refused to sign consent, had unclear ocular media, have history of intraocular surgery or presbyopia that could not be corrected due to other pathologies were excluded from the eligible participants. Those with prior history of intraocular surgery or best corrected distance vision worse than 6/60 were also excluded.

#### **4.10 Study limitations**

- 1 The study population was biased because the participants in the study were self-referred and most may already have ocular morbidity.
- 2 Many patients did not carry their spectacles to the outreach for assessment
3. Conclusions from the study can not be extrapolated to the general population and the whole country.

#### **4.11 Examination Technique**

Before the actual examination took place the patients' personal data was recorded as elaborated in the data collection form such as date of birth, residence, education status, use of spectacles. This data was used in evaluation and data analysis.

Examination of the patients was done in two phases. The first was to examine and to correct, if necessary, for distance vision. For presbyopia to be effectively assessed the patient must be rendered emmetropic for distance. The second step was to examine for presbyopia and if present it was also determined and recorded.

##### **i) Distance vision examination**

The patient was seated on a chair and a tumbling E chart was placed or hanged on a wall 6 meters away opposite him/her in a well lit room. The patient was asked to cover the left eye first and read with the right eye. The patient was then taken through the chart from the top up to the point he or she could not read any further. This visual acuity was recorded in the data collection form (Appendix A). The right eye was covered and he/she was asked to read with left eye and the value recorded likewise.

If the patient was unable to read up to the 6/9 line with either eye, he/she was given a trial frame to put on. The left eye was occluded and corrective lenses were inserted into the most posterior slot of the trial frame in front of the right eye. Different lenses were tried until the best corrected visual acuity was obtained. Next the right eye was occluded and same procedure was followed for the left eye. The value of the final corrective lenses used and the best distance visual acuity obtained with them for each eye was also recorded in the data collection form.

In the eventuality that a distance vision did not improve to the minimum desired level of 6/9, a detailed examination was done. This entailed examination of the anterior segment with a direct ophthalmoscope and use of fluorescein strips if necessary to determine any pathology. The intraocular pressure was measured next. This was done by instilling topical lignocaine onto the cornea to anaesthetise it then a schiottz tonometer was placed directly on to the cornea. The value was read off and converted using the tables provided with the instrument. The eye was then dilated with tropicacyl eye drops and the ocular media, the lens and fundus were examined for any pathology with a direct ophthalmoscope. For good visualisation during fundoscopy, a dark room was improvised with a curtain over the window. Appropriate management or referral was initiated depending on the pathology obtained.

#### ii) Presbyopia examination

After the best corrected distance visual acuity was obtained, the lenses were retained within the trial frame and he/she was examined for presbyopia. However, if no correction was required for the distance correction none was present at the start of this examination. With corrective lenses for distance insitu where applicable, an occluder was placed in front of the lenses of the left eye in the outermost slot. A near vision chart was held in front of the patient

at 33cm or one ruler-length away. An overhead lamp was not available for this exercise so good illumination by sitting next to the window was used as the next best available option. The patient was taken through the chart reading from the bigger letters to the smaller ones up to the point where he/ she could not read any further. The last line read by the patient was recorded in the data collection form. If he/she could not read up to the N8<sup>7</sup>.<sup>10</sup> line then possibility of presbyopia was entertained. Different corrective concave lenses in increasing order of power were added to the outermost slot in front of those used to correct for distance vision until near vision of N6 or better was obtained. However, if a patient improved by one line or more but not up to the desired N6 or better they were still considered to have presbyopia. The best near vision was determined by adjusting the power of lenses and recorded together with the power of the plus lenses used to obtain it. Next, the right eye was occluded and the same procedure is repeated for the left eye.

A focimeter could not be used to determine the power of the patients' spectacles due to lack of electricity so neutralisation technique was used instead. This was recorded in the data collection form. The patients' vision with his/her own correction if available was taken and recorded in the form.

#### **4.12 Data collection**

Data was collected and filled in a questionnaire (Appendix A)

#### **4.13 Data management and Analysis**

The collected data was kept in safe place for data entry process. Questionnaires were checked for any missing or wrong entries. A data base was designed for input of data. Data was



analysed and inferential statistics were obtained using statistical packages (SPSS version 12.0 and Epi Info version 3.4.1.).

The data is presented in tables and figures where applicable. Parametric tests were used to examine any significant association between presbyopia and sex, age and education status.

A logistic regression was used to explore the significant variable in the modelling of the presence of presbyopia coverage. The Dependent/outcome variable was taken as the presence of presbyopia.

Odds Ratios (OR) and its associated 95% Confidence Interval (CI) were employed to determine the factors more likely to explain the explanatory/outcome variable.

P-value of less than 0.05% was considered statistically significant.

#### i) Further analysis

Data collected was further analysed into categories so as to meet the desired objectives.

#### Objective 1- Magnitude of presbyopia

From the data collected, the total number people found to have presbyopia compared to the total number patients examined, was calculated so as to give us the magnitude of presbyopia.

This was sub-classified as per each centre or region that was visited for data analysis.

#### Objective 2- Pattern of presbyopia

Different categories were assigned to the patients depending on the bio-data obtained from them and recorded in the data collection sheet. These were the category of age or age groups:

35-39 years, 40-44years, 45-49years, 50-54years, 55-59years, 60-64years, 65-69years and 70years old and above. Another category was the level of education the patient has so far received.

This was categorised into no education, primary school education, secondary education, and tertiary education. Another category was sex: male or female. All areas visited

were categorised as rural as per the Kenya demographic survey frame. Using these categories mentioned above, the magnitude and pattern of presbyopia was analysed and enabled conclusions to be obtained and compared with previous studies done on the same subject.

### Objective 3- Spectacle coverage and reasons for not wearing spectacle correction

The reason(s) for not wearing spectacles were obtained directly from the patient. Various reasons were enumerated in the data collection form to capture this. With this information, reasons were determined why people with presbyopia did not obtain spectacles and for some of those who had spectacles, why they opted against using them. This can be used as a reference to identify areas to be addressed.

#### **4.14 Materials**

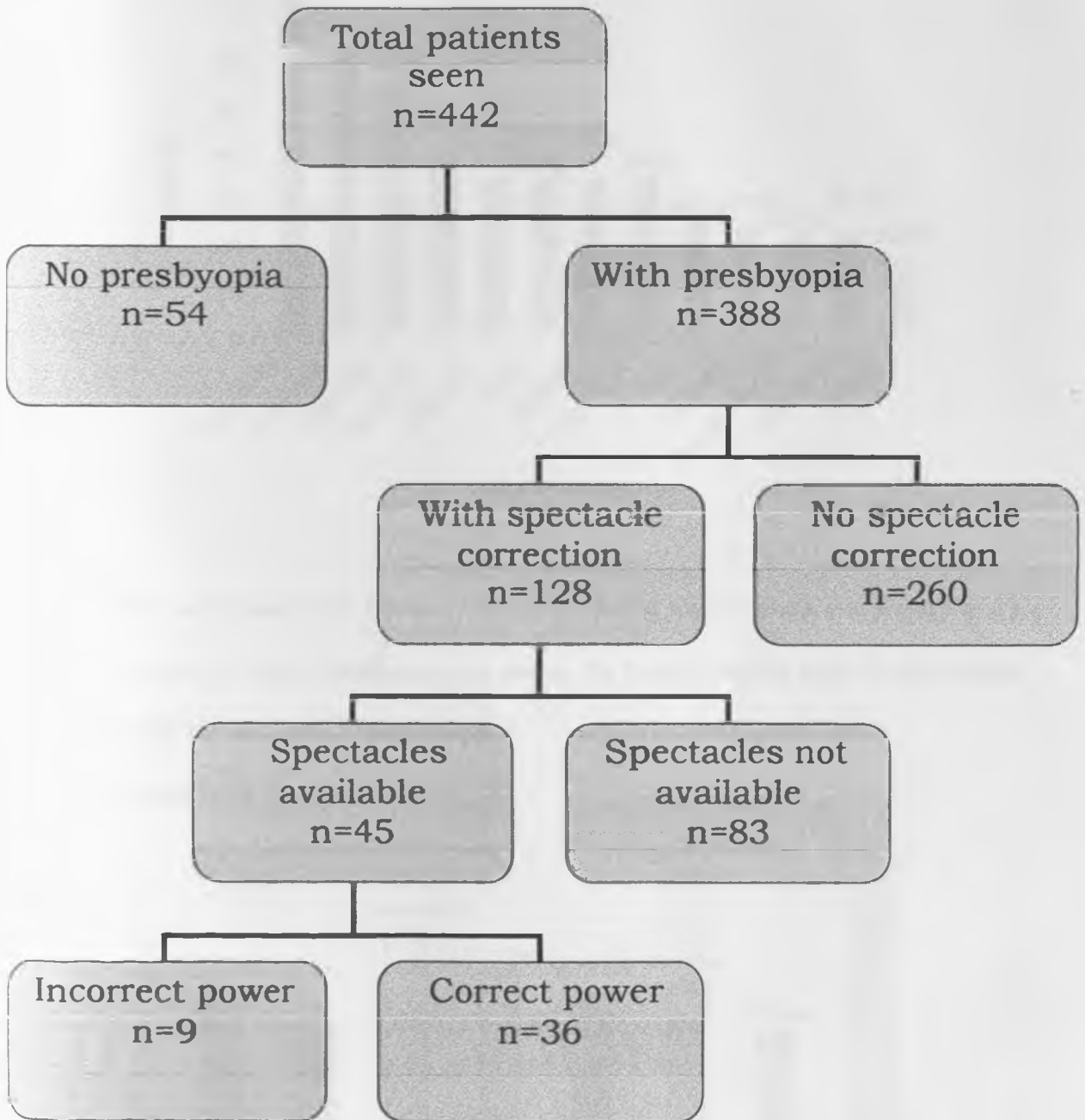
The materials used in conducting the study were Questionnaires, a torch, a refraction set with trial frames, illiterate E and near vision charts. Others included direct and indirect ophthalmoscopes, 20D loupe, topical mydriacyl, topical lignocaine and a schiottz tonometer

## **5. ETHICAL CONSIDERATIONS**

Prior to examination, informed consent was obtained. Additional explanation of each step was given concurrently with the examination. Standard non-invasive techniques were utilized in the examination of each patient. After completion of examination, appropriate prescription for spectacle correction was given. If any other pathology was found appropriate treatment was initiated. If the problem could not be handled at the site of the camp, then these patients were referred to the nearest appropriate eye care centre or to Kenyatta National Hospital eye clinic. All information obtained in the whole exercise is kept confidential. All eyedrops used are registered in Kenya.

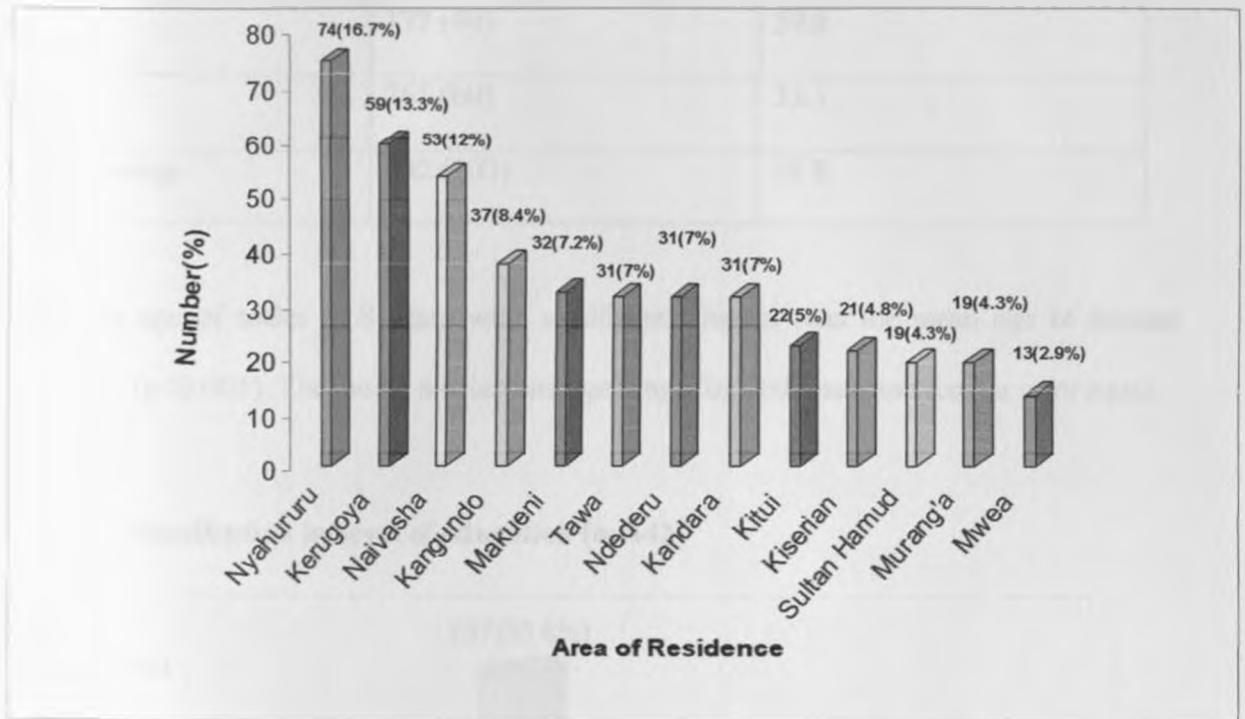
## 5. RESULTS

Figure 2: Summary flowchart



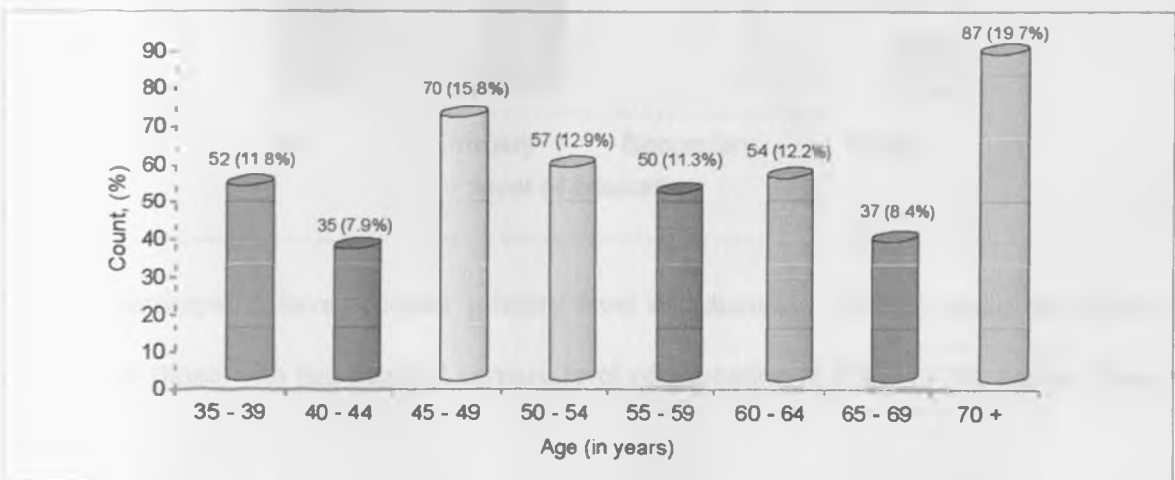
## I. STUDY POPULATION

**Figure 3: Area of Residence (n = 442)**



A total of 442 participants were recruited from 13 different towns visited. An average of 34 patients was seen per visit. Nyahururu town posted the highest turnout with 74 participants while Mwea had the least with 13 participants.

**Figure 4: Distribution by Age (n = 442)**



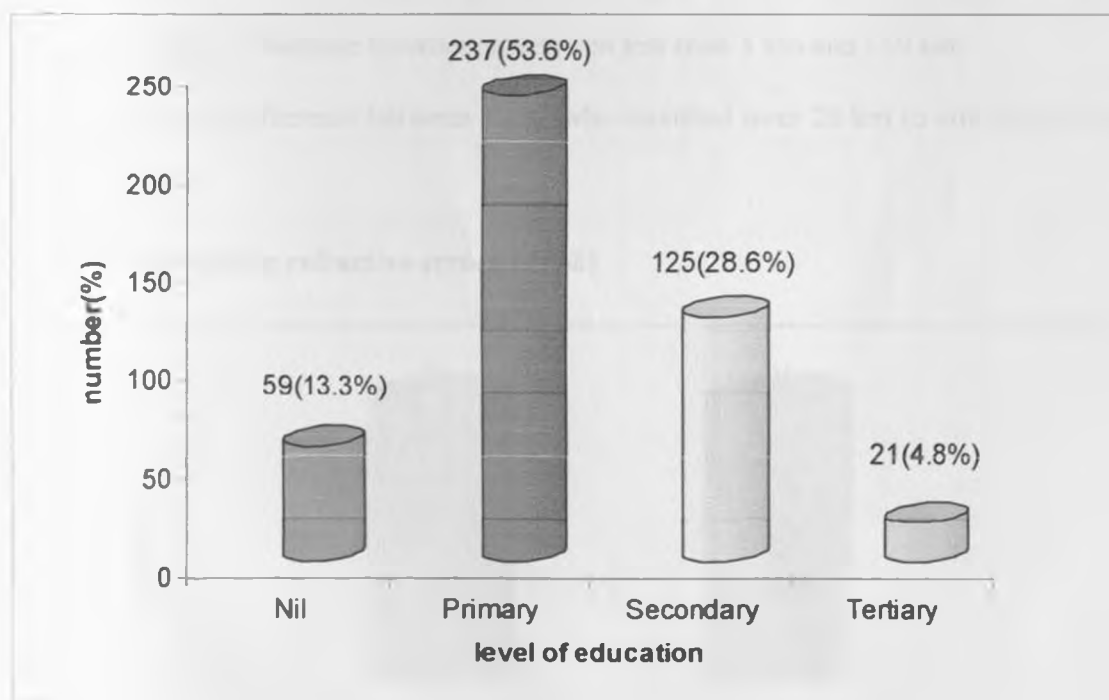
The age range was from 35 to 85 years. The smallest sized age group was the 40-45 age group (7.9%) while the largest was the 70+ age group (19.7%)

**Table 4: Distribution by age and sex (n=442)**

	Number (%)	Mean Age (years)
Male	177 (40)	59.8
Female	265 (60)	53.1
Total/average	442 (100)	55.8

The mean age of males 59.8 years were significantly higher than the mean age of females 53.1 years ( $p < 0.001$ ). The mode, median and age range for both male and female were equal.

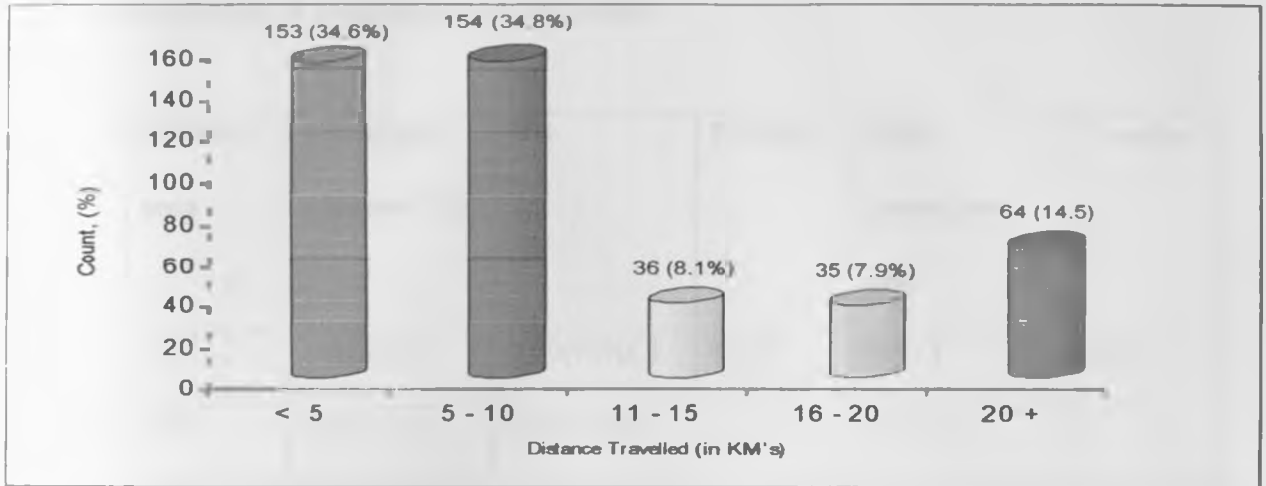
**Figure 5: Distribution by level of education (n=442)**



Most of participants have received primary level of education (53.6%) while the smallest group were those who had attained tertiary level of education (4.8%). 13.3% had no formal education.

There was no significant difference in education levels between males and females OR=1.21 (95%CI =0.79-1.85);  $p=0.349$ .

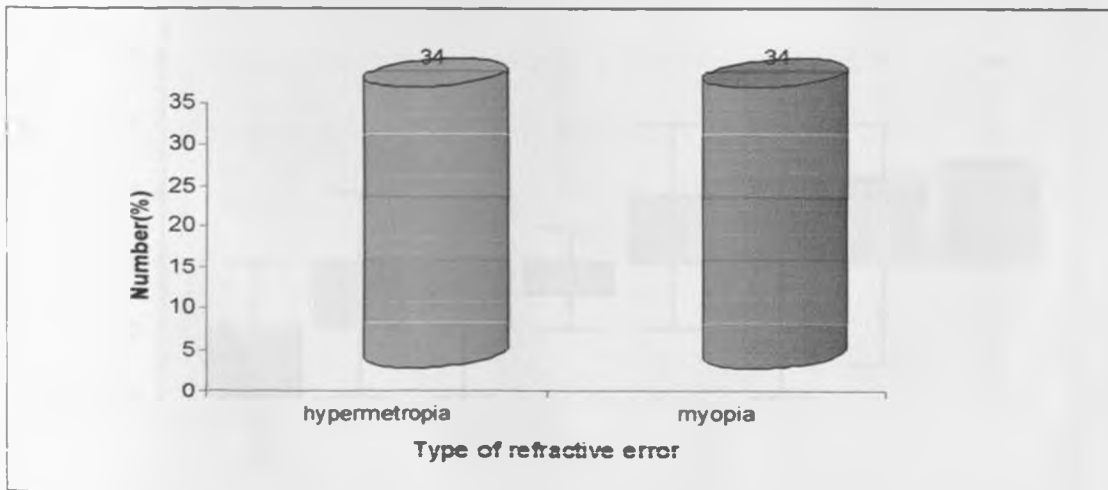
**Figure 6: Distance travelled to the camp to seek eye services (n = 442)**



Majority of participants lived within a 10 km radius of an outreach centre (79.4%); 16% lived between 10 and 20km away while 14.5% lived more than 20 km away from the outreach centre. The range of distance travelled is between less than 1 km and 150 km.

There was no sex difference between those who travelled over 20 km to attend the outreach camp  $p=0.138$

**Figure 7: Pre-existing refractive errors (n=68)**



There were 68 (15.4%) participants with pre-existing refractive errors out of which those with myopia were 34 and hypermetropia were 34. There was no significant difference in refractive error between males and females  $p=0.069$ ; OR = 1.62 (95%CI= 0.93-2.80)

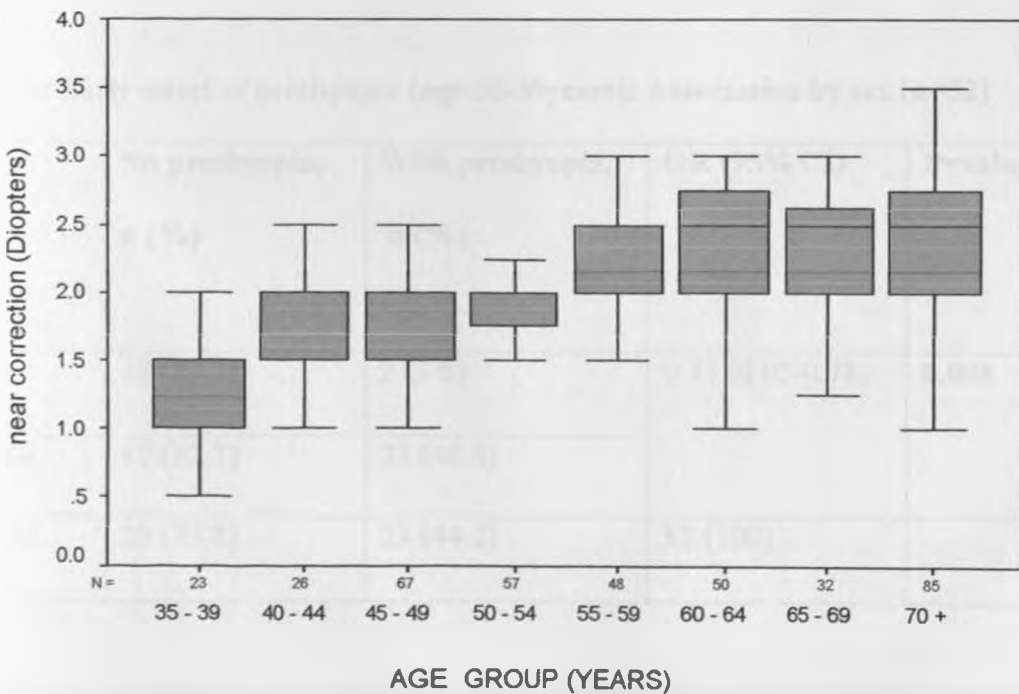
## II. ANALYSIS OF PRESBYOPIA

**Table 5: Association of presbyopia by sex (n=388)**

	Patients seen	Presbyopic patients (%)	OR	P=	Mean correction (D)	P=
Male	177	151(38.9)	0.69(95%CI 0.37-1.26)	0.195	+2.18	0.001
Female	265	237(61.1)			+1.97	
<b>TOTAL</b>	442	388(100.0)			+2.05	

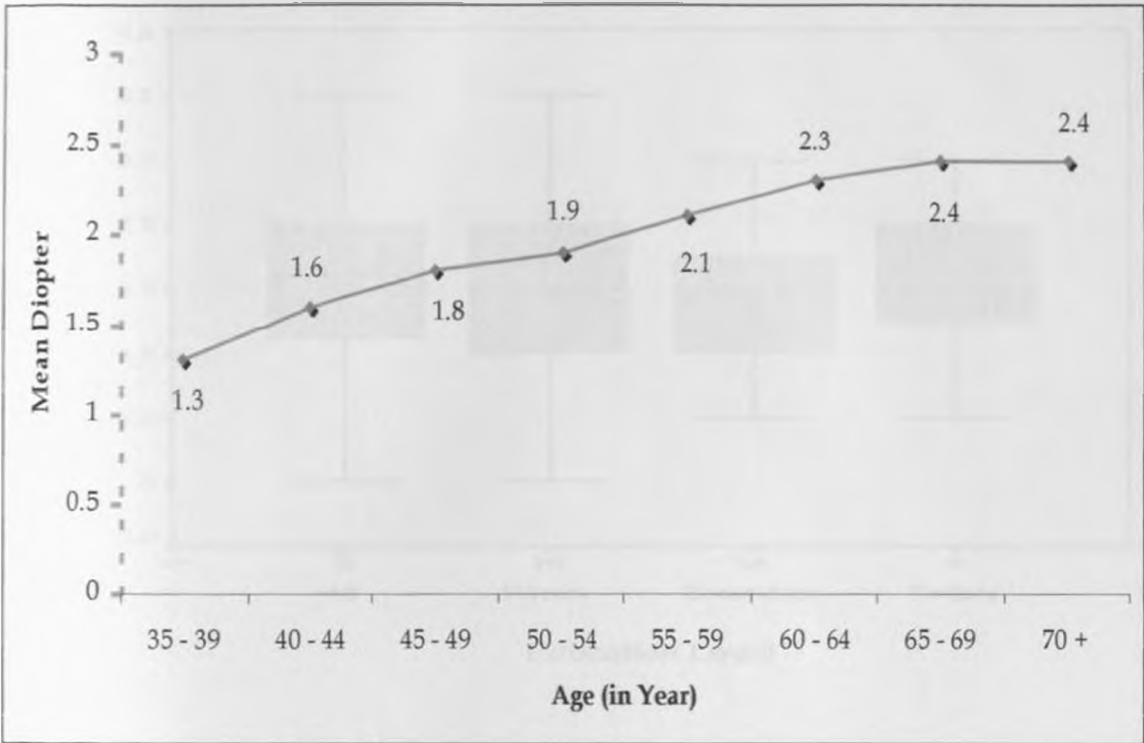
388 out of 442 (87.8%) patients were found to have presbyopia. There was no significant difference in frequency of presbyopia by sex (p-value = 0.195), but males required a significantly higher near correction compared to women p=0.001.

**Figure 8: Association of presbyopia by age (n = 388)**



The near correction diopteric power increases with age and plateaus at 65 years.

**Figure 9: Mean presbyopic correction by age group (n = 388)**



There is an almost linear progression in the required near correction by age. It commences at an average of 1.3D in the 35 to 39 year age group and plateaus at 2.4D at 65 years and above.

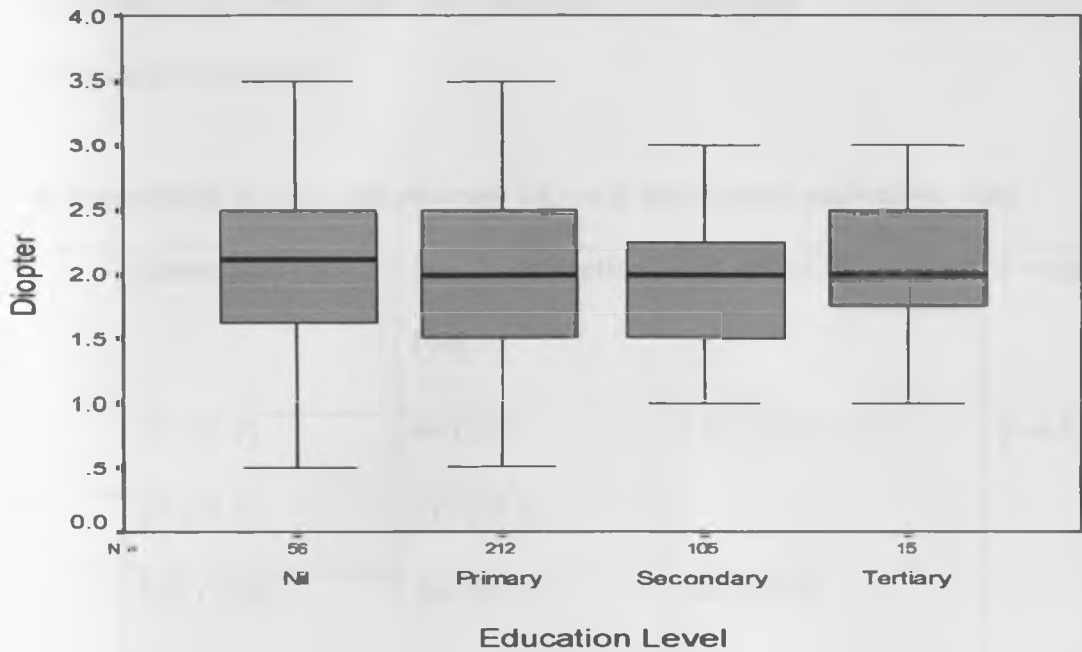
**Table 6: Early onset of presbyopia (age 35-39years): Association by sex (n=52)**

Sex	No presbyopia, n (%)	With presbyopia, n (%)	OR (95% CI)	P=value
Male	12 (23.1)	2 (3.8)	0.13 (0.02-0.78)	0.008
Female	17 (32.7)	21 (40.4)		
<b>TOTAL</b>	<b>29 (55.8)</b>	<b>23 (44.2)</b>	<b>52 (100)</b>	

Significantly more females than males presented with presbyopia in this age group (p=0.008).



**Figure 10: Association between presbyopia correction and education level (n=388)**



The trend shows that those with lower education level generally used a higher dioptric power for near correction.

**Table 7: Association of presbyopia correction by education level (n=388)**

Education level (n=388)	Mean presbyopic correction in Diopters(D)	P-value
Secondary & Above (120)	+1.91 (0.57)	0.004
Primary & Below (268)	+2.11 (0.63)	

Those who have attained secondary education and above were associated with a lower mean presbyopia correction (p=0.004).

### III. SPECTACLE COVERAGE

Only 45 patients brought with them their spectacles to be examined. Of these, 9 had incorrect power of spectacle correction.

**Table 8: Association of spectacle coverage by sex in presbyopic patients (n=388)**

Sex	Correction (%)	No correction (%)	OR (95%CI)	P=
Male	61 (15.7)	90 (23.2)	1.72 (1.09-2.71)	P=0.01
Female	67 (17.3)	170 (43.8)		
<b>TOTAL</b>	<b>128 (33.0)</b>	<b>260 (67.0)</b>	<b>388 (100.0)</b>	

Males were more likely to have spectacle correction p-value= 0.01.

**Table 9: Association of spectacle coverage by education level (n=388)**

Education level	Correction n (%)	No correction n (%)	OR(95% CI)	P=
Secondary and above	46 (11.9)	74 (19.1)	1.41 (0.88-2.27)	P=0.134
Primary and below	82 (21.1)	186 (47.9)		
<b>TOTAL</b>	<b>128(33.0)</b>	<b>260 (67.0)</b>	<b>388 (100)</b>	

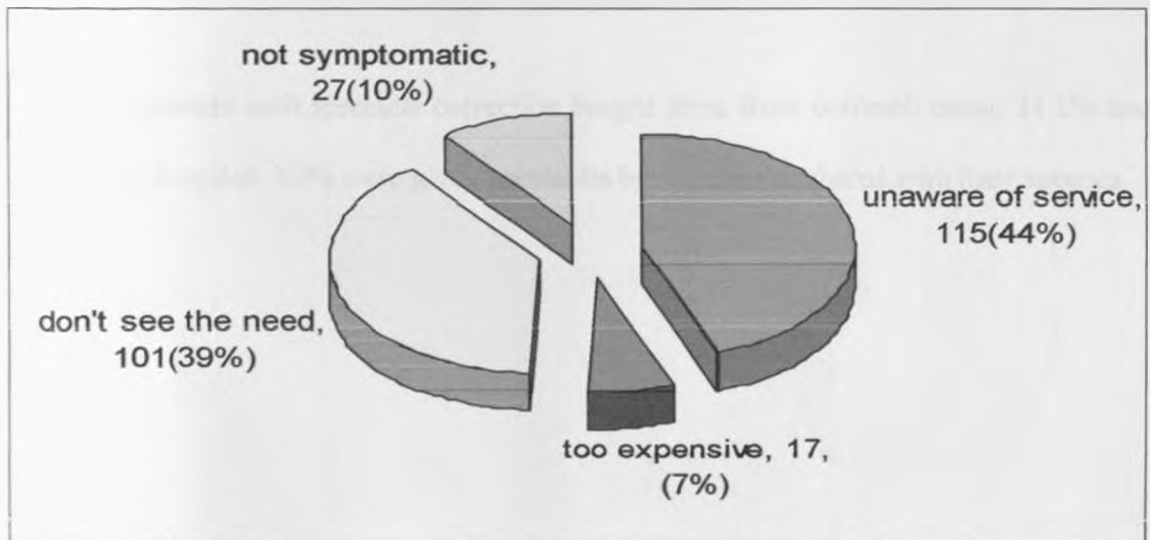
33% of participants with presbyopia had spectacle correction however there was no significant difference in presbyopic spectacle uptake with respect to education level attained (p=0.134)

**Table 10: Association of spectacle coverage by distance from the centre (n=388)**

Distance from centre (km)	Correction n (%)	No correction n(%)	OR (95% CI)	P=
≤10	93 (24.0)	181 (46.6)	1.16 (0.71-1.91)	P=0.536
>10	35 (9.0)	79 (20.4)		
<b>TOTAL</b>	<b>128 (33.0)</b>	<b>260 (67.0)</b>	<b>388 (100)</b>	

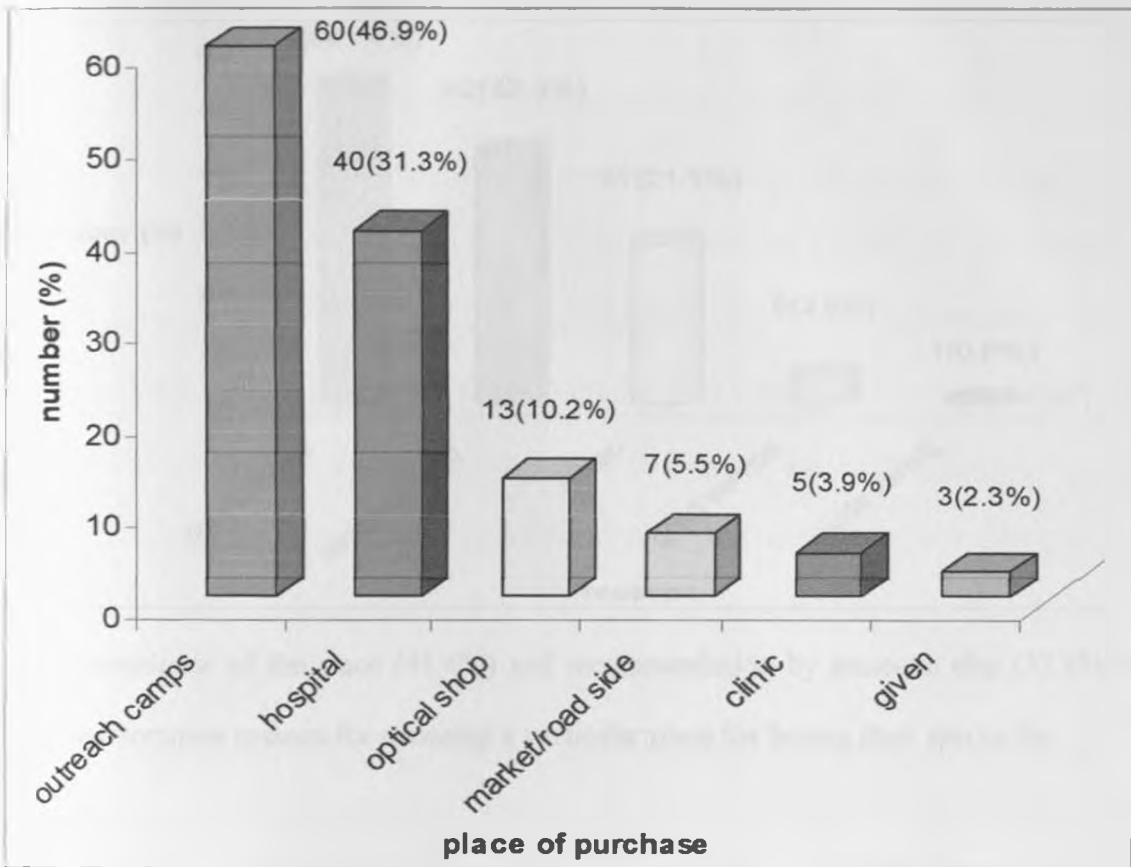
Distance of the participants residence from the outreach centre did not influence significantly the uptake of spectacle p=0.536.

**Figure 11: Reasons given for not wearing spectacles in patients with presbyopia (n=260)**



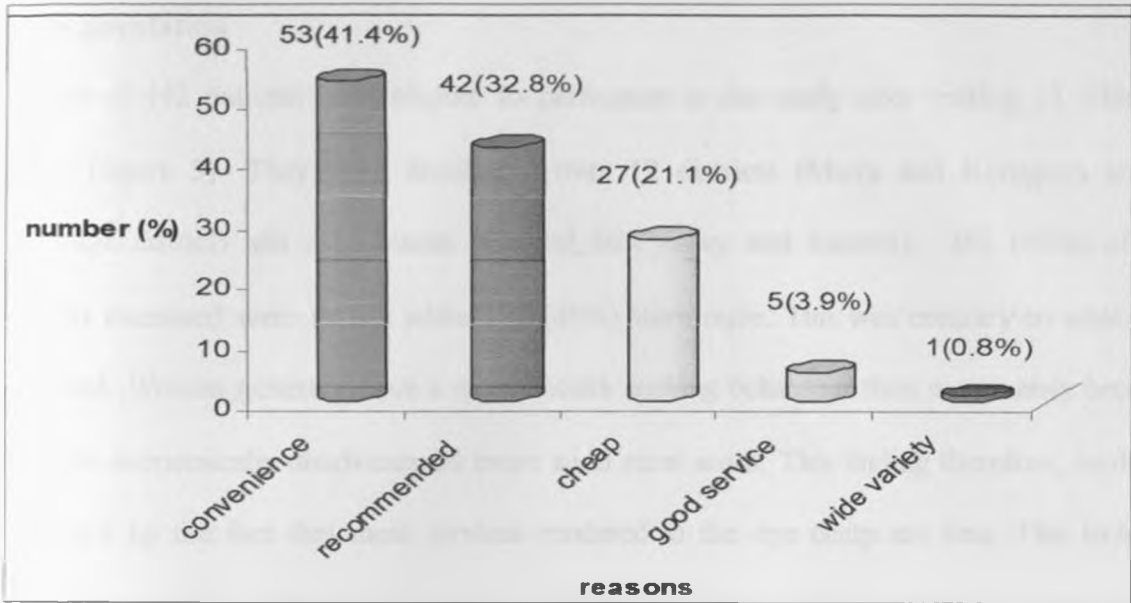
44% of presbyopia participants were not aware that their condition can be corrected by spectacles; 39% were comfortable with their presbyopia and did not see the need to seek help. Only 17% cited cost as the main inhibiting factor from buying spectacles. Another 10% were not aware they were presbyopic.

**Figure 12: Choice of place to buy their spectacles (n=128)**



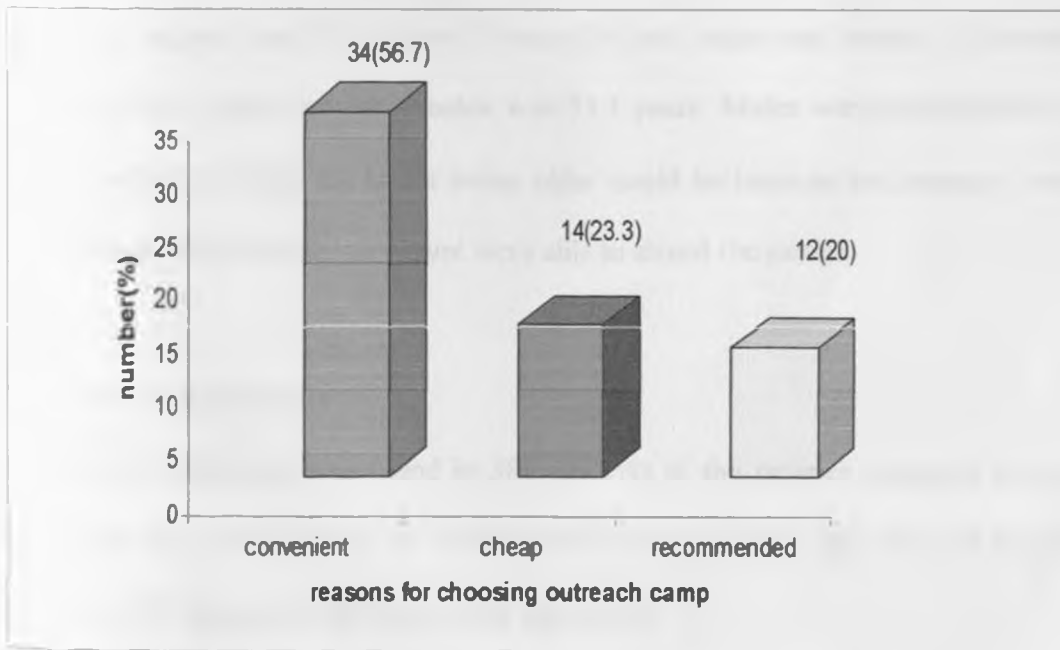
46.9% of patients with spectacle correction bought them from outreach camp; 31.1% bought theirs from hospital. 2.3% were given spectacles by relatives or shared with their spouses.

**Figure 13: Reasons for choice of place to buy spectacles (n=128)**



The convenience of the place (41.4%) and recommendation by someone else (32.8%) were the most common reasons for choosing a particular place for buying their spectacles.

**Figure 14: Reasons for choosing outreach centre to buy spectacles (n=60)**



Outreach camps were chosen for obtaining their spectacles mainly because it was convenient (56.7%). Other reasons were cost (23.3%) and recommendation by others (20%).

## 6. DISCUSSION

### Study population

A total of 442 patients were eligible to participate in the study after visiting 13 different towns (figure 3). They were distributed over 12 districts (Mwea and Kerugoya are in Kirinyaga district) and 3 provinces (Central, Rift valley and Eastern). 265 (60%) of the patients examined were female while 177 (40%) were male. This was contrary to what was expected. Women generally have a worse health seeking behaviour than men mainly because they are economically disadvantaged more so in rural areas. This finding therefore, could be explained by the fact that most services rendered at the eye camp are free. This includes consultation at the camp site, transport to and from hospital and any surgeries carried out at Lions SightFirst Eye Hospital. Food and their hospital stay are catered for without any additional cost to the patient. The elimination of cost reduces the barriers to access the eye services by women and thereby increase their turnout.

Their ages ranged from 35 years to 85 years for both males and females. The mean age for males was 59.8 years and for females was 53.1 years. Males were significantly older than females  $p < 0.001$  (Table 4). Males being older could be because the younger ones are the bread winners of the family and fewer were able to attend the camps.

### Prevalence of presbyopia

Evidence of presbyopia was found in 388 (87.8%) of the patients examined (table 5). This was higher than what Patel *et al*<sup>9</sup> found in the same age group (61.7%) and closer to what Sherwin *et al*<sup>10</sup> found (85.4%) in an older age group.

This high prevalence could be explained by the fact that the study was done in a camp setting where subjects were patients who were seeking an eye service of one kind or another therefore the probability of capturing those with presbyopia was higher.

#### **Association between presbyopia and sex**

The prevalence of presbyopia was found to be higher among females 89.4% than in males 85.3%. This was not found to be statistically significant  $p=0.195$ (Table 5). This was similar to findings in the studies by Patel *et al*, Nirmalan *et al* and Duarte *et al*.<sup>7,8,9</sup>

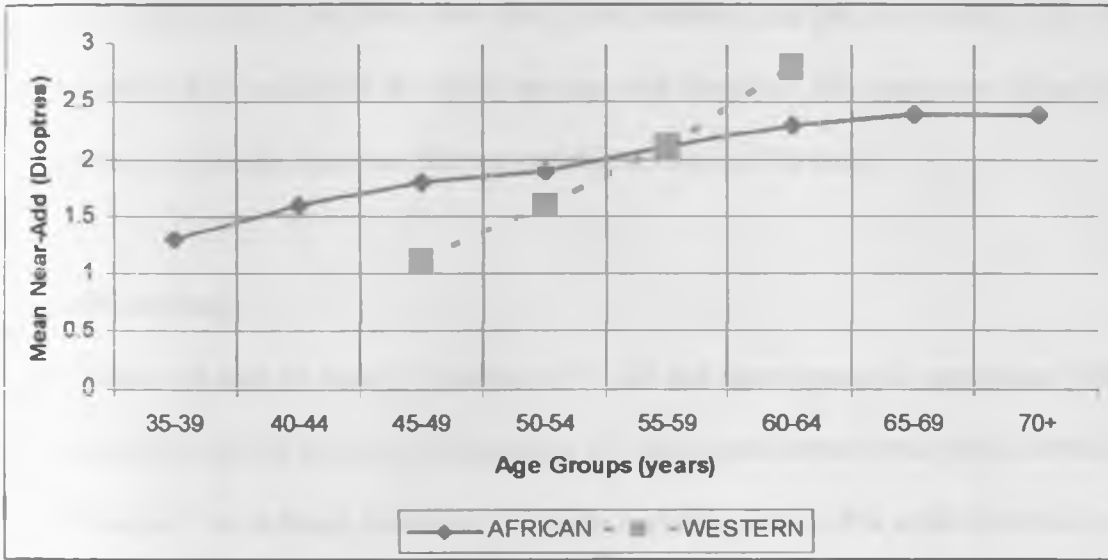
However the mean correction for males (+2.18D) was higher compared to females (+1.97D) and this was statistically significant  $p=0.001$  (table 2). This could be explained by the fact that males were significantly older than females. The median and mode presbyopia correction was equal for both sexes, +2.00D.

#### **Association between presbyopia and age**

The average age of presbyopic males was 62.3 years while that of females was 54.2 years. Patients who were examined were grouped into clusters of 5 years each for ease of analysis. There was an increase in degree of presbyopia with increasing age in almost a linear pattern which levelled off at 65 years of age (figure 8, 9). This was different from that found by Patel *et al* whose study showed it plateaus earlier at 50 years.

Those below the age of 40 years represented 11.8% (52) of the total patients examined. Presbyopia was found to be more prevalent in females compared to males in this category ( $p=0.008$ ) (table 6). This correlated with studies done by Duarte *et al*<sup>7</sup> and Pointer J.S *et al*<sup>23</sup>. This could be due to a better health seeking behaviour among females in this age group or purely be an indication that there was an earlier onset of presbyopia in females.

**Figure 15: Presbyopia correction: Proposed normogram for Kenyan African Population**



(Western values adapted from Principles and Practice of Ophthalmology)<sup>22</sup>

Further studies may need to be conducted on larger scale i.e. population based, to get a more refined picture of the best values.

### Association between presbyopia and education level

At least 53.6% (237) of patients had received primary education. Also included in this category were those who had attended adult literacy education classes. Only 4.8% had received tertiary education (figure 10).

There was no significant difference in education levels between males and females  $p=0.349$ . Those who had less education were associated with significantly more severe presbyopia  $p=0.004$  (table 7). This was contrary to the finding in the study done by Patel *et al*<sup>p</sup> who found higher education was associated with more severe presbyopia. This could be due to incorrect interpretation of clarity of near chart patterns when excessive power was used and the near chart symbols appeared darker or bigger in the non-educated group of patients.



The correlation between education status and severity of presbyopia has not been clearly elucidated in literature. It is thought that the more educated one is (and therefore the categories used above) the more time they spend reading and this prolonged strain on the ciliary muscles may accelerate the aging process and therefore they are prone to earlier and more severe presbyopia, however this was not found to so in this study.

### Spectacle coverage

Of the patients found to have presbyopia, 67% did not have spectacle correction (table 8). This was similar to that found by Nirmalan *et al*<sup>7</sup> who found unmet presbyopia correction of 70%. J.Ramke<sup>15</sup> et al found an unmet spectacle correction of 73.8% while Sherwin *et al*<sup>10</sup> and Patel *et al*<sup>6</sup> also found unmet spectacle need of 80% and 94% respectively.

Males were more likely to have spectacle correction than females; ( $p=0.01$ ; OR 1.72, (95% CI 1.09-2.71)) (Table 8). This could be because the male participants in the study were significantly older and more economically endowed so as to acquire the spectacles when prescribed.

Spectacle coverage was not affected by education status ( $p=0.134$ ) (table 9) nor by distance from the outreach centre ( $p=0.536$ ) (table 10) contrary to Dandona *et al*<sup>18</sup> who found increased spectacle uptake with increased education status.

Various reasons were given by participants as to they why stayed without correction (figure 11). The most common were not being aware that their condition could be corrected (44%) and not seeing the need to have spectacle correction (39%; figure9). 20% of patients were found to have incorrect presbyopia correction; however this was based on the few patients,

(35%) who came with their spectacles. This incorrect power could be due to lack of renewal of the prescription as the presbyopia progresses.

Out reach camps were the most popular site patients chose to buy their spectacle correction from (46.9%) followed by hospitals (31.3%) while the 3% either were given or shared spectacles with someone else (figure 12). The choice of place mainly depended on the convenience to the patient (41.4%) and it being recommended by others (32.8%) (figure 13).

Outreach camps were chosen mainly because they were convenient (56.7%) to the patient in terms of proximity to their home and comprehensive care they would get there, low cost of the spectacles (23.3%) and also because previous patients who attended them recommended them to others (20%) (figure 14).

#### **Distance from the centre**

69.4% of the participants lived within 10km radius of the centre used for the outreach while 14.5% lived outside a 20km radius, the furthest being 150km away (figure 6). Majority of patients attended to at the camp did not have a consistent alternative centre for eye care.

Distance from the outreach centre did not influence significantly the uptake of spectacles  $p=0.536$  This is contrary to what was expected probably because there are other outlets providing spectacles for example optical shops, local health institutions or at the market place.

## 7. CONCLUSION

1. There was 87.8% prevalence of presbyopia in patients attending outreach camps in the age group 35 years and above.
2. Increasing age and lower education status were associated with more severe presbyopia. Females had an earlier presentation of presbyopia.
3. Spectacle coverage was 33% but 20% of those who brought their spectacles had the incorrect spectacle power.
4. 69.4% of patients resided within a 10km radius of an outreach camp. Distance from the outreach camp did not influence the uptake of spectacles in patients with presbyopia.

## **8. RECOMMENDATIONS**

- 1 Increase awareness to communities that presbyopia is a condition that can occur as early as mid 30's and can easily be corrected with spectacles. These spectacles can be used in all types of near work and not just reading and are therefore appropriate for illiterate individuals.**
- 2. Health care workers in the eye unit should be aware of presbyopia occurring as early as mid 30's and patients should be examined for it whether or not they are symptomatic. Increased detection is through liaising with other units in the hospital for appropriate referral to the eye unit either from out-patient unit or in-patients on discharge. Presbyopia detection and management should also be incorporated in outreach programmes to capture those in the community who are unable to attend to an eye unit for one reason or another. Those found not to be presbyopic at first visit will be advised they may get it later on while those found to be presbyopic will be given a prescription and provided with appropriate spectacles. They will be advised on to change them, if need be, later on because presbyopia is a progressive condition.**
- 3 Policy makers should incorporate the detection and management of presbyopia in the national eye care plan. This has to be coupled with provision of appropriate and affordable spectacles at every eye unit. This will make presbyopic services accessible, affordable and available and reduce the morbidity and increased dependence associated with uncorrected presbyopia.**
- 4. Population based studies need to be conducted in the African setting to develop our own protocol of presbyopia correction because the age adjusted presbyopic correction differs from that in western countries.**

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# APPENDIX A : PRESBYOPIA QUESTIONNAIRE

## PART 1

Date \_\_\_\_\_

1. Date of birth:    /    /    Age: \_\_\_\_\_ years
2. Residence: \_\_\_\_\_ (SUBLOCATION)
3. Distance travelled from home to this centre for eye service: \_\_\_\_\_ km
4. Sex:     M             F
5. Education:     Nil     Primary     Secondary     Tertiary

## PART 2

6. Do you have difficulty in reading [e.g. Bible/Newspaper], focusing near objects or doing near work?     Yes     No
7. If yes above (Q6), do you normally wear spectacles while reading?  
 Yes     No
8. If No above (Q7), why not?     Don't see the need  
 I look ugly in them             Broken/lost  
 Too expensive             they don't help  
 Did not know service is available  
 others \_\_\_\_\_
9. Where did you buy your spectacles from?     Outreach camp  
 Optical shop     hospital     clinic     market/roadside     given to  
me/ sent by relative     others \_\_\_\_\_



10. Why did you buy them from there?  Cheap  convenient  wide variety

good service  recommended to me  others

11. How much did the spectacles cost you? Ksh \_\_\_\_\_

(Which year? \_\_\_\_\_)

**PART 3 (examine if available)**

12. Type of spectacles  Nil  Readers  Bifocal

Progressives

13. The status of the spectacles:  clean  scratched

not available  dirty  broken  others

14. Power of spectacles

RE

LE

Bifocals/progressives Distance

D

D

Near add

D

D

Readers only

D

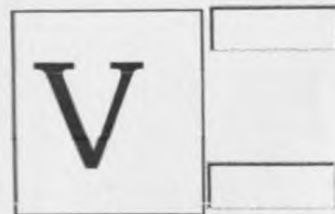
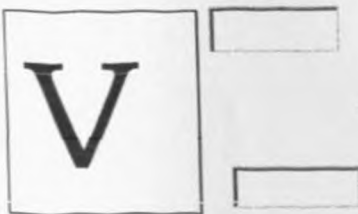
D

**PART 4**

15. DISTANT VISION of the Patient: - (if worse than 6/9, refract subjectively)

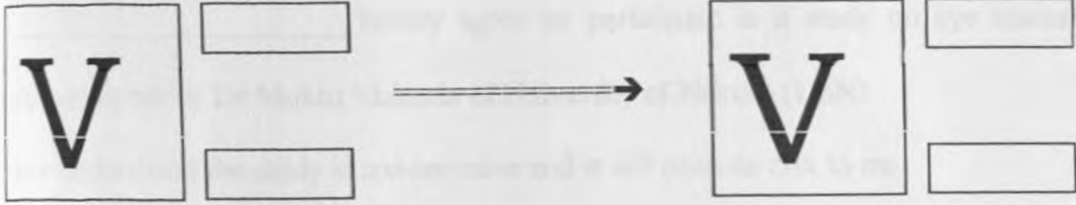
Without correction

Patients own correction



Without correction

Best corrected



16 NEAR VISION: With the above correction still in the trial frame, do near vision. (If worse than N6 refract with plus lenses)

With distance correction

Patients own correction



With distance correction

Best corrected



## APPENDIX B: CONSENT FORM

I \_\_\_\_\_ hereby agree to participate in a study on eye assessment as explained to me by Dr Mukiri Mukuria of University of Nairobi (UoN).

I have understood the study is non-invasive and it will pose no risk to me.

Signature \_\_\_\_\_

Date \_\_\_\_\_

Dr. Mukiri Mukuria

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### Cheti cha Kibali

Mimi \_\_\_\_\_ nakubali kupimwa macho na Dkt Mukiri Mukuria kutoka chuo kikuu ya Nairobi (UoN) baada ya kuelezwa na kuelewa kuwa kipimo hiki hakihitaji upasuaji wala hakitanidhuru.

Sahihi \_\_\_\_\_

Tarehe \_\_\_\_\_

Dkt Mukiri Mukuria

**APPENDIX C: THE MAGNITUDE AND PATTERN OF PRESBYOPIA AMONG PATIENTS SEEN ON OUTREACH WITH LIONS SIGHTFIRST EYE HOSPITAL, LORESHO**

Minimum sample size= 363; target number =450

Proposal= 35 pages; expected final book size = 70 pages

**MMED THESIS PROPOSED BUDGET – DR MUKIRI MUKURIA**

<b>ITEMS</b>	<b>Unit Cost (Ksh)</b>	<b>Quantity</b>	<b>Total (ksh)</b>
<b>1. Proposal preparation</b>			
Typing & printing draft	40x35	1	1,400
Copies to supervisor	3x35	3	315
Revision/correction of drafts	3x35	3	315
Printing final draft	40x35	1	1,400
Copies to ethical committee:			
Photocopies	3x35	3	315
Binding	100	3	300
Ethical committee fees	1500	1	1,500
<b>Subtotal</b>			<b>5,545</b>
<b>2.Data collection:</b>			
<b>Stationery &amp; equipments e.g.</b>			
Questionnaires (3 pages each)	3x3	450	4,050
Torches,	200	1	200
Pens,	20	5	100
Folders	250	1	250
Flash disk	1500	1	1500
CD	200	2	200
<b>Consumables &amp; Lab lx eg</b>			
Batteries,	100/pair	5 pairs	500
Lignocaine	150	3	450
Mydriacyl	150	3	450
<b>Contracted services e.g.</b>			
Stastician	20,000	1	20,000
Research assistant	12,000	1	12,000
<b>Transport</b>	400per return trip	24trips	9,600
<b>Communication: Airtime</b>			1,000
<b>Sub total</b>			<b>50,300</b>

<b>3.Data management &amp; Reporting</b>			
Typing & printing of preliminary Results	40x70	1	2,800
Copies to supervisors:	3x70	3	630
Revision of Results:	3x70	3	630
Photocopies:- Black and White	3x70	8	1,680
Coloured	40x10	8	3,200
Binding of books	200	8	1,600
<b>Sub total</b>			<b>10,540</b>
<b>5. Contingencies (10%)</b>			<b>6,640</b>
<b>GRAND TOTAL</b>			<b>73,025</b>

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