

**MAGNITUDE AND PATTERN OF SIGNIFICANT  
REFRACTIVE ERRORS AMONG PRIMARY SCHOOL  
CHILDREN IN NTCHEU AND LILONGWE DISTRICTS IN  
MALAWI //**

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**A DISSERTATION SUBMITTED AS PART FULFILLMENT FOR THE  
DEGREE OF MASTERS OF MEDICINE (OPHTHALMOLOGY),  
UNIVERSITY OF NAIROBI**

## DECLARATION

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

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## **DEDICATION**

With love and dedication to my loving wife Flora and my beautiful daughter Wongani.

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## ABBREVIATIONS

1. DS	Diopter Sphere
2. DC	Diopter Cylinder
3. PMMA	Polymethyl Methacrylate
4. LASIK	Laser in Situ Keratomileusis
5. PRK	Photorefractive keratectomy
6. RE	Right Eye
7. LE	Left Eye
8. VA	Visual Acuity
9. CC	With Correction
10. SC	Without Correction
11. SPSS	Statistical Package for Social Sciences
12. DRE	Disabling Refractive Errors
13. WHO	World Health Organisation
14. RESC	Refractive Error Study in Children
15. BCVA	Best Corrected visual acuity
16. D	Dioptres
17. ICD	International Classification of Diseases

## ABSTRACT

A cross sectional school based study was conducted on significant refractive errors in primary school children in Lilongwe and Ntcheu districts in Malawi.

The objective of the study was to determine the prevalence and pattern of significant refractive errors in primary school children aged 12 – 15 years in the two districts.

**Method:** All children aged 12 – 15 years attending randomly selected public schools and were present during the survey period were included in the study. The random sampling was a two stage process; first three education zones were randomly selected in the two districts. With lower numbers of school children in the rural areas, three full primary schools were again randomly selected from each of the three zones in Ntcheu and two schools from each of the three zones in Lilongwe. In the selected schools all pupils aged 12 – 15 years were examined.

A case was defined as a pupil with a significant refractive error if the visual acuity during the study period was 6/12 or worse in the better eye with the use of a Snellens chart and was improving with refraction. Objective and subjective refraction was done only in the cases. Data was analysed using SPSS version 12.0. A p-value of  $< 0.05$  was considered statistically significant.

**Results:** A total number of 1448 pupils in Lilongwe and 1276 pupils in Ntcheu participated in the study. In Lilongwe the prevalence of refractive errors was 2.3%. Myopia accounted for 1.7%, hypermetropia 0.4% and astigmatism 0.3%.

In Ntcheu, an overall prevalence of 2.4% was noted with hypermetropia accounting for 1.4%, myopia only 0.8% and astigmatism 0.1%.

The prevalence of myopia was significantly higher in Lilongwe as compared to Ntcheu with a p-value = 0.012. The prevalence of hypermetropia was significantly higher in Ntcheu with a p-value = 0.001. No significant difference was found with the prevalence and pattern of astigmatism in the two districts.

**Conclusion:** A low prevalence of significant refractive errors was found in the two districts in Malawi. There is no significant difference in the refractive error magnitude in the two districts. There is a significant difference however in the patterns of refractive

errors in the urban and rural districts, with more myopia in the urban than the rural while hypermetropia is more in the rural setting.

### **1.0.0 Introduction**

A recent review of the impact of Vision 2020 by A Foster on preventable blindness other than uncorrected refractive errors indicates that the current estimates of global blindness are less than projected and thus the trend is in the right direction to meet vision 2020 goals(1).

Refractive errors still rank among the leading causes of visual impairment worldwide and according to a report by Fotouhi et al, are responsible for high rates of low vision and blindness in certain areas(2). School children are considered a high risk group because refractive errors can seriously affect their learning abilities and their physical and mental development(3).

Studies on the prevalence of refractive errors among children in different parts of the world show significant differences and population based studies concerning refractive errors in children are very limited in southern Africa (4 – 7). School children aged 12 – 15 are considered a high risk group because at this point hyperopia is stabilizing, myopia is setting in and puberty and near work effects begin to exert their influence on refractive error pattern development.

In developed countries, screening for eye diseases including refractive errors in school going children is done routinely. In the UK for instance, Cummings et al noted that almost all children with significant visual problems including refractive errors are

detected before entry into school and by the age of 8 years only 1.7% have not been screened for eye diseases(8).

In many developing countries including Malawi, there are no national preschool or school eye screening programmes and in most cases screening is done for the purpose of research. Therefore little is known about the prevalence and public health importance of refractive errors in school age children. Effective management of visual impairment due to refractive errors requires the establishment of proper service structures to match the magnitude of the problem. Unfortunately Fotouhi's report from Dezful in Iran indicates that we are not doing so well on meeting the goal to eliminate visual impairment caused by uncorrected refractive errors(2).

## **2.0.0 Literature Review**

### **2.1.0 Refractive Errors Defined**

Refractive errors are not diseases per se, but ocular disorders. There is an error in the focusing of light by the eye. Normally light is refracted by the cornea and the lens so that a clear image can be focused on the retina and be seen. For those with refractive errors the image is either focused in front or behind the retina resulting in blurry images.

Refractive errors are frequently categorized as spherical errors or cylindrical. Spherical ones occur when the optical power of the eye is either too large or too small to focus light on the retina. Cylindrical errors occur when the optical power of the eye is too powerful or too weak across one meridian of the optics. The three basic types are discussed as below.

#### **2.1.1 Hyperopia**

Hyperopia is also referred to as hypermetropia or far sightedness. In this type of spherical refractive error, an image of a distant object is focused behind the retina, either because the eyeball axis is too short or because the refractive power of the cornea and the lens are insufficient(9).

Hyperopia is usually present at birth where more than 75% of the eyes are hypermetropic to the extent of +2.50DS to +3.00DS. The process of emmetropisation continues postnatal till about the age of 12 – 14 years when hyperopia resolves completely. Williams et al reported that by the age of 7 years, 10.8% of the children are still hyperopic and only 2% by the age of 15 years (9).



The hyperopic condition makes close objects appear out of focus and may cause headaches, eye strain, or fatigue. Lack of interest in school and difficulty reading are often seen in children with hyperopia. Based on the magnitude of refractive error, hyperopia is categorized as:

- 1) Low hyperopia is a refractive error of  $+2.00\text{DS}$  or less
- 2) Moderate hyperopia is a refractive error of  $\geq +2.25\text{DS}$  to  $\leq +5.00\text{DS}$
- 3) High hyperopia is  $\geq 5.25\text{DS}$

### **2.1.2 Myopia**

Also referred to as near or short sightedness, is a refractive defect of the eye in which collimated light produces image focus in front of the retina when accommodation is relaxed. Distant objects appear blurred.

Boris and Duke Elder classified myopia by cause as axial myopia which is attributed to excessive or increase in the eyeball's axial length and refractive myopia which is attributed to the condition of the refractive elements of the eye.

Refractive myopia has been further sub classified into curvature myopia which is attributed to excessive or increase in curvature of one or more of the refractive surfaces of the cornea. In those with Cohens syndrome, myopia appears to result from high corneal or lenticular power. Index myopia is attributed to variation in the index of refraction of one or more of the ocular media.

The World health organization has grouped myopia and other uncorrected refractive errors with cataract, macular degeneration, infectious diseases and vitamin A deficiency among the leading causes of blindness and visual impairment in the world (1). Myopia is the commonest refractive error seen in children. It rarely occurs below the age of 5 years and new cases appear throughout childhood and adolescence particularly between the ages of 6 – 15 years (10).

People with myopia can be classified into two groups

- 1) Low to modest degrees of myopia of  $-6.00\text{DS}$  or less
- 2) High myopia of greater than  $-6.00\text{DS}$

The former is often referred to as simple or school myopia. The later is often referred to as pathological myopia and is often associated with potentially blinding conditions such as retinal detachment, macular degeneration and primary open angle glaucoma among others.

### **2.1.3 Astigmatism**

Astigmatism is a refractive error of the eye in which there is a difference in degrees of refraction in the different meridians (corneal surface or the lens). Lens astigmatism is common in the elderly. Astigmatism causes difficulties in seeing fine detail. In some cases, vertical lines and objects such as walls may appear to the patient to be leaning over like the Tower of Pisa.

The prevalence of astigmatism increases with age. Higher amounts of astigmatism may cause blurry vision, squinting, asthenopia, fatigue or headaches. Astigmatism may be classified based on the axis of the principal meridian as regular, where the principal meridians are perpendicular. Regular is further classified into

- 1) With the rule where the axis line is between 0 and 30 degrees or 150 and 180 degrees.
- 2) Against the rule where the axis line is between 60 and 120 degrees.
- 3) Oblique where the axis line is between 30 and 60 degrees or 120 and 150 degrees.

In irregular astigmatism, the principal meridians are not perpendicular.

Astigmatism may be simple when not combined with myopia or hyperopia or compound when an eye has both myopia or hyperopia and astigmatism.

### **2.2.0 Prevalence of Refractive Errors**

In monitoring refractive errors as a priority in vision 2020, Catherine et al noted that the magnitude of refractive errors is not reliably known and that there is a large global variation in the prevalence of refractive errors (11).

Disabling refractive errors (DRE) in children are defined as presenting visual acuity equals or less than 6/12 in the better eye due solely to uncorrected refractive errors. Based on this cut off point several studies have reported different figures. School-age children 5 to 15 years old with presenting vision equals or less than 6/12 in the better eye are

considered to be visually impaired according to the specific recommendation of the WHO Refractive Errors Working Group (12).

The global prevalence of refractive errors has been estimated from 800 million to 2.3 billion (11). In the USA, refractive errors are estimated to affect 25% of the population by the age of 15 years. In school children aged 5 – 15 years the World Health Organisation estimates that 40 million have visual acuity of 6/12 or less with uncorrected refractive errors or improperly corrected (12).

Etyale, the WHO representative for vision 2020 in Africa reported at a special session on refractive errors at an international Agency for prevention of blindness meeting in 2001, that 5 – 15% of children are considered to have refractive errors ( $VA \leq 6/12$ ), the majority of who are uncorrected (1).

In developed countries, screening for refractive errors in preschool and school children is done routinely even though there is active debate about its value and cost effectiveness (12).

The recent population based refractive error study in children surveys, collected data from 6 countries (3 – 7). Reports indicated wide geographic and ethnic variations with high myopia prevalence in East Asian countries and urban areas.

In the rural areas of Mwanza region, Wedner et al reported a refractive error prevalence of 1.0% in school children (13). In Nairobi, Kenya Nzuki et al found that the prevalence of significant refractive errors was 10.2% in school children in Langata division. Seventy percent of the pupils studied were in the age group 12 – 15 years with an age range of 12-18 years. Of these 9.2% had myopia, 0.3% had hyperopia and 0.5% had astigmatism (14). Similarly, Kawuma et al found the prevalence of significant refractive errors of 11.6% among primary school children aged 12 – 13 years in Uganda, 52% of these had astigmatism with few cases hyperopia and myopia (15).

In Tanzania's Mwanza city, Wedner et al found the overall prevalence of significant refractive errors in secondary school pupils age 11 – 17 years was 5%(16).

The prevalence noted in both rural and urban areas of Mwanza by Wedner was much lower than what Nzuki et al found in Nairobi, Kenya though Wedner used a visual acuity of less than 6/12 and no cycloplegia was used in the study. Of the 6.1%, myopia accounted for 5.6%, hyperopia 0.4%, astigmatism 0.1%, strabismus 0.2%, amblyopia 0.4% and other non-refractive causes of poor eyesight were 0.8%(16).

Reports from Asia indicate a high prevalence of significant refractive errors in school children in comparison to other parts of the world. In Singapore for instance the prevalence of significant or disabling refractive errors among the school children aged 12 – 17 years was found to be 22.3% by Ho et al (17).

Ming-Zhi Zhang et al conducted a study in China on astigmatic error of greater than 1.00D cylinder in children, aged 6 to 7 years in Singapore and Xiamen. A wide variation in prevalence was found, for Xiamen city (6.8%), Xiamen countryside (8.7%), and 17.1% in Singapore (18).

In India a study conducted by Malta et al, showed 12.5% children to have refractive errors. Of these, 55.6% had myopia; hypermetropia accounted for 16.9% cases and astigmatism 27.4 % (19). In the last three studies, a visual acuity of equals or less than 6/12 was used as a cut off point.

### **2.3.0 Geographic Variation and Ethnic Groups**

In many studies carried out in different parts of the World, myopia has been found to be the most common refractive error in terms of prevalence. The recent population based refractive error study in children surveys (RESC) collected data from 6 countries and reported high myopia prevalence rates in East Asian countries and in urban areas (3 – 7). The cut off point was  $VA \leq 6/12$  in the age groups 5 – 15 years. Among children aged 12 years, the prevalence of myopia is higher in China (18 – 49.7%) and Malaysia (24.8%) than in Nepal (2%), South Africa (2%), India (10%) and 10% in Chile (3 – 7).

In a study conducted by Naidoo et al in South Africa, a prevalence of myopia of 4% was noted in the 14 year olds and 9.6% in the 15 year old age group compared with a hyperopia prevalence of 1.8%. In the ages less than 12 years hyperopia was more common (4).

Crawford et al examined school children from ten ethnic groups in Hawaii and found significant differences in refractive errors among the different ethnic groups. Chinese school children exhibited the greatest amount of myopia (17%), followed by Koreans (13%), and Japanese (12%). Myopia occurred within other groups in the following descending order; Caucasians, Spanish, Portuguese, Filipinos, Puerto Ricans, Partial Hawaiians and Hawaiians. Hyperopia was found in 3% to 5% for all the groups with the exception of the Portuguese who exhibited 10% (20).

Wedner et al found that the prevalence of refractive errors was different depending on the ethnic group of the students. It was found that the Tanzanians of Asian origin were 3.6 times more likely to be myopic compared to the black Tanzanians (16). Similarly McLaren et al found that the Tanzanians of Asian origin aged 7-14 years were more likely to be myopic than black Tanzanians with a similar age range (21).

Saw SM et al found that the prevalence of myopia was higher in Singapore Malays than in Malays in Malaysia. Similarly Singapore Chinese had higher prevalence than Malaysian Chinese. Also Singapore Indians had a higher prevalence than Malaysian Indians. Since Malays, Chinese, and Indians in Malaysia have a genetic make up similar to that of Malays, Chinese and Indians in Singapore, environmental factors may contribute to the higher myopia rates differences seen (22).

Ip et al did explore ethnic differences in refraction as well as ocular biometry in a population based sample of 11 – 15 Australian children in the Sydney myopic study.

The most common refractive error (59.4%) was mild hyperopia defined as spherical equivalent of +0.50DS to +1.99DS. Myopia with a spherical equivalent of -0.50DS or less was found in 11.9%. Myopia prevalence in this study was still noted to be lower among European Caucasian children (4.6%) and Middle Eastern children (6.1%) than among East Asian children (39.9%). Caucasian children had the most hyperopic mean (+0.82D) and shortest mean axial length (23.23mm) while East Asian children had the most myopic mean (-0.69DS) and the greatest mean axial length of 23.86mm (23).

The different types of refractive errors have been documented differently in different parts of the world. In South Africa, Naidoo et al found that in children aged 5 – 15 years with significant refractive errors, astigmatism of at least 0.75DC was found in 6.7% of right eyes and 6.8% of the left eyes. Of the children presenting with astigmatism, 20% had with the rule astigmatism and about 30% had against the rule astigmatism (4).

In Taipei, Shih et al noted that 33% of the school children had astigmatism of less than 1.00DC in their study. In Taipei, most astigmatism was with the rule (83%). The rate of myopic astigmatism increased with age while the rate of hyperopic and mixed astigmatism decreased with age (24).

#### **2.4.0 Age and Sex variation of refractive errors**

Refractive error prevalence is not static throughout all ages in life. The distribution of adult refractive error is narrower than predicted from a normal distribution, showing a marked peak about emmetropia and a standard deviation of approximately 1.00D.



In contrast, the distribution of refractive error in childhood is normally distributed with a mean of about +2.00D and a standard deviation of 2.75D (25).

In a review of refractive errors in China, Edwards et al noted that by the age of 7 years, myopia is already prevalent. The incidence of myopia thereafter averages 11 to 12%; by the age of 17 years, more than 70% are myopic and this prevalence is greater than in people of European descent. In Hong Kong it was noted that myopia is much less prevalent in the older generation (26).

In the rural and urban areas of Gujarat in India, Trived et al also found a gradual shift toward less positive values of refractive errors occurring with increasing age in both boys and girls. Myopia risk in particular was associated with a female gender (27). In Kenya, Nzuki et al, found that female pupils were more myopic with a 54% prevalence compared with male pupils at 46% (14).

Dandona et al collected data on refractive errors from subjects of all ages in Hyderabad, India, as part of the population-based Andhra Pradesh eye disease study. In subjects 15 years or less, myopia was found in 4.4%, hyperopia 59.4% and astigmatism among 6.9%, while in adults greater than 15 years old myopia rose to 19.3%, hyperopia fell to 9.8%, and astigmatism was detected in 12.9% (5). The Dandona study showed that variations were present in different age groups but there was no analysis on the gender variations.

Similarly, Baldwin et al found that myopia tended to increase as the age of the children increased with the younger being more hyperopic and the older ones being more myopic.

Myopia in this study was reported in 25% of the children aged between 10 to 15 years(28).

In Australia, Ip et al reported a higher prevalence of myopia in girls than boys in both Caucasians and East Asians. In Caucasians 8.4% of the girls were significantly myopic as compared to 4.5% amongst boys. Among East Asians, 19.8% of the girls were significantly myopic compared to 14.9% of the boys. Boys were noted to be significantly hyperopic as compared to girls (23).

From the National Health and Nutrition Examination Survey (NHANES) as reported by Macias et al, astigmatism as a cause of visual impairment (VA 20/40 or worse) was found to increase with age. The astigmatic component prevalence ranged from 21.2 percent in young males to as high as 57.3% in females (29).

### **2.5.0 Refractive Errors Variation with Socioeconomic Status**

Refractive errors particularly myopia is of diverse aetiology. A small proportion of myopia is clearly familial, generally early in onset and of high level, with defined chromosomal localisation and in some cases causal genetic mutations.

In a recent review article on myopia by Morgan et al, they noted that in most economically developed societies, most myopia appears during childhood, particularly during school years. The chromosomal localisation characterised so far for high familial myopia do not seem to be relevant to school myopia (30).

This discussion on the aetiology of myopia has been going on over the last century and the emphasis on biological versus environmental theory has been alternately popular as the explanation of choice. Some studies among children and adolescents have shown a plausible connection between reading and the development of myopia (Angle and Weissman 1975; Richler and Bear 1980; Wong et al 1993; Zylbermann et al 1993), whereas this could not be confirmed by others (Ashton 1985).

Saw's findings render some weight to the environmental influence as regards the progression and development of myopia in children. In their study the prevalence of myopia was higher in Singapore Malays than in Malays in Malaysia. Similarly Singapore Chinese had higher prevalence than Malaysian Chinese. Also Singapore Indians had a higher prevalence than Malaysian Indians. Since Malays, Chinese, and Indians in Malaysia have a genetic make up similar to that of Malays, Chinese and Indians in Singapore, environmental factors might have contributed to the higher myopia rates differences seen (22).

Similarly, in Tanzania, Wedner et al found that the urban area children were 5.6 times more myopic than their counterparts in the rural areas. This was regardless of their ethnic status only that children from the urban were of slightly older age (13, 16).

In Norway, Bertina Kinge et al did investigate the effect of near work on development and progression of myopia among adults exposed to high education demands. A significant relationship between refractive change towards myopia and time spent on

reading and on practical near work was found. This was a 3 year longitudinal refraction study, measuring refraction at the beginning and end of the 3 year period (31).

Researchers attribute the high rates of myopia in Asia due to their rigorous schooling system and the long hours children spend studying. Support for the myopigenic effects of near work comes from animal studies. Neonatal chicks and monkeys experience increased ocular growth and become myopic or less hyperopic after wearing minus lenses to compensate for the hyperopic defocus.

In Gujarat, Trivedi et al also noted that myopia risk in children was associated with having a father with a higher level of schooling. This seems to be the effects of similar environmental exposure. Researchers argue that parents with myopia would pass on their own academic standards or love of reading to their children than passing on a myopic refractive error itself (27).

In Nepal, Garner, et al found that children with similar genetic backgrounds who led a rural lifestyle had a prevalence of myopia of only 2.9% compared with 21.7% for children who led an urban lifestyle including more rigorous reading. Both the high education status of parents and the types of entertainment they are exposed to in the urban areas such as video games and TV including a lot of near work have been implicated as aetiological factors (32).

In Kenya, Nzuki et al and Muma et al findings in the urban and rural settings showed marked differences in the prevalence of refractive errors in urban settings of Langata

(10.2%) in Nairobi and the rural areas of Makeni (5.2%) respectively. In Makeni the prevalence of hyperopia was much higher as compared to the prevalence of myopia and an opposite scenario was found in the Nzuki study (14, 33).

In Malawi, Lewallen et al in a study conducted in the adult population in the rural agricultural workers versus the urban students didn't show significant differences in myopia between the two groups. There was however a positive association between literacy and a shift towards less positive values of refractive errors (34).

#### **2.6.0 Importance of Refractive Error correction**

In order to improve access, epidemiologic research on the types and distributions of refractive errors will enable more efficient planning to both improve access to care, and provision of corrective eyewear(1, 5).

Children with uncorrected refractive errors may complain of blurred vision, asthenopia, accommodative dysfunction, binocular dysfunction, nystagmus, amblyopia, and strabismus. Wedner et al reported a prevalence of nystagmus of 0.5% and 0.2% amblyopia (16).

Without eyeglasses, children with refractive errors struggle in school, straining to make out blurry images on the black board, straining to see classroom demonstrations, and falling behind on everyday tasks like homework. Even leisure activities such as playing ball or watching movies present difficulties that teachers, family, and friends do not

always understand(4). Frustrated by the inability to see clearly, a child may act out and be labelled as having a learning or behaviour problem (5, 22).

Poor vision may even lead a child to drop out of school as a result of chronically poor academic performance. For a child with visual impairment, corrective eyeglasses are as academically essential as books, papers, and pencils (13).

### 2.7.0 Study Definitions

The following definitions were considered for the study.

**Amblyopia:** Unilateral or bilateral decreased best corrected visual acuity caused by form visual deprivation and/or abnormal binocular interaction for which there is no pathology of the eye or visual pathway.

**Aphakia:** absence of the crystalline lens from the papillary area.

**Blindness:** vision of less than 3/60 in the best-corrected eye.

**Child:** child was considered as someone below the age of 15 years of age.

**Low vision:** Vision of worse than 6/18 and up to 3/60.

**Nystagmus:** Is a repetitive, involuntary to and fro oscillation of the eyes which may be physiological or pathological.

**Disabling Refractive Error:** Presenting visual acuity of  $\leq 6/12$  in better eye due solely to uncorrected refractive error. *Also referred to as significant refractive errors.*

**Significant astigmatism:** of more than +/- 0.5 dioptre

**Significant hyperopia:** of more than + 0.5 dioptre

**Significant myopia:** of more than - 0.5 dioptre

**Strabismus:** Any deviation of the eye

**Vision 2020:** Global initiative by NGOs and governments to reduce the burden of avoidable blindness (preventable and treatable) by the year 2020. One of the components targeted is to identify and treat the refractive errors in children.

## **2.8.0 Correction of Refractive Errors**

This can be done with spectacles, contact lenses or surgery

### **2.8.1 Spectacle correction**

#### **2.8.1.1 Hypermetropia**

Refraction is conducted under cycloplegia and spectacles are given for the error of 2.00DS or more.

#### **2.8.1.2 Myopia**

Low degree of myopia is considered to be up to -6.00DS and this should be given optical correction. High myopia should be given the lenses with the best visual acuity without any distress. One must not be overcorrected in order to allow them to be able to accommodate. Myopic patients with severe pathological changes and complications such as retinal detachment in the fundus can be helped with surgery and low visual aids.

#### **2.8.1.3 Astigmatism**

Cylindrical lenses are used to correct astigmatism. Smaller astigmatism without asthenopia and eyestrain may be left without correction

## **2.8.2 Contact lenses**

These can be hard or soft contact lenses. They can be used to correct all forms of refractive errors. The hard ones made of PMMA are mostly not water absorbing and can be used to correct astigmatism of several dioptres.

The soft ones made of HEMA are hydrophilic and can be used effectively for myopia and hyperopia. These are not good for astigmatism as they can easily take the shape of the cornea.

## **2.8.3 Intraocular lens**

### **2.8.4 Refractive surgery**

#### **2.8.4.1 Radial keratotomy**

This form of correction decreases myopia by flattening the cornea through a series of deep radial incisions.

#### **2.8.4.2 Laser in situ keratomileusis (Lasik)**

This can correct myopia up to -16.00DS

#### **2.8.4.3 Excimer laser photorefractive keratectomy**

Photorefractive keratectomy (PRK) with excimer laser involves the reshaping of the anterior cornea for correction of refractive errors. It is useful for myopia up to -6.00DS, hyperopia +2.50DS and astigmatism of 3.00DC.



### 3.0.0 Rationale

Childhood blindness from refractive errors presents an enormous problem in terms of morbidity, economic loss and social burden. Very little data exists on the prevalence of refractive errors in primary school children in sub Saharan Africa.

In Malawi, data is lacking on the prevalence of refractive errors in primary school children in both rural and urban settings. It is thus imperative to generate baseline data on the magnitude of refractive errors in school going children. The data generated herein might therefore help in assessing how much need there is for interventional measures in correcting refractive errors in children.

Availability of eye care personnel is still poor in Malawi, particularly with regard to optometrists and they are also poorly distributed. This has resulted in most of the population finding refractive services inaccessible or unaffordable. Optometrists practice exclusively in the private sector (with the exception of the three Lions Hospitals), whereas ophthalmologists focus mainly on the management of ocular disease and surgery and provide little with regard to refractive services. Ophthalmic nurses and clinical officers with training in basic refraction techniques are often deployed to eye care services other than refraction. The findings from this study might therefore be used for advocacy in terms of making the refractive services available, accessible and affordable.

Malawi, though not an industrialised country, has both the urban and the rural set up. As to what extent the urban lifestyle may impact on the development of myopia or a shift towards less positive refractive errors remains to be known in Malawi.

Thus a study looking at both settings is worthwhile.

#### **4.0.0 Objectives**

##### **4.1.0 Broad Objective**

To determine the prevalence and pattern of significant refractive errors in rural and urban areas in primary school children in Ntcheu and Lilongwe districts in Malawi.

##### **4.1.1 Specific Objectives**

- 1) To determine the prevalence of significant refractive errors in primary school children aged 12 – 15 years in rural and urban districts of Ntcheu and Lilongwe respectively.
- 2) To determine the pattern of significant refractive errors in primary school children.
- 3) To determine the proportion of uncorrected significant refractive errors in primary school children.

## 5.0.0 Methodology

The study was done in Central region of Malawi in two districts, one rural and one urban. In the Central region of Malawi, the widest poverty gap exists between the 2 districts of Lilongwe in the urban set up and Ntcheu in the rural set up.

Computer generated random numbers were used to sample the zones to be included in the study in the two districts. Two zones in the urban and three zones in the rural district of Ntcheu were randomly selected. This took into consideration the approximate numbers of children aged 12 – 15 years in primary schools in the two set ups.

In each zone, computer generated numbers were again used to sample the schools to participate in the study.

The minimum sample size required per district was based on the formula below for a cross sectional study

### Determination of the Sample Size

To calculate the required we took into account the sampling fraction  $n/N$ , and the design effect  $W$ .

Therefore the sample size was calculated as follows: -

- $n = T^2pqw/E^2 + T^2pqw/N$
- With  $N > 10,000$ ,  $n = T^2pqw/E^2$
- Where:

- n=minimum sample required for the study
  - p=Estimated Prevalence of refractive error in children.
  - T=1.96, reliability coefficient for the normal distribution to the significant level 0.05
  - e=0.05 degrees of precision at 95% level of confidence (maximum tolerable random sampling error, (at p = 10% e is 0.025 and at p = 5%, e = 0.015)
  - N=population size
  - w=Design effect
- n for Ntcheu =  $\frac{1.96^2 (0.05 \times 0.95 \times 1.5)}{0.015^2} = 1,216$  pupils

Minimum sample size for Ntcheu: 1,216

- For Lilongwe: n =  $\frac{1.96^2 \times 0.1 \times 0.9 \times 1.5}{0.025^2}$
- n= 830 pupils
- Minimum sample size for Lilongwe: 830

### 5.1.0 Study Design

Comparative cross sectional school based study

### 5.1.2 Study Site

The two districts in Malawi's central region were studied. The urban district of Lilongwe and the rural district of Ntcheu were chosen. The school enrolment in the rural areas was estimated by the District Education Manager to be about 60 per school for the 12– 15 year olds. Three zones were thus chosen in Ntcheu with three schools sampled per zone.

In the urban district of Lilongwe, the school enrolment is high. The minimum number as estimated by the district education manager was 100 students per school in the age group 12 – 15 years. Therefore for the three zones chosen in Lilongwe, two schools per zone

were sampled. The actual enrolment in Lilongwe was however observed to be much higher than the approximation given by the District Education manager. Thus the number of participants almost doubled from an estimated minimum of 830 to 1448 pupils.

### **5.1.3 Study Population**

From the selected schools in the two districts, all pupils aged between 12 and 15 years were included in the study as long as they consented to take part in the study and were present during the study period.

### **5.1.4 Case Definition**

Significant Refractive Errors for the purpose of this study was based on the recommendations made by the WHO refractive error working group in Geneva. School age children presenting with visual acuity less than or equal to 6/12 in the better eye are considered to be visually impaired according to their recommendations (33). Note that visual impairment in the WHO classification (ICD - 10: H54) is defined instead as best corrected visual acuity in the better eye worse than 6/18.

Disabling Refractive Errors (DRE) in children are defined as presenting visual acuity equal to or less than 6/12 in the better eye due solely to uncorrected refractive errors.

### **5.2.0 Procedure**

Permission was sought from the head teachers of the schools. The school register was used to get the right aged pupils, who were then recruited in the study. Demographic data of each pupil was obtained. History was taken in regard to ocular complaints. Family history of use of spectacles was also obtained. Visual acuity was assessed using a Snellen's chart. An ocular examination using a torch and magnifying 20 Dioptre loupe

was performed. Objective cycloplegic refraction (OR) was carried out on those pupils with visual acuity of 6/12 or worse in the better eye, followed by subjective refraction the next day.

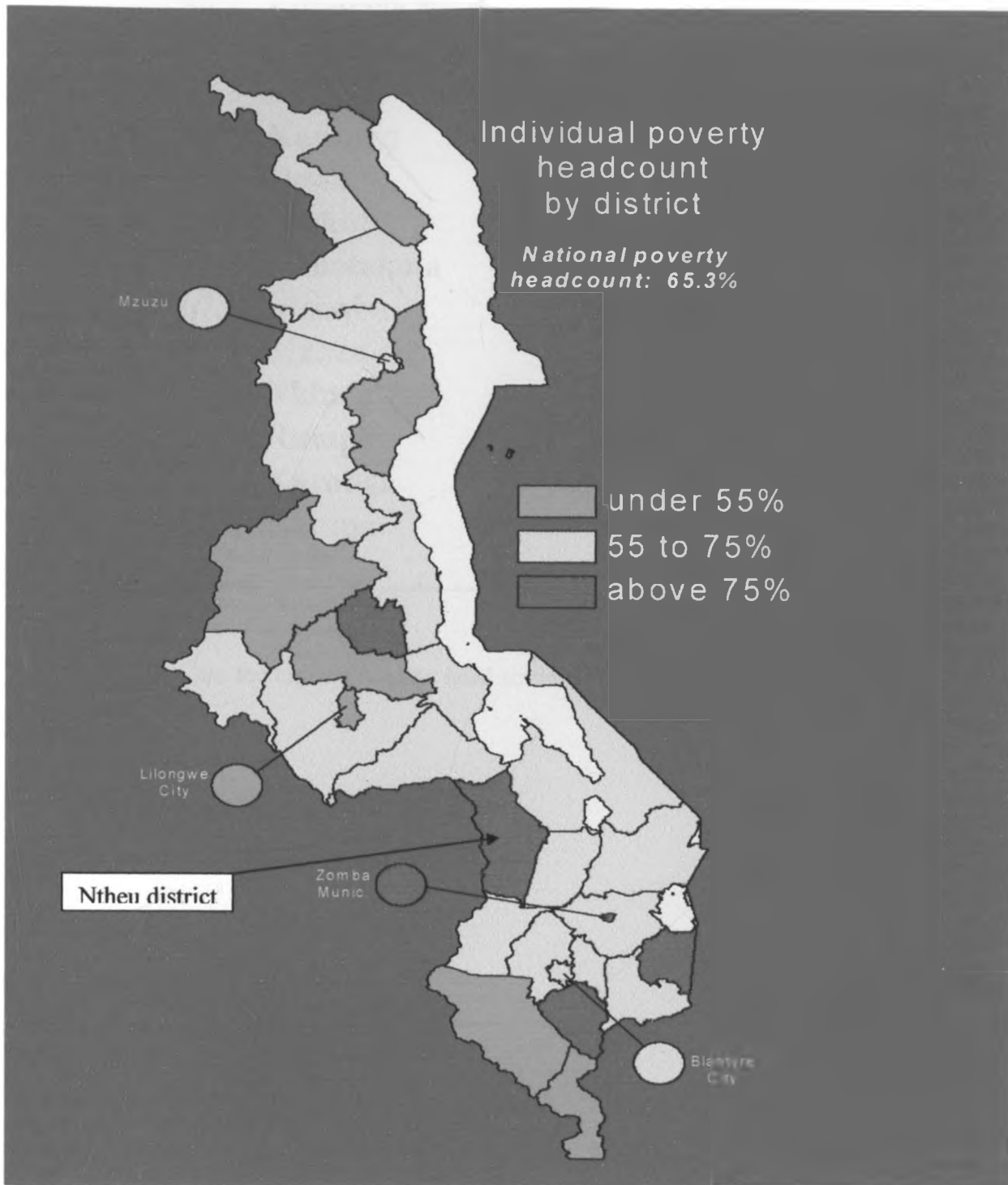
The type of refractive error after refraction was grouped into hypermetropia, myopia or astigmatism. Prescriptions were given to those pupils who needed spectacles.

All data was analyzed using the SPSS version 12.0 statistical software and Epi info version 3.4.1. Results were presented using ratio proportion, rates, tables and diagrams wherever appropriate. Statistical significance testing was carried out whenever appropriate and level of significance was taken at 5%.

#### **6.0.0 Ethical Considerations**

1. Confidentiality of pupils' records was highly observed.
2. Correction and follow up was recommended for pupils with refractive error.
3. Only medications approved by the Malawi Ministry of Health were used for objective refraction and the side effects were explained.
4. Permission from the Malawi Ministry of Education (MoE) and the Head teachers was obtained.
5. Pupils with other ocular findings or diseases were referred to Lions Sightfirst Eye Hospital, Lilongwe for appropriate management.

**Figure 1: Map of Malawi showing individual poverty head count by district.**



**Table 1: Poverty Levels Head Count by District in Malawi**

<b>Nsanje</b>	<b>51.3</b>	<b>Salima</b>	<b>60.8</b>
<b>Chikwawa</b>	<b>54.8</b>	<b>Lilongwe rural</b>	<b>65.6</b>
<b>Mwanza</b>	<b>71.4</b>	<b>Lilongwe city</b>	<b>37.9</b>
<b>Blantyre rural</b>	<b>65.3</b>	<b>Mchinji</b>	<b>68.0</b>
<b>Blantyre city</b>	<b>60.5</b>	<b>Kasungu</b>	<b>48.9</b>
<b>Zomba rural</b>	<b>71.9</b>	<b>Dowa</b>	<b>53.6</b>
<b>Zomba munic.</b>	<b>78.0</b>	<b>Ntchisi</b>	<b>76.3</b>
<b>Thyolo</b>	<b>76.8</b>	<b>Nkhotakota</b>	<b>65.3</b>
<b>Mulanje</b>	<b>67.2</b>	<b>Mzimba</b>	<b>67.5</b>
<b>Phalombe</b>	<b>83.9</b>	<b>Mzuzu city</b>	<b>70.9</b>
<b>Machinga</b>	<b>63.5</b>	<b>Nkhata Bay</b>	<b>47.7</b>
<b>Mangochi</b>	<b>69.8</b>	<b>Rumphi</b>	<b>65.8</b>
<b>Chiradzulu</b>	<b>74.0</b>	<b>Karonga</b>	<b>42.1</b>
<b>Ntcheu</b>	<b>84.0</b>	<b>Chitipa</b>	<b>71.3</b>
<b>Dedza</b>	<b>73.3</b>		

Note that Ntcheu has the highest poverty head count while Lilongwe has a lower poverty head count.



## **7.0.0 Materials**

1. Questionnaire
2. Pens, pencils and rubbers
3. Torch with batteries and spare bulbs
4. Snellen's chart
5. Retinoscopes
6. Cyclopentolate 1%
7. Ophthalmoscopes, direct and indirect
8. Lensometer
9. 20 diopetre loupe
10. Refraction set and trial frame
11. Vehicle for transport
12. Curtain for darkening the room
13. Support personnel ( 3 refractionists and 1 driver)

## 9.0.0: RESULTS

### Study population

**Table 2: Distribution of study participants by district and zones (n = 2726)**

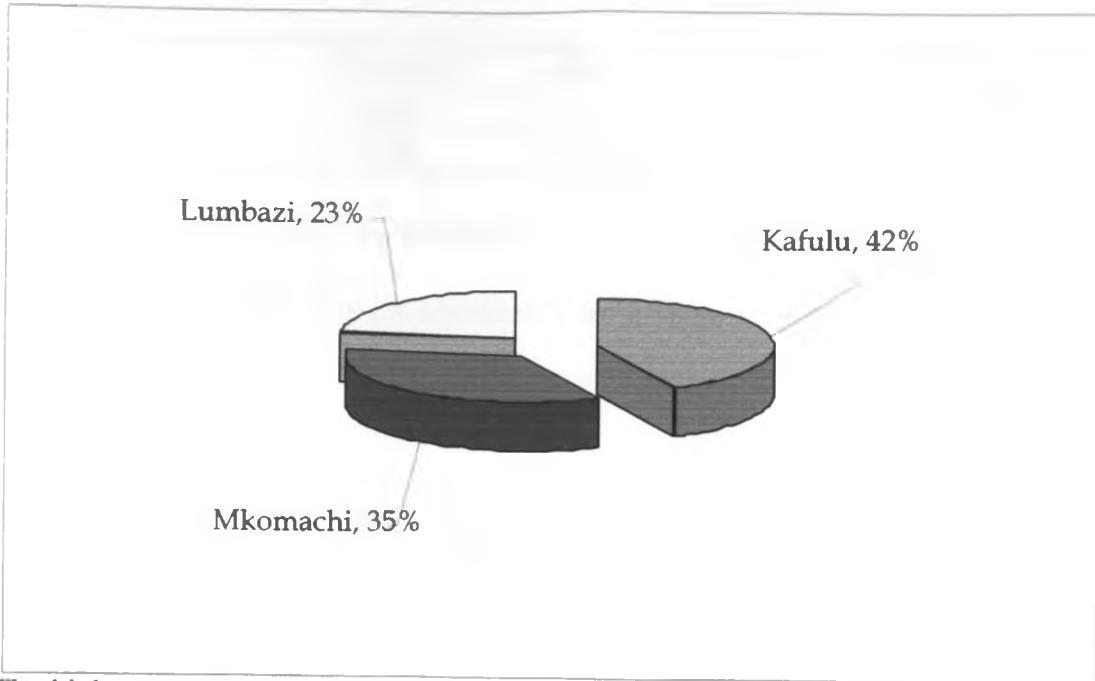
District	Zone	Frequency	Percentage
Lilongwe (Urban)	Kafulu	619	22.7
	Mkomachi	490	18.0
	Lumbazi	339	12.4
<b>Urban Sub-total</b>		<b>1,448</b>	<b>53.1</b>
Ntcheu (Rural)	Muluma	448	16.4
	Kasinje	448	16.4
	Bunyenga	382	14.0
<b>Rural Sub-total</b>		<b>1,278</b>	<b>46.9</b>

Most of the study participants were from the urban at 53.1% and the rural represented 46.9%.

Two schools were randomly selected from each zone in the urban district of Lilongwe and three schools were randomly selected from each zone in the rural district of Ntcheu.

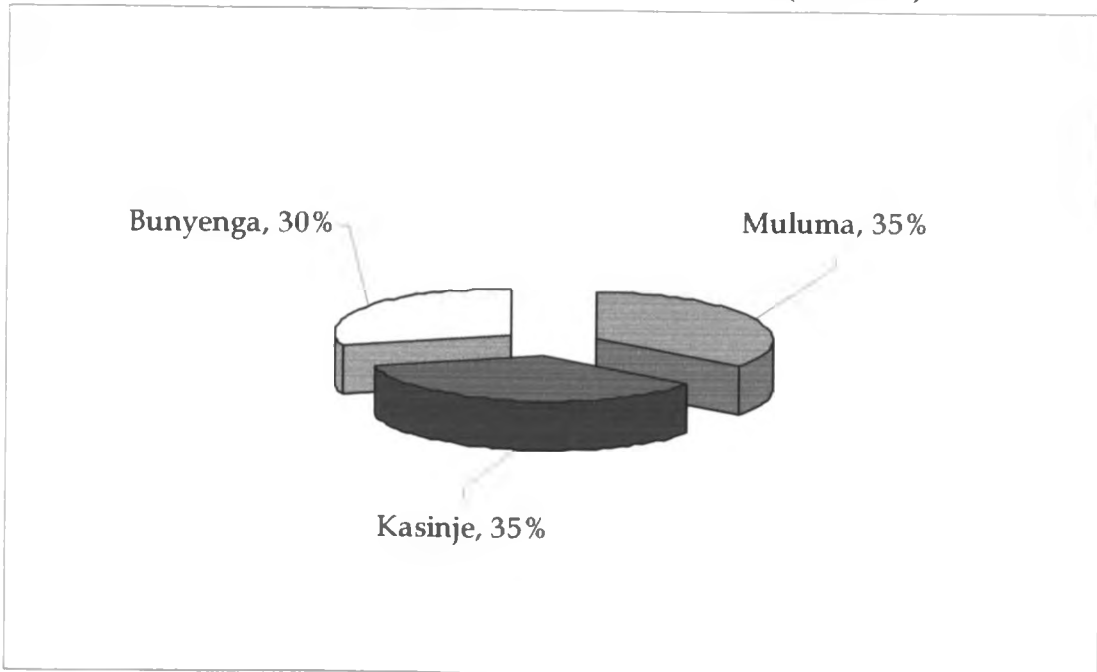
All the schools studied in both Lilongwe and Ntcheu were public schools with no boarding facilities. Thus the participants for each district were residents in that particular district.

**Figure 2: Distribution of Study participants by zones in Lilongwe (n = 1448)**



The highest number of participants was noted in Kafulu zone (619) in Lilongwe and the least was from Lumbazi (339)

**Figure 3: Distribution of participants by zones in Ntcheu (n = 1278)**



In Ntcheu, Muluma and Kasinje zones had the most participants with 448 pupils each. Bunyenga recorded the lowest.

**Table 3: Study participation rate in the two districts of Lilongwe and Ntcheu (n = 2,803)**

	Present	Absent	Percent Turn-up
Lilongwe	1,448	17	98.8
Ntcheu	1,278	60	87.2

Study participation rate was about 99% in Lilongwe and 87% in Ntcheu. In both places this was satisfactory i.e. above 80% for a cross sectional study.

**Table 4: Distribution by age in the two districts (N = 2,726)**

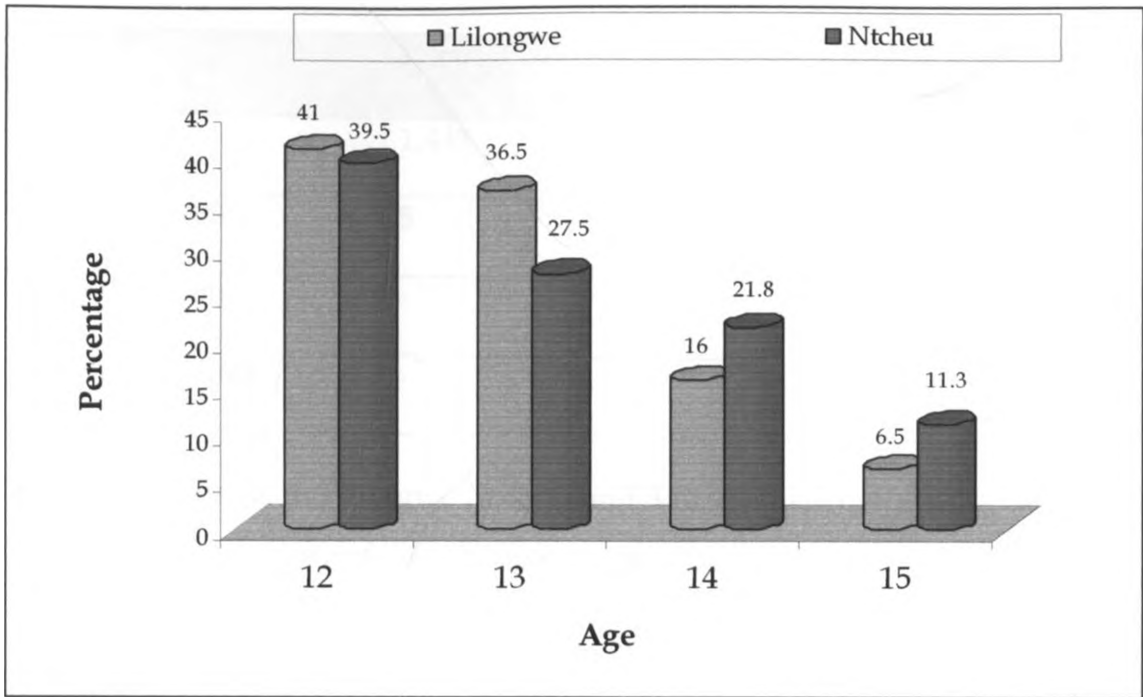
In Lilongwe alone , n = 1448

In Ntcheu alone, n = 1278

Age	District		Total, n (%)
	Lilongwe, n (%)	Ntcheu, n (%)	
12	593 (41.0)	505 (39.5)	1098 (40.3)
13	529 (36.5)	351 (27.5)	880 (32.3)
14	232 (16.0)	278 (21.8)	510 (18.7)
15	94 (6.5)	144 (11.3)	238 (8.7)

The mean age of the study subjects was 12.96 ( $\pm$  0.019) years, with a standard deviation of 0.968. The oldest pupil was 15 years of age and the minimum age being 12 years (range = 3).

**Figure 4: Distribution by age in the two districts of Lilongwe and Ntcheu (n = 2726)**



The majority of the pupils were in the age groups 12 and 13 yrs (41% and 36% respectively) in both districts.

**Table 5: Distribution by sex in the two districts (n = 2,726)**

District	Sex		p value
	Male	Female	
Lilongwe, n (%)	688 (47.5)	760 (52.5)	0.322
Ntcheu, n (%)	583 (45.6)	695 (54.6)	0.243

Majority of the study participants were females in both Lilongwe and Ntcheu which represented 53.4% of the total sample and males were 46.6%. However, there was no statistically significant difference.

## PRESENTING VISUAL ACUITY DURING THE STUDY PERIOD

**Table 6: Distribution of Visual Acuity in the best eye ( n = 2,726)**

VA	District	
	Lilongwe, n (%)-urban	Ntcheu, n (%)-Rural
6/6 - $\geq$ 6/18	1,443	1275
<6/18 - $\geq$ 6/60	5	3
< 6/60 - $\geq$ 3/60	-	-
Worse than 3/60	-	-

Only five participants in Lilongwe (0.35%) and 3 (0.24%) participants in Ntcheu were in the WHO category of visual impairment

**Table 7: Distribution of grouped presenting Visual Acuity in the better eye (n = 2,726)**

VA category	District		P-value
	Lilongwe, n (%)-urban	Ntcheu, n (%)-Rural	
> 6/12	1,412 (97.6)	1,246 (97.5)	-
$\leq$ 6/12	37 (2.5)	34 (2.7)	0.962
<b>Total</b>	<b>1,448 (100.0)</b>	<b>1,278 (100.0)</b>	

There is no statistically significant difference in the magnitude of visual impairment (WHO Refractive Errors working group definition) in the two districts.

**Table 8: Cause of significantly reduced visual acuity in the better eye in Lilongwe and Ntcheu (n = 71)**

Characteristic	Lilongwe (n = 37)	Ntcheu (n = 34)
Refractive error	33	31
Others	4	3

Other causes included bilateral cataracts, ocular albinism, and corneal scars

**Table 9: Distribution of Visual Acuity in the better eye by sex (n = 2726)**

VA grouped	Lilongwe		Ntcheu	
	Male, n (%)	Female, n (%)	Male, n (%)	Female, n (%)
> 6/12	674 (98.0)	737 (97.0)	564 (96.7)	681 (98.0)
≤ 6/12	14 (2.0)	23 (3.0)	19 (3.3)	15 (2.0)
Total	688 (100)	760 (100)	583 (100)	695 (100)

Lilongwe p-value = 0.304

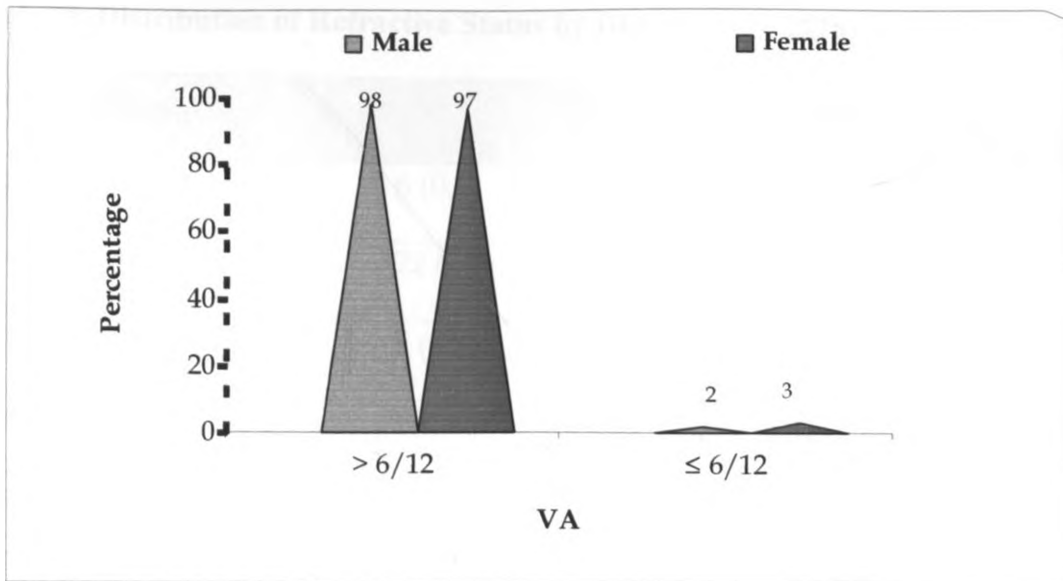
Ntcheu p-value = 0.295

In Lilongwe, the prevalence of visual impairment was more in girls (3%) than boys (2%). This was however not statistically significant with a p value of 0.304.

In Ntcheu, visual impairment was noted more in boys (3.3%) than girls (2%).

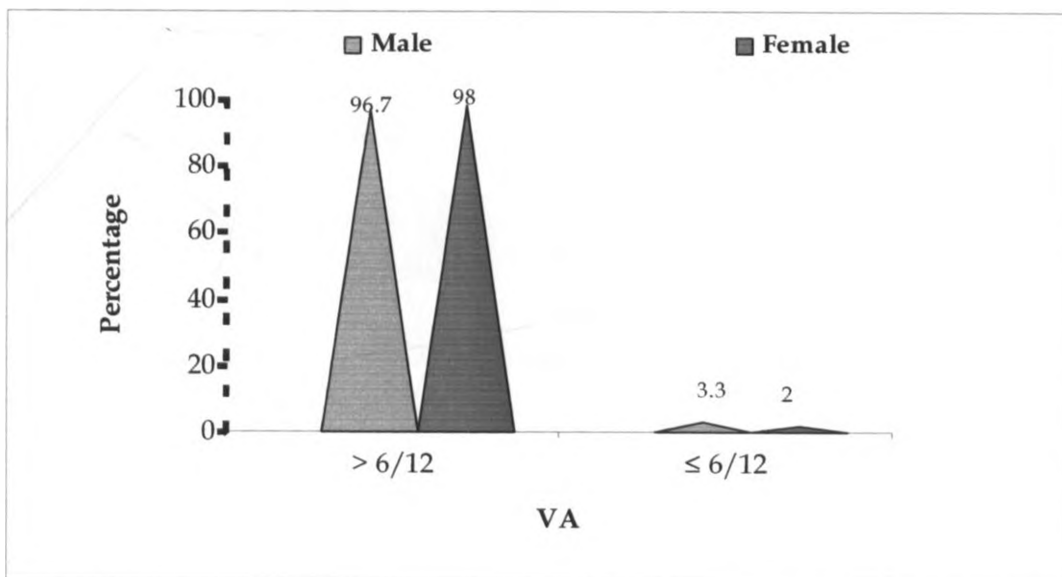
This too was not statistically significant

Figure 5: VA distribution by sex in Lilongwe district (n = 1,448)



In Lilongwe more females were noted to be visually impaired (3%) than boys (2%)

Figure 6: Visual acuity distribution by sex in Ntcheu district



In Ntcheu, more boys were visually impaired than girls.



## REFRACTIVE STATUS

**Table 10: Distribution of Refractive Status by Districts (n = 2726)**

Refractive Status	District	
	Lilongwe, n (%)-urban	Ntcheu, n (%)-Rural
Hypermetropia	6 (0.4)	19 (1.4)
Myopia	22 (1.7)	10 (0.8)
Astigmatism	5 (0.3)	2 (0.1)
Emmetropia	1415 (97.6)	1247 (97.7)
<b>Total</b>	<b>1,448 (100.0)</b>	<b>1,278 (100.0)</b>

Astigmatism included both hypermetropic and myopic astigmatism.

There is a difference in the pattern of refractive status in the two districts. In Lilongwe the most frequent status is myopia while in Ntcheu the most prevalent status is hypermetropia.

**Table 11: Magnitude of Significant Refractive Errors (n=64)**

No. with corrected VA (DRE)	District	
	Lilongwe, n (%)-urban	Ntcheu, n (%)-Rural
33	33/1,448 = 2.3%	
31		31/1,278 = 2.4%
64	64/2,726 = 2.3%	

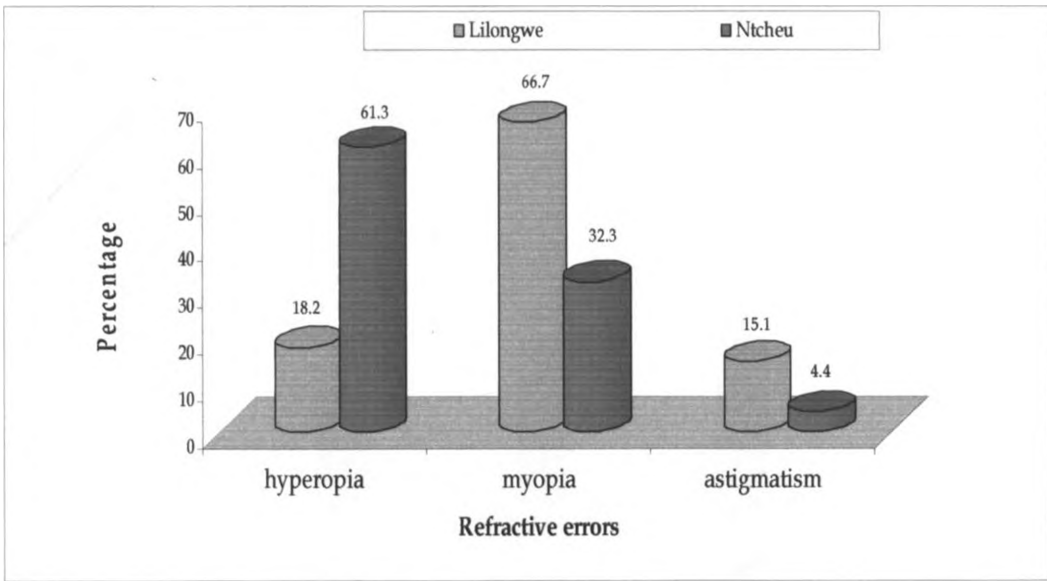
There is no difference in the prevalence of significant refractive errors, also referred to as disabling refractive errors (DRE) by WHO refractive error working group in the urban district of Lilongwe (2.3%) and the rural district of Ntcheu (2.4%) in Malawi.

**Table 12: Distribution of Refractive Errors by Districts (n = 64)**

Refractive Status	District		P-value
	Lilongwe, n (%) -urban	Ntcheu, n (%) -Rural	
Hypermetropia	6 (18.2)	19 (61.3)	<b>0.001</b>
Myopia	22 (66.7)	10 (32.3)	<b>0.012</b>
Astigmatism	5 (15.1)	2 (6.4)	0.428
<b>Total</b>	<b>33 (100.0)</b>	<b>31 (100.0)</b>	

There is a significant difference in the prevalence of myopia and hypermetropia when comparing the prevalence of each status in the two districts of Lilongwe and Ntcheu.

**Figure 7: Frequency of refractive errors by districts (n = 2,726)**



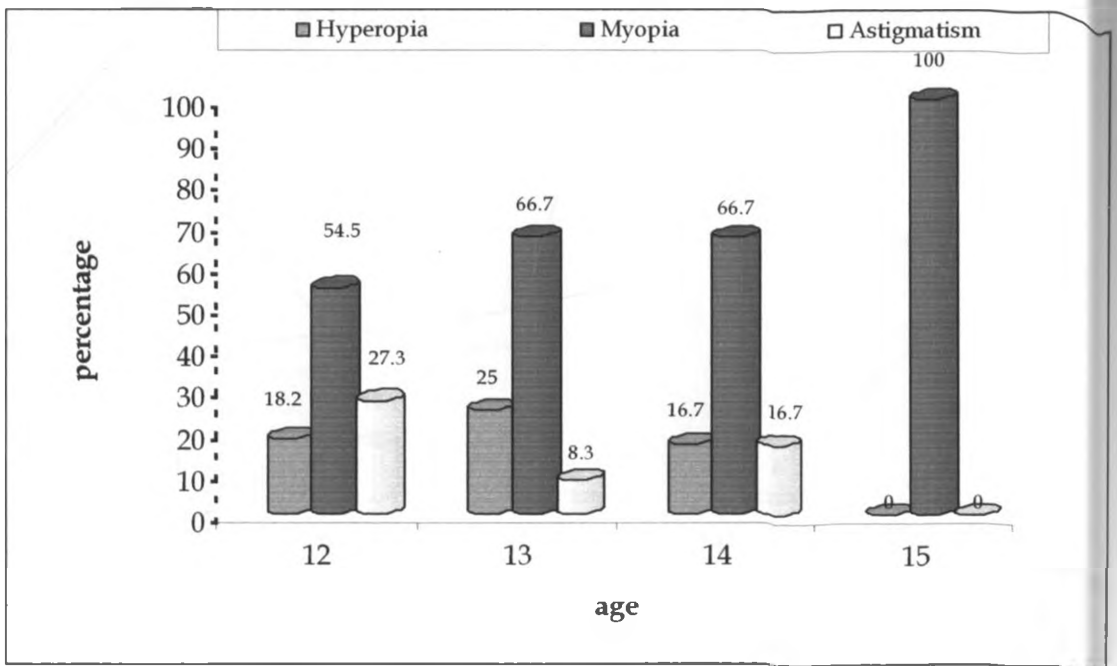
Of those with significant refractive errors in Ntcheu district, 61% were hyperopic and only 32% were myopic. Hyperopia was noted more in Ntcheu (61%) than in Lilongwe (16%). This was statistically significant with a p value = 0.001

**Table 13: Distribution of Significant Refractive Errors by age in Lilongwe (n = 33)**

Refractive status	Age in years				P-value
	12 yrs, n (%)	13yrs, n (%)	14yrs, n (%)	15yrs, n (%)	
Hypermetropia, n (%)	2 (18.2)	3 (25.0)	1 (16.7)	-	0.735
Myopia, n (%)	6 (54.5)	8 (66.7)	4 (66.6)	4 (100)	0.436
Astigmatism, n (%)	3 (27.3)	1 (8.3)	1 (16.7)	-	0.491
Total	11 (100)	12 (100)	6 (100)	4 (100)	

There is a decline in the prevalence of hypermetropia with increasing age from 12 to 15 years while myopia displays an increasing prevalence with increasing age. None of these patterns however is statistically significant.

**Figure 8: Distribution of status of refractive errors in Lilongwe (n = 33)**



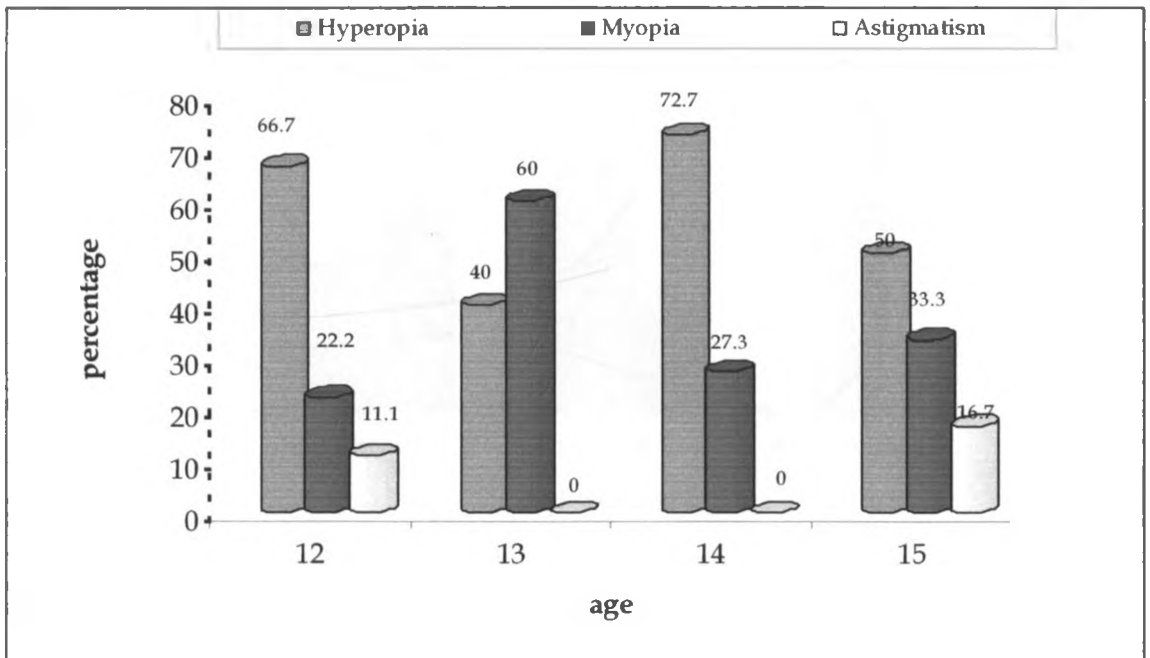
It was noted that in the ages 14 and 15 myopia predominates though not statistically significant. Note n = 33 in this case refers to the disabling refractive errors noted in Lilongwe district only.

**Table 14: Distribution of significant refractive errors by age in Ntcheu district (n = 31)**

Refractive Status	Age in Years				P-value
	12yrs, n (%)	13yrs, n (%)	14yrs, n (%)	15yrs, n (%)	
Hypermetropia	6 (66.7)	2 (40)	8 (72.7)	3 (50.0)	0.574
Myopia	2 (22.2)	3 (60.0)	3 (27.3)	2 (33.3)	0.512
Astigmatism	1 (11.1)	-	-	1 (16.7)	0.482
<b>Total</b>	<b>9 (100)</b>	<b>5 (100)</b>	<b>11 (100)</b>	<b>6 (100)</b>	

No clear pattern in the prevalence and pattern of significant refractive errors is noted in Ntcheu with increasing age.

**Figure 9: Distribution of the status of refractive errors by age in Ntcheu (n = 31)**



The frequency of hypermetropia is higher in all age groups in Ntcheu, though there is a general decrease as the children become older i.e. from age 12 to age 15 years.

**Table 15: Distribution of refractive error status by sex (n = 64)**

Sex	Lilongwe (n = 33)			Ntcheu (n = 31)		
	hyperopia	myopia	astigmatism	hyperopia	myopia	astigmatism
Male	2 (33)	9 (41)	1 (20)	8 (42)	7 (70)	2 (100)
Female	6 (67)	13 (59)	4 (80)	11 (58)	3 (30)	0 (0)
Total	8 (100)	22 (100)	5 (100)	19 (100)	10 (100)	2 (100)

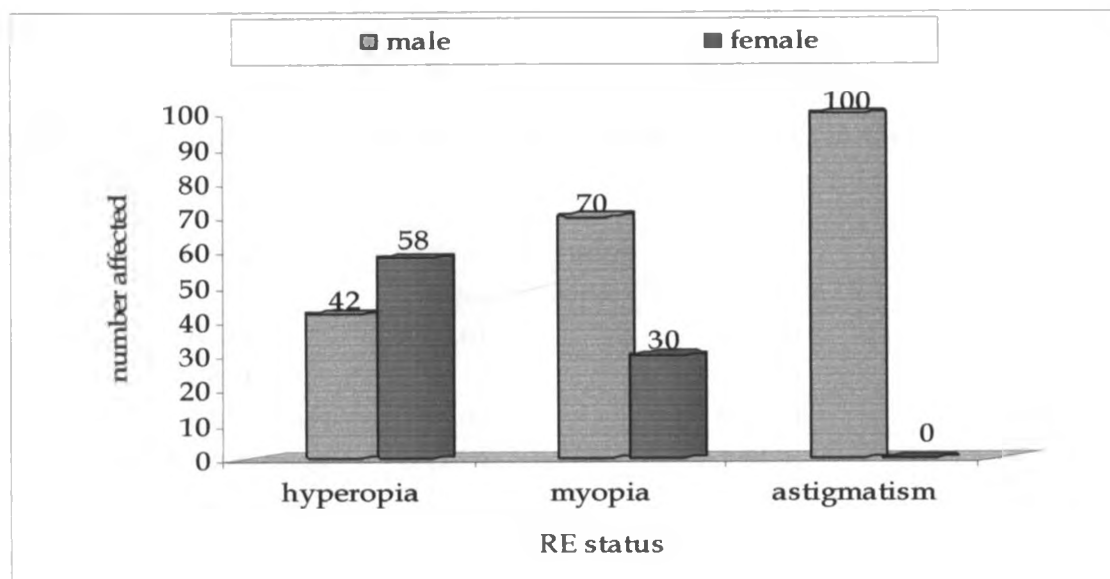
p-value = 0.552

p-value = 0.148

In Lilongwe all the refractive error types were noticed more in girls than boys with a p value of 0.552.

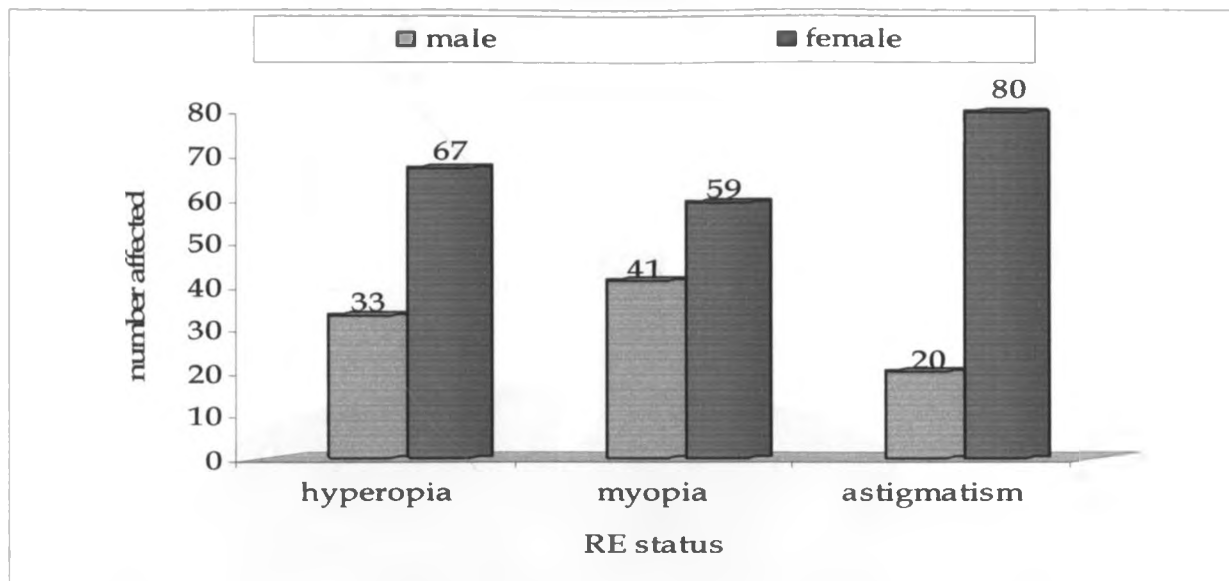
In Ntcheu however myopia was more in boys (70%) than girls (30) with a p value of 0.148

**Figure 10: Refractive status distribution by sex in Ntcheu (n = 31)**



Girls were more hyperopic in Ntcheu while boys were more myopic, but this was not statistically significant.

**Figure 11: Distribution of refractive status by sex in Lilongwe (n = 33)**



All refractive errors are notably higher in girls in Lilongwe, even though this is not statistically significant.

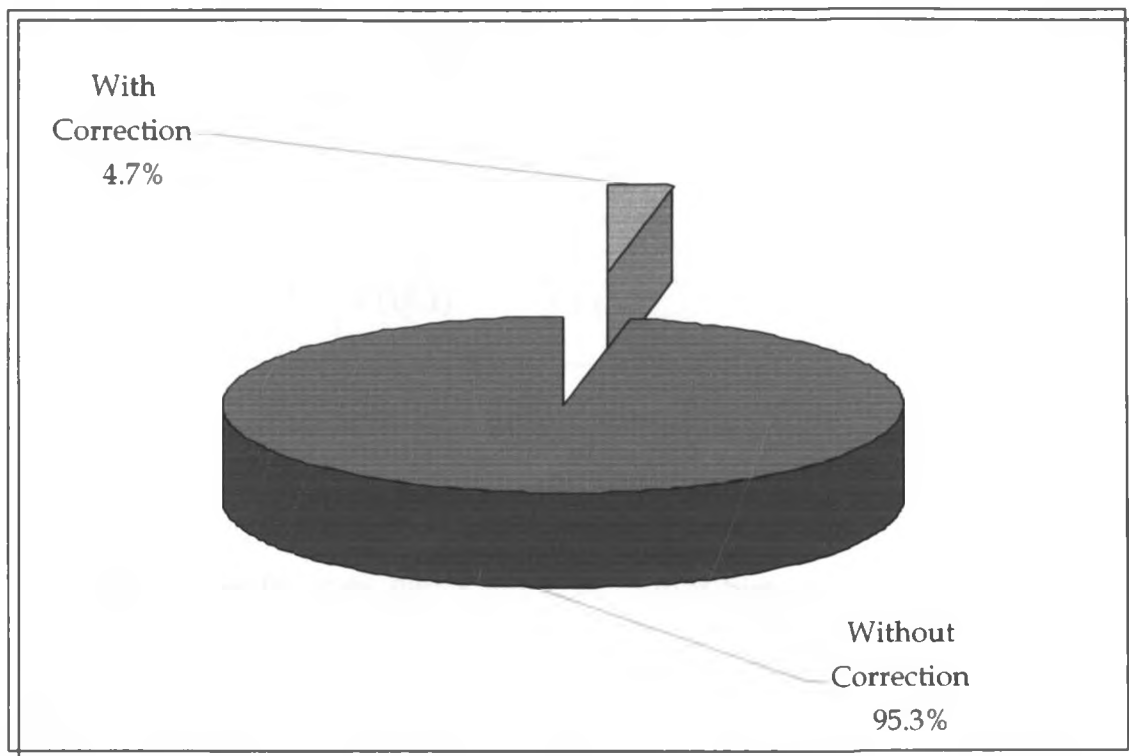
**Table 16: Significant refractive errors distribution by zones in the two districts (n = 64)**

District	Zone	Refractive status		
		Hypermetropia (%)	Myopia (%)	Astigmatism(%)
Lilongwe	Kafulu	4 (0.6)	9 (1.4)	1 (0.2)
	Lumbazi	-	5 (1.5)	1 (0.3)
	Mkomachi	2 (0.4)	8 (1.6)	3 (0.6)
Ntcheu	Bunyenga	8 (2.0)	3 (0.8)	2 (0.5)
	Muluma	3 (0.7)	3 (0.7)	-
	Kasinje	8 (1.8)	4 (0.9)	-

The prevalence of hypermetropia is higher in the rural zones (Ntcheu) than in the Lilongwe zones while myopia prevalence is higher in the Lilongwe zones.

## SPECTACLE CORRECTION

**Figure 12: Spectacle correction amongst participants with disabling refractive errors (n = 64)**



Out of 64 with disabling refractive errors, only 3 had correction and these were all from Lilongwe. All were fully corrected.

**Table 17: Refractive Status and family history of wearing spectacles in both districts****(n = 64)**

Districts	Family history in each category					
	Myope (%)	n	Hypermetrope (%)	n	Astigmatism n (%)	P values
Lilongwe	5 (15.1)		1 (3.0)		-	0.270
Ntcheu	1 (3.2)		-		-	-
<b>Total</b>	<b>6 (18.1)</b>		<b>1 (3.2)</b>			

There is an association between a myopic refractive error and a family history of wearing spectacles in both districts though not statistically significant. In Lilongwe 15% of myopes had a positive family history of wearing spectacles while only 3% of the hypermetropes had a positive family history of wearing spectacles.



## **10.0.0: DISCUSSION**

### **10.1.0: STUDY POPULATION**

A total of 1,465 primary school pupils were eligible to participate in the study in Lilongwe and a total of 1,338 were eligible in the rural district of Ntcheu. Only 17 pupils in Lilongwe and 60 pupils in Ntcheu were absent during the study period. Thus there was a satisfactory response rate of 99% in Lilongwe and 87% in Ntcheu (Table 3).

Pupils aged 12 – 15 years participated in the study in the two districts. Most participants were in the age groups 12 to 13 years. There is a drop in the number of participants in the groups 14 years and 15 years. This could be due to the fact that there were no standard 8 pupils during the survey. They had already sat for their exams and were on holiday. The mean age of the study participants was 12.96 years with a standard deviation of 0.968.

There was no statistically significant difference between the male and female participants in both Lilongwe and Ntcheu in this study. Note however that in Lilongwe females were 53% and in Ntcheu they were 55% (Table 5). This is in tandem with the 1998 Malawi population census where females comprised 55% of the population in Ntcheu and 51% in Lilongwe.

None of the schools selected in the two districts had boarding facilities. All the urban school children were residents of Lilongwe. The same applied to the rural schools. None of them was a boarding school.

## 10.2.0: REFRACTIVE STATUS

The prevalence of refractive errors in this study population was 2.3% in Lilongwe and 2.4% in Ntcheu (Table 12). In Lilongwe, the prevalence of myopia was 1.7%, hypermetropia 0.4%, and astigmatism 0.3% while in the rural district of Ntcheu, the prevalence of hypermetropia was 1.4%, myopia 0.8% and astigmatism only 0.1%

This is comparable to the prevalence reported in the Refractive Error in School Children (RESC) survey finding done by Naidoo et al in Durban, South Africa which was 2.9% (4). It is much lower than the prevalence reported by Nzuki et al of 10% and much higher than the prevalence reported in rural Mwanza primary school children in Tanzania of 1% by Wedner et al (13, 14).

The low prevalence of refractive errors in Malawi could be explained by the low industrialization of the country. This also explains for a generally low prevalence of refractive errors in sub-Saharan Africa.

The zonal distribution of significant refractive errors in both districts reflected the magnitude of the refractive error status more prevalent in either of the two districts. No significant difference was noted in the zones within the same district. Myopia was more prevalent in the Lilongwe zones and hypermetropia was noted more in Ntcheu zones.

In Southern Africa, wide ranging prevalence figures have been reported. The highest prevalence of refractive errors was reported in Uganda by Kauma et al of 11%, and in

Kenya by Nzuki et al with a prevalence of 10% (14, 15). The age group in the Nzuki study was relatively older (12 – 18 years) than in this study. The lowest prevalence so far in southern Africa was the one reported by Wedner et al in rural Mwanza region of Tanzania. The reported prevalence was 1% in school children aged 9 – 15 years (13).

### **10.3.0: MYOPIA**

The prevalence of myopia in Lilongwe was 1.7% and in Ntcheu it was only 0.8%. This difference was statistically significant when comparing the two districts using epi info statistical package with a p- value = 0.012. In Lilongwe, of the 33 participants with significant refractive errors, 22 (67%) were myopic. In Ntcheu, of the 31 participants with refractive errors only 10 (32%) had myopia. Similar findings were documented in Tanzania by Wedner et al (16). They found that urban children were 5.6 times more myopic than their counter parts in the rural areas (16).

The prevalence of myopia of 1.7% in Lilongwe compares well with that noted by Naidoo et al in Durban school children in South Africa. They found a myopia prevalence of 2%, though their age group ranged from 7 to 15 years (4).

The high rates of myopia in Lilongwe as compared to Ntcheu could be attributed to a lot of near work amongst the urban children. The high education status of parents and the types of entertainment they are exposed to in the urban areas such as video games and TV including a lot of near work could be implicated as aetiological factors in Lilongwe. In Ntcheu, electricity coverage is only limited to a few trading centres. This, coupled with

the increased poverty levels does limit the amount of near work. Children in the rural areas are also involved in activities such as farming and looking after cattle which do not require near strenuous vision.

Lewallen et al noted slightly higher myopia prevalence (2.5%) in an older age group of students at an urban teachers college in Blantyre, Malawi (34). A significant difference was also noted between rural agricultural workers and urban teachers in Malawi with more myopic shift in the urban group (34). The findings from this study do support the notion that myopia is uncommon in non industrialised societies such as Malawi.

Support for the myopigenic effects of near work comes from animal studies (28). Neonatal chicks and monkeys experience increased ocular growth and become myopic or less hyperopic after wearing minus lenses to compensate for the hyperopic defocus (28).

In Lilongwe, myopia does predominate in the later ages of 14 and 15 i.e. 67% and 100% respectively (Table 10 and figure 8). The increase in globe size and the cumulative environmental exposure effects occurring with increasing age explains this pattern. This is similar to the findings of Trivedi et al in Gujarat, India and Ip et al in Australia (27, 22). In both studies, high myopia prevalence was associated with a female gender. A similar scenario was also noted by Nzuki et al in Kenya (14). In Ntcheu no clear pattern was observed across the age groups 12 to 15 years. In both districts the variation of myopia with sex was not statistically significant.

The low prevalence of myopia noted in Ntcheu is similar to the prevalence found by Wedner et al in three primary schools in rural Mwanza region of Tanzania of 0.7% (13). The prevalence of myopia in Makueni, Kenya by Muma et al was 1.7% (33). This is slightly higher than the one found in our study.

#### **10.4.0: HYPERMETROPIA**

The prevalence of hypermetropia showed an opposite trend to that of myopia in the two districts. The prevalence of hypermetropia in Lilongwe was 0.4% and that of Ntcheu was 1.4%. The two places significantly differed with a p- value of 0.001 (Table 12).

Distribution of hypermetropia by age and sex in both Lilongwe and Ntcheu did not show any significant difference (Tables 13, 14, and 15). However in both Lilongwe and Ntcheu, hypermetropia was more in early age groups of 12 and 13. This has been documented also in several other studies (4, 13, 14, 33). A particularly higher hypermetropia prevalence was found by Muma et al in rural Kenya of 3.2% (33). Hypermetropia was noted more in boys than girls in this study.

A low prevalence of hypermetropia of 0.4% in Lilongwe noted in this study is similar to the urban prevalence reported in Langata in Kenya of 0.3% by Nzuki et al (14).

Less near work may account for the presence of hypermetropia in the rural setting. The strikingly high prevalence in comparison to the urban areas however may need to be explored in specifically designed case control studies to explain the association as has

been done with myopia. The environmental stimuli of extensive near work in the urban may play a role in converting a rural hypermetrope to a myope when they migrate and reside in the urban. Zhang et al in China noted that hyperopes converted more to a myopic status with a change of environmental stimuli (urban near work) over a period of 28 months as compared to emetropes (18).

The definition used in this study may actually have underestimated the prevalence hypermetropia in both districts. Hypermetropes tend to accommodate, hence could have been able to read the 6/12 line with effort even with a huge refractive error and consequently missed as normal subjects in the study.

Hypermetropia associated with esotropia was noted in one child in Ntcheu, and one child in Lilongwe district. However, they were fully corrected to 6/6 partial during the study.

In a study by Fotouhi et al in Iran, they did compare the patterns of refractive errors between the urban and rural areas of Dezful (2). Myopia was significantly more in the urban (3.7%) than the rural (2.9%). Hypermetropia however was noted to be very high in the rural as compared to the urban areas of Dezful (21.4% and 13.8% respectively) (2).

## **10.5.0: ASTIGMATISM**

Of the 1,448 participants examined in Lilongwe, only 5 (0.3%) were noted to have astigmatism, while in Ntcheu district only two (0.1%) out of 1,278 participants had astigmatism. No statistically significant differences were noted in the analysis of the effects of age and sex in the both districts.

Relatively similar prevalences have been noted in other studies. Nzuki et al reported a prevalence of 0.5% and Muma et al reported 0.3% (14, 33). Wedner et al reported a prevalence of 0.1% in secondary school children in Mwanza city (16).

## **10.6.0: SPECTACLE CORRECTION**

Of the 64 participants with disabling refractive errors, only 3 participants (4.7%) had spectacle correction. These were only in Lilongwe. It is also worth noting however that a myope with 6/12 is not severely handicapped, they can do close work for hours without any difficulty and sitting near the front would negate would negate any difficulties they had with distance vision.

In Ntcheu 3 had been prescribed spectacles and in Lilongwe, seven had been prescribed spectacles.

Those who did not have the correction which had been prescribed to them attributed it to the fact that they could not afford to buy. The majority, however, had not been seen at a health facility and therefore did not even know that they had significant refractive errors.

In Lilongwe, it was also noted that a positive family history of wearing spectacles was more common in myopes than hypermetropes. In Ntcheu a positive family history of wearing spectacles was almost nonexistent (Table 17).

So far, explanations for familial school myopia as evidenced in this study are more environmental than genetic. Parents with low degrees of myopia may pass the hard work attitude (rigorous studying behaviour) to their children. The chromosomal localization characterized so far for high familial myopia does not seem to be relevant to school myopia which was noted in this study.

No one was found to be using contact lenses. None had previous cataract surgery, but one was found during the study period to have significant cataracts in Ntcheu, with vision of 3/60 right eye and 6/60 left eye. She was referred to Lions Sightfirst eye hospital in Lilongwe for cataract surgery.



## **11.0.0: CONCLUSION**

Significant refractive errors occur among primary school children aged 12 to 15 years in Malawi. The prevalence of refractive errors is 2.3% in Lilongwe district and 2.4% in Ntcheu district. No statistically significant difference is noted between the rural and the urban districts in Malawi.

However, there is a significant difference in the patterns of significant refractive errors between the urban and the rural district. Significant myopia is noted in the urban setting while significant hypermetropia is noted in the rural setting.

A large number of primary school children do not have correction. This applies to both the rural and the urban setting in Malawi

The prevalence of significant refractive errors in Malawian primary school children as in other sub-Saharan African countries is too low to justify a regular school screening programme.

## **12.0.0: RECOMMENDATIONS**

Routine school screening for refractive errors is not justified in Malawi since the prevalence of significant refractive errors in both urban and rural primary schools is too low.

There is great need in Malawi to create awareness on the use of corrective lenses. There is also need to bring such services closer to the people and to make such services affordable in Malawi.

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15.0.0 APPENDICES

Appendix A: STUDY PROJECT EXAMINATION SHEET

Date: \_\_\_\_\_ Study # : \_\_\_\_\_

Name \_\_\_\_\_ Age \_\_\_\_\_ Sex \_\_\_\_\_

Residence: \_\_\_\_\_

Present ocular complaint: \_\_\_\_\_

Prescription of spectacles \_\_\_\_\_ (Yes or No) Duration of use if yes: \_\_\_\_\_

If no why \_\_\_\_\_

Power of spectacle: RE \_\_\_\_\_

LE \_\_\_\_\_

Family History of spectacle use: Father \_\_\_\_\_ Mother \_\_\_\_\_ Sibling \_\_\_\_\_

Parents \_\_\_\_\_ occupation/ \_\_\_\_\_ Education \_\_\_\_\_

Ocular surgery: \_\_\_\_\_

Visual Acuity: \_\_\_\_\_ RE \_\_\_\_\_ LE \_\_\_\_\_

Refraction: Objective RE \_\_\_\_\_ LE \_\_\_\_\_

Subjective RE \_\_\_\_\_ LE \_\_\_\_\_

BCVA RE \_\_\_\_\_ LE \_\_\_\_\_

Any other ocular findings: \_\_\_\_\_

Diagnosis: 1. Emmetropia \_\_\_\_\_ 2. Hyperopia \_\_\_\_\_ 3. Myopia \_\_\_\_\_ 4. Astigmatism \_\_\_\_\_

Spectacle prescription: RE \_\_\_\_\_ LE \_\_\_\_\_



**Appendix B: CONSENT FORM**

Name of Head teacher: .....

Name of Child: .....

Name of school: .....

Date: .....

Dr. Vincent T Msiska of the University of Nairobi (UON) has requested me to allow my pupil to participate in the study on eye assessment. This study is non-invasive and poses no risk to pupil.

Having understood how the study will be done and what it involves;

I ..... Agree that my pupil takes part in the study.

Head teacher:.....

Signature: .....

Date: .....

## Appendix C: OPHTHALMIC PRESCRIPTION

Date: .....

School screening study project in Ntcheu/Lilongwe by **Dr. Vincent T Msiska** of the University of Nairobi (UON).

Dear Parent,

Please note that your child ..... who had an eye examination today was found to have a refractive error and he is hereby prescribed the following spectacles:

Right Eye: .....

Left Eye: .....

Dr. Vincent T Msiska

UNIVERSITY OF NAIROBI  
MEDICAL LIBRARY

**Appendix D: PATIENT REFERRAL FORM**

Dear Parent,

Please note that your child ..... who had an eye  
examination was found to have .....

Please kindly bring him / her to the *Eye clinic at Lions Sightfirst Eye Hospital in  
Lilongwe* for review.

Dr. Vincent T Msiska