

**PREVALENCE AND PATTERN OF SIGNIFICANT REFRACTIVE
ERRORS IN HIGH SCHOOL STUDENTS IN MERU
MUNICIPALITY, MERU CENTRAL DISTRICT, KENYA**

NJERU, SAMUEL N. (HND OPHTHALMOLOGY)

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APRIL 2009

*Njeru, Samuel N.
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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or for any other award.

Njeru Samuel N.

Signature



Date

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We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

Dr. S. A. Otieno

Lecturer, Department Zoological Sciences

Kenyatta University

Signature



Date

20TH APRIL 2009

Dr. Jefitha Karimurio

Lecturer, Department of Ophthalmology

University of Nairobi

Signature



Date

20/04/2009

DEDICATION

This work is dedicated to my late dear mother Grace R. Njeru, for her struggle in ensuring that I went through my early education.

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ACRONYMS / ABBREVIATION

CS	Cataract Surgeon
D	Dioptries
DEO	District Education Officer
GOK	Government of Kenya
KU	Kenyatta University
LT	Left eye
MOE	Ministry of Education
MOH	Ministry Of Health
NGO	Non-Governmental Organization
OA	Ophthalmic Assistant
OCO	Ophthalmic Clinical Officer
PH	Pinhole
RE	Refractive Errors
RT	Right eye
SRE	Significant Refractive Error
VA	Visual Acuity
WHO	World Health Organization
ZES	Zonal Eye Surgeon

DEFINITION OF TERMS FOR REFRACTIVE ERROR

Amlyopia (Lazy eye): This is impaired macula or central vision which occurs in the absence of organic disease and is due to lack of continuous use of one or both foveae for visual fixation.

Anisometropia: Difference in refractive error of the eyes, e.g., one eye hypermetropic and the other myopic.

Astigmatism: A condition where abnormal curvature of the cornea causes two focal points to fall on two different points on the retina, that is serious enough to cause visual disturbance.

Cycloplegia: It is a drug that causes paralysis of the ciliary muscle so that the accommodation power of the eye is removed.

Dioptres: These are units of measurement for the power of the lenses. The power of the lens in dioptres is the reciprocal of its focal length (f) in meters: $d=1/f$.

Emmetropia: This is normal situation where the images from distant objects are focused at the centre of the retina.

Hypermetropia: This is far sightedness which is serious enough to cause visual disturbance. The image from distant objects forms behind the retina.

Myopia: This is short sightedness which is serious enough to cause visual disturbance. The image of a distant object forms in front of the retina.

ABSTRACT

Uncorrected refractive errors are an important cause of visual impairment in many. Visually disabling refractive error affects a significant proportion of both genders of the global population. Lack of practitioners is the main reason for high rates of visual problem due to uncorrected refractive errors. In developing countries, it is difficult to provide refractive services mainly due to lack of sufficient data on these errors. The proportion of school children who are visually impaired due to refractive errors can be used to assess the level at which the development of refractive services for schools can be established in a country or region. The main objective of this study was to investigate prevalence, pattern and some of the factors for continued presence of uncorrected significant refractive errors (SRE) among high school students in Meru Municipality, Meru Central District of Eastern Province, Kenya. This was a cross-sectional study that was conducted in two selected secondary schools. Stratified random sampling technique was used to select the study population. Data was collected through structured questionnaires and physical examination of the study subjects who met the eligibility criteria. Chi square test of independence was used to determine the relationship between variables such as prevalence, pattern, refractive status, health seeking behaviour and their association with the sex of the study subjects. The number of students who participated in the study was 164 with boys and girls having equal representation. The participants were between 13 to 18 years old, with a mean of 15.4 years. The study showed that the overall prevalence of SRE was 8.5% (n=164). Sex specific prevalence indicated no significant difference between the two sexes ($\chi^2 = 1.24$, d.f =1 $p > 0.05$). The pattern of SRE revealed that myopia was the leading cause of decreased visual acuity, contributing 6.7% of all the students who underwent the screening process. All boys with SRE were myopic, compared to 66.6% for girls. However, there was no significant difference between them ($\chi^2 = 2.05$, d.f =1 $p > 0.005$). Astigmatism was second with 1.1% prevalence and lastly, hypermetropia with 0.6%. The study has shown poor health seeking behaviour by students, with 78.6 % (n=14) having not sought correction of their visual problem. About 7.1% of students with SRE had spectacle correction with correct power of lenses while 14.2% (n=14) had spectacles with wrong lens power. The main reason for students with SRE not wearing glasses was inaccessibility to refractive services, with 52.6% of them having never been examined for their refractive state. SRE among students was also associated with family history of wearing spectacles. In conclusion, SRE among high school students in Meru Municipality require attention, with myopia being the main problem. Screening programmes for refractive services through primary health care can offer a reasonable solution to the problem and is therefore highly recommended. Multi-sectoral approach between stakeholders in the ministries of Health and Education can yield meaningful output in alleviating the situation.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Visual impairment from significant refractive errors affects a significant proportion of the world's population. They occur in both sexes and in all ages of different ethnic communities. Although they are easier to detect and correct, they have remained a common problem among populations and particularly in the developing world (Holden *et al.*, 2000). Lack of personnel particularly in the developing world contributes greatly to the magnitude of significant refractive errors, with a ratio of 1:600,000 optometrists in the rural areas (Holden *et al.*, 2000). Essentially, there are three types of refractive errors, namely myopia, hypermetropia and astigmatism.

Just like any other developing country, Kenya is faced with the problem of insufficient personnel with adequate knowledge to tackle the problem of significant refractive errors (SRE). Majority of significant refractive errors manifest themselves during teenage life (Holden *et al.*, 2000). Understanding the scope of these problems will be crucial in planning how to address them. Although the World Health Organization (WHO) definition for low vision is vision of $<6/18$ on the Snellen's chart, levels of visual testing in school screening programs vary from country to country (WHO, 2000a). This depends on the vision needed for particular activities, but generally visual acuity of $\leq 6/12$, caused by refractive errors, is considered significant enough to cause visual disturbances in school going children. School vision testing programmes not only help the children, but also help communities as awareness about good vision is increased among teachers and parents (Murthy, 2000).

Usually, correction of these refractive errors is done through issuance of prescriptions for spectacles since the only treatment for these conditions is wearing of glasses. However, many students do not access these spectacles probably because parents or guardians are not aware of the problem, or the cost is too high for them to afford. This means that a vast majority of the students have to learn to live with their visual problem. Teachers can detect visual problems among students, but in many instances do not know how to refer them because they lack training on primary eye care (Khan, 2005). Some individuals, whose refractive error differs greatly in the two eyes, may end up with amblyopia “lazy eye”, where the brain switches off the poorer eye to give chance to the better one to see. This is because great difference in refractive error in a person results in blurred image. Some of these students may not perform well in school, because they have visual disturbances that are serious enough to affect their learning processes, but they are not aware of their problem or cannot afford corrective services.

Many of school health care services have been conducted through primary health care programs, but these have been limited to primary school level, leaving out tertiary and universities unattended (McCusker, 2000). Even then, these services have been limited to vitamin ‘A’ supplementation, dental care, helminthic infections etc, but little has been done in the area of visual impairment from refractive errors in schools. Many of the students with visual problems may therefore remain in schools undiagnosed (McCusker, 2000). Appropriate measures should therefore be put in place to create awareness of these problems so that reasonable solutions can be found. Among the best options would be intersectoral approach where all those concerned such as teachers and primary eye care

workers would put their effort together and sort out these visual problems in high schools. Currently, the refraction services in Kenya are provided by Zonal Eye Surgeons (ZES), Ophthalmic Clinical Officers (OCO), and Cataract Surgeons (CS) and to some extent Ophthalmic Assistants (OA). Others include private opticians and refractionists in the private sector.

Accurate data on the prevalence and incidence of correctable visual impairment are difficult if not impossible to find, although there are some reliable population-based studies on prevalence from some countries. Preliminary surveys and anecdotal observations indicate relatively low prevalence of myopia in the African population in comparison to Asian population (Murthy, 2000). The prevalence and type of refractive error varies enormously from country to country. High prevalence of myopia is found in South East Asia and low prevalence of any type of refractive error in Nepal (Murthy, 2000). However, there is very little data from African countries on refractive errors (Holden and Resnikoff, 2002).

Global estimates indicate that although the magnitude of refractive errors is not reliably known, large variations in prevalence exist (WHO, 2000a). The burden of refractive error is set to increase alarmingly due to an increase in myopia in both the developed and developing world. The impact and importance of uncorrected refractive errors has now been recognized by WHO in its *vision 2020* programme. WHO has established refractive error working group as a part of *vision 2020* activities in recognition of this important facet of international eye care. In Kenya, the Ministry of Health (MOH) has come up

with a national strategic plan for eye care, for the years 2005-2010 that recognises refractive services in all districts by the year 2010 (MOH, 2005). While refractive error is amongst the most common causes of visual impairment, it is easily diagnosed, measured and corrected by provision of appropriate spectacles (Murthy, 2000).

This study was conducted to establish the prevalence and pattern of significant refractive errors among high school students in Meru Municipality.

1.2 Statement of problem and justification

Uncorrected SRE is a common problem in the developing world yet there is little or no reliable data on these errors (Holden *et al.*, 2000). Lack of adequate personnel contributes to the magnitude of refractive errors particularly in the developing world. Although natural refractive error is not a significant cause of blindness in most population based surveys, it remains a significant cause of low vision (Lewallen *et al.*, 1995). Refractive errors are responsible for 13% of all significant visual loss in Kenya, most of which require spectacle correction (Schwab and Steinkuller, 1995). If uncorrected, refractive errors have negative impact on education and quality of school life (WHO, 2000a). The number of students seeking refractive services at Meru District Hospital which is within Meru Municipality has been observed to increase by the staff working at the eye unit. Yet the proportion of those with SRE in high schools in the area is not known and no survey has been conducted to determine their magnitude. Moreover, there is no established screening programme that offers refractive services in high schools in the area. There is therefore, a great need for epidemiological information on significant refractive errors in

high school students in the area, the results of which can be used to strategise for remedial measures.

1.3 Study Questions

- i) What is the proportion of students with significant refractive errors among the high school students in Meru Municipality, Meru Central District?
- ii) What is the pattern of significant refractive errors among the students?
- iii) What are the factors that affect health seeking behaviour of students with SRE?

1.4 Null Hypothesis

Significant refractive errors do not affect high school students in Meru Municipality.

1.5 Overall objective

To estimate the prevalence and pattern of significant refractive errors among high school students in Meru Municipality.

1.6 Specific objectives

- (i) To determine the magnitude of corrected and uncorrected significant refractive error among the high school students of Meru Municipality.
- (ii) To establish the frequency of occurrence by type of significant refractive errors among the high school students in Meru Municipality.
- (iii) To establish the factors affecting health seeking behaviour of the students.

1.7 Significance of the study

The prevalence of refractive errors differs greatly from region to region, with higher proportions being found in developing countries. Even within a country, variation exists between communities and socio-demographic strata. In setting community priorities, baseline studies would be an important component for providing epidemiological information to policy makers for planning, implementation and evaluation of refractive services. The same information is useful in planning for refractive services intervention strategy, development of a screening programme and provision of low cost spectacles. In the same way, the information obtained can be used for evaluating impact on refractive error programme in schools.

1.8 Limitations of the study.

The study was limited to two schools within the target population. Form one and Form three classes were screened for SRE. The Form four classes were doing district examinations at the time and therefore any distraction was avoided. Form one class was selected to represent lower secondary and Form three to represent the upper secondary.

1.9 Delimitations of the study

The study was confined to a sample of students in the selected high schools in Meru Municipality with an assumed male/female ratio of 1:1, who were direct beneficiaries of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

It is estimated that 2.3 billion people worldwide have refractive error. The vast majority of these people could have their sight restored by spectacles but only 1.8 billion have access to eye examinations and affordable correction (WHO, 2000b). This leaves approximately 500 million people mostly in developing countries, of which 1/3 are in Africa, and majority of whom are children with uncorrected refractive errors, causing blindness and impaired vision (WHO, 2000b). Lack of refraction services and spectacle provision in underserved communities has negative consequences in terms of lost educational and employment opportunities, impaired quality of life and productivity for the individual, the family and society (WHO, 2000b). Many people are not aware that there is a cure for their compromised vision, and have no one to provide treatment, or cannot afford the appliances they need (Holden *et al.*, 2000). It is particularly important for us to recognise how people actually function day to day and what level of vision they need for these activities. The presenting visual acuity should be taken into consideration when assessing the magnitude of visual disability in the community (Taylor, 2000).

2.2 Development of refractive errors

The natural history of refractive errors indicates that they are inherited. The mode of inheritance is complex, as it involves many variables such as race, sex, age and geographical location (Vaughan and Asbury, 1983). Ocular growth is essential to the understanding of the development of refractive errors (RE). The eye is approximately 17

millimetres long at birth. From birth to age six years, the eye grows by around five millimetres, loses four dioptres (D) of corneal power and 20 dioptres of lens power. The cornea and lens are the two organs that give the eye the highest refractive power. Myopia is only 2% by the age of six years. During the following eight years, when the average eye grows only an additional one millimetre, the prevalence of myopia increases more than sevenfold, to 15% by the age of 15 years (Ellwein, 2000).

2.3 Genetics and refractive status

Although most researchers agree that people's refractive status is genetically determined, a growing body of evidence shows that visual experiences early in life may affect ocular growth and eventual refractive status (Douglas, 2002). A study of the correlation between refractive error in parents and siblings showed stronger correlations than would be expected by chance (Hammond *et al.*, 2001). More than one gene is reported to be involved in transmission of myopia. Family history was one of the most important factors. Only 6%-15% of myopia came from parents without myopia. In families with one parent having myopia, 23%-40% of children had myopia and where both parents had myopia, the figure rose to 33%-60%. A study on refractive errors in children and parents reported that children with myopic parents, though not yet myopic themselves, tended to have longer eyes than children with non-myopic parents, resulting in a predisposition to becoming myopic later in life (Zadnik *et al.*, (1994). Additional evidence supporting the role of genetics in the development of myopia includes the wide variability of the prevalence of myopia in different ethnic groups. The prevalence of myopia in Asia is as high as 70-90%, in Europe and America, 20-40% and Africa 10-20% (Saw *et al.*, 1996).

2.4 Normal vision

In order to better understand how refractive errors affect our vision, it is important to understand how normal vision occurs in people (Pavan-Langston, 1991). For persons with normal vision, the following sequence takes place in the human eye: Light enters the eye through the cornea, the clear, dome-shaped surface that covers the front of the eye. From the cornea, the light passes through the pupil. The iris or the coloured part of the eye regulates the amount of light passing through. From there, the light then hits the lens, the transparent structure inside the eye that focuses light rays onto the retina. Next, it passes through the vitreous humour, the clear, jelly-like substance that fills the centre of the eye and helps to keep it round in shape. Finally, it reaches the retina which is the light-sensitive nerve layer that lines the back of the eye, where the image appears inverted. The optic nerve, which is the nerve for vision, is responsible for interpreting the impulses it receives into images. The focal point of distant rays of an emmetropic eye is shown below (Figure 1).

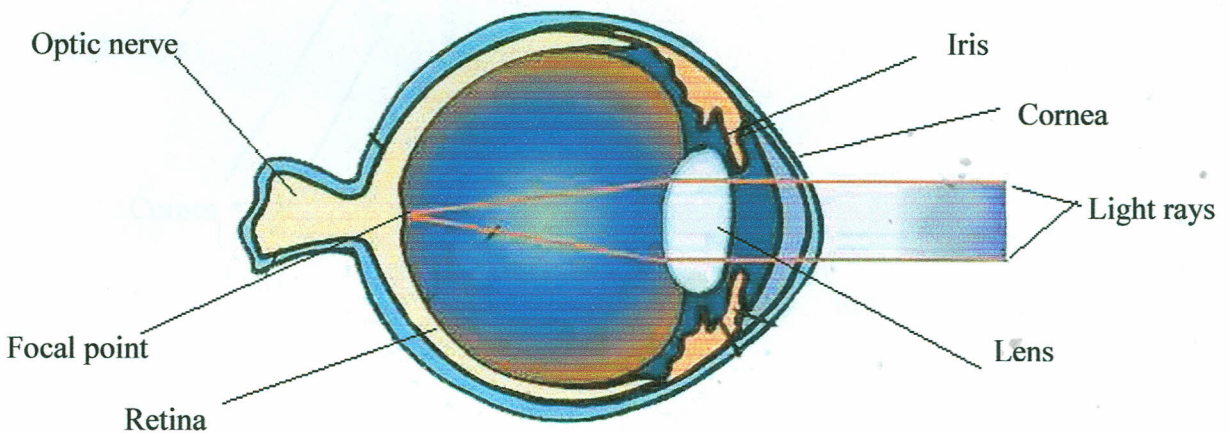


Figure 1: Focal point of parallel rays on the retina of emmetropic eye

2.5 Refractive errors

The most common refractive errors are myopia, astigmatism and hypermetropia.

2.5.1 Myopia

Commonly known as nearsightedness, myopia is a condition in which the image of a distant object becomes focused in front of the retina either because the eyeball axis is too long, or because the refractive power of the eye is too strong (Figure 2). This condition makes distant objects appear out of focus and may cause headaches or eye strain (Garcia and Pavan–Langston, 1991).

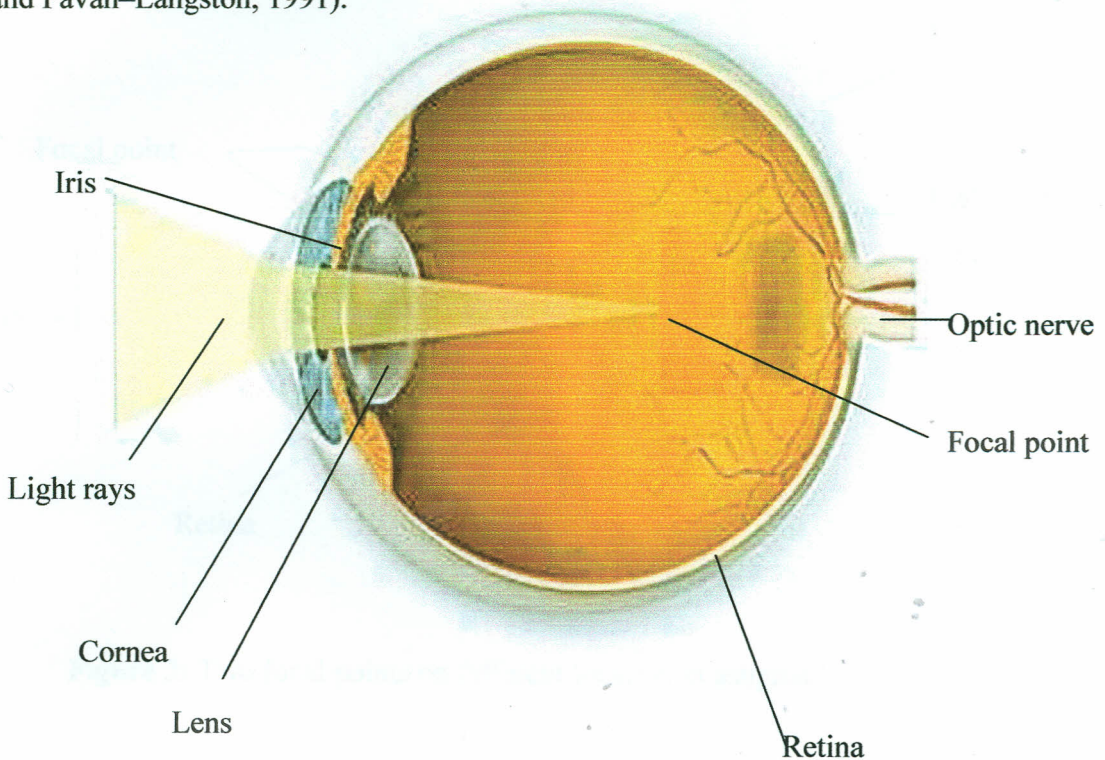


Figure 2: The focal point in front of the retina in myopia

2.5.2 Astigmatism

This is a situation in which an abnormal curvature of the cornea causes two focal points to fall in two different locations either in front or behind the retina or both. This makes objects, both close and distant appear blurry (Figure 3). Astigmatism may be combined with nearsightedness or farsightedness and this is called mixed astigmatism (Garcia and Pavan-Langston, 1991). Eyeglasses, contact lenses, or corrective surgery may help to correct or improve the condition.

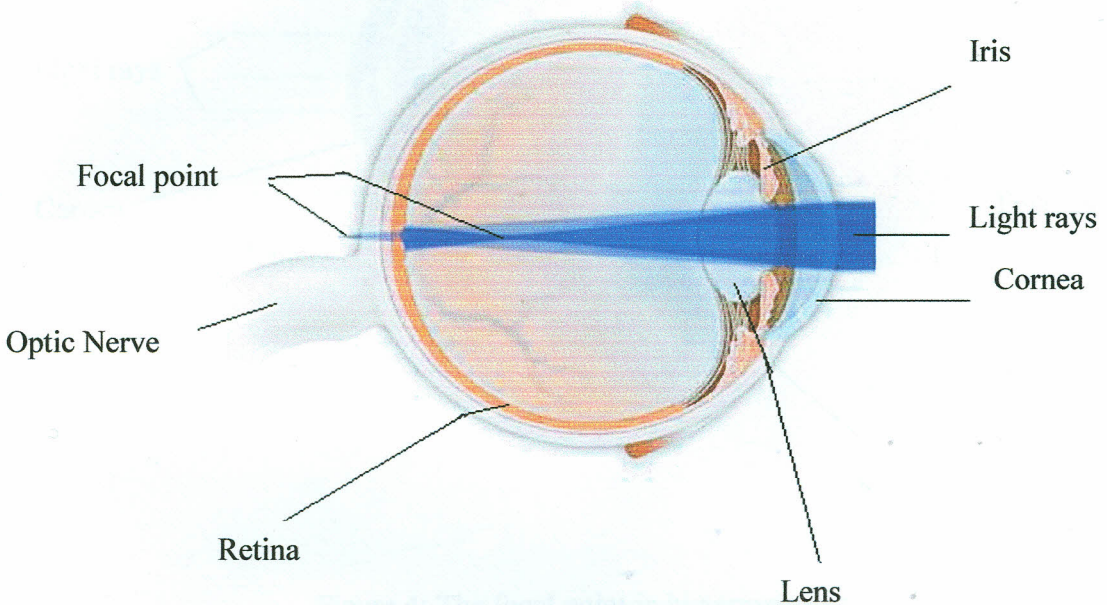


Figure 3: Two focal points on different location in astigmatism

2.5.3 Hypermetropia

Commonly known as farsightedness, hypermetropia is the most common refractive error in which an image of a distant object becomes focused behind the retina, either because the eyeball axis is too short, or because the refractive power of the eye is too weak

(Figure 4). This condition makes close objects appear blurring and far objects normal (Garcia and Pavan-Langston, 1991).

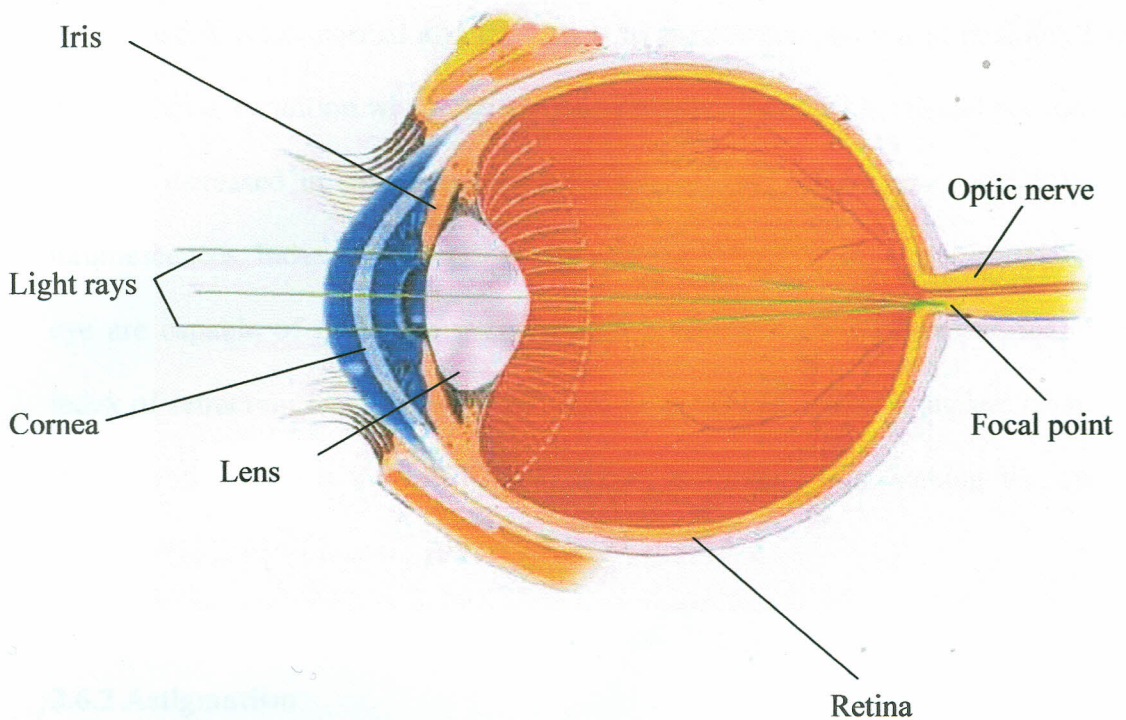


Figure 4: The focal point in hypermetropia

2.6 Aetiology of refractive errors

The various forms of refractive errors have different causes but most are due to anatomical changes in the eye structures.

2.6.1 Myopia

Myopia is rare at birth but begins to develop as the child grows. It is usually detected at around the age of 9-10 years and increases with age, culminating at mid-teenage life (Garcia and Pavan-Langston, 1991). There are several forms of myopia (Vaughan and Asbury, 1983). Axial myopia is the type in which the anterior-posterior diameter of the eye is longer than normal that is, twenty four millimetres. However, the curvature of the cornea and lens are normal and the lens is in the correct anatomical position. Curvature myopia is the condition where the anterior-posterior diameter is normal but the curvature may be increased in some situations, for example, hyperglycaemia which causes lens intumescences. Index of refraction myopia is one in which the various components of the eye are capable of refracting rays from an object to their expected normal. Here, the index of refraction of the lens is increased especially in sclerotic nuclear cataract where the sclerotic changes increases the index of refraction, thus making the eye myopic (Garcia and Pavan-Lanston, 1991).

2.6.2 Astigmatism

Astigmatism is caused by irregularity on the surface of the cornea where some meridians on the cornea surface become steeper than others. Corneal toricity astigmatism accounts for most of astigmatism in the eye. The vertical meridian and the horizontal meridian have different steepness. If the vertical meridian is steeper than the horizontal meridian this is called astigmatism "with the rule". If the horizontal meridian is steeper than the vertical meridian it is known as astigmatism "against the rule". The same difference in steepness of the meridian could happen obliquely (Vaughan and Asbury, 1983).

2.6.3 Hypermetropia

Several types of hypermetropia can be distinguished. Structural hypermetropia is based on the anatomical configuration of the eye such as the flattening of the cornea and the crystalline lens. In these two conditions, rays of light from distant objects are focused behind the retina. In axial hypermetropia, there is shortening of anterior-posterior diameter (from the front of the cornea to the retina) of the eye than the normal. The refracting portions like the lens and cornea are otherwise normal. Curvature hypermetropia results when either the crystalline lens or the cornea has a weaker than the normal curvature resulting to lower refractive power (Garcia and Pavan-Langston, 1991). Index of refraction hypermetropia is the result of decreased index of refraction due to decreased density in some parts of the optic system of the eye, thus lowering the refractive power of the eye (Garcia and Pavan-Langston, 1991).

Accommodation hypermetropia arises when the capacity of the natural lens in the eye elongates or shortens depending on the distance where the object a person wants to see is. This elasticity of the lens is of great importance than structural factors leading to it because accommodation is the key dynamic factor in correcting at least part of refractive error (Vaughan and Asbury, 1983). Accommodation hypermetropia is grouped into three parts namely: Latent hypermetropia, Manifest facultative hypermetropia and Manifest absolute hypermetropia.

In latent hypermetropia, a portion of refractive error is completely corrected by accommodation. It is measurable not by manifest refraction but with paralysis of

accommodation through cycloplegia refraction. Latent hypermetropia is the difference in measurement between manifest hypermetropia and the results of cycloplegia refraction, which reveals total hypermetropia of latent and manifest (Vaughan and Asbury, 1983). Manifest facultative hypermetropia is that portion of hypermetropia that may be corrected by patient's own power of accommodation or by correction with lenses or both. Vision is normal with or without corrective plus lenses, but the accommodation is not relaxed without the glasses. In manifest absolute hypermetropia, there is a portion of hypermetropia which cannot be compensated for by the patient's accommodation. Distance vision is blurring despite the patients' accommodation power. These patients readily accept the aid of plus lenses because it makes distant objects clear (Vaughan and Asbury, 1983).

2.7 Symptoms of refractive errors

The symptoms of refractive errors will depend on type and severity. In myopia, blurring of distant objects is the commonest symptom. School going children will complain of not seeing the black board and will sit near it. Squinting of the eyes to sharpen the images is a frequent symptom of myopia especially for distant objects. Headaches, though not common, may be present in low grade myopia (Naidoo and Govender, 2002). The most frequent symptom of hypermetropia is frontal headache that worsens as the day progresses and is aggravated by reading. Blur vision for distant objects is not common in mild and moderate hypermetropia but is usually found in those with hypermetropia of +3.00 dioptres or more. Light sensitivity from unknown cause is common and is usually relieved by wearing spectacles (Naidoo and Govender, 2002). The symptoms of

astigmatism will normally present as those of myopia or hypermetropia, depending on whether one has myopic or hypermetropia astigmatism or a mixture of the two (Naidoo and Govender, 2002).

2.8 Correction of refractive errors

The correction of myopia is done by minus lenses which diverges the rays of light before it enters into the eye so that the image that would otherwise form in front of the retina is pushed to form on the retina. Eyeglasses or contact lenses may help to correct or improve myopia by adjusting the focusing power to the retina. Corrective surgery may also help by changing the shape of the cornea to a more spherical, round shape instead of an oblong shape (Murthy, 2000).

The correction of hypermetropia is by plus lens that converges light in a way that images that would form behind the retina are focused on it, making the objects clear. Astigmatism correction is done by cylindrical lenses that are either minus or plus depending on the type. The process of determining the correct power of the lens that one needs to correct refractive error is called refraction (Waddel, 2000).

2.9 Procedure for correcting refractive errors

The refractive state of the person's eye is measured by looking in the distance, usually six meters, so that the ciliary muscle is relaxed. Testing of vision is very important. Each eye is measured separately to make sure that the test chart is read as far down as possible on good lighting on the letters. If the visual acuity is below the expected normal, the

pinhole test is used to check if it improves. The pinhole test acts as a universal lens that lets a narrow beam of light through the eye and reduces blur on the retina. If the vision improves on pinhole, it indicates presence of refractive error (Waddel, 2000). To find out what power of the lens is needed, lenses of various power are put on the trial frame according to what is read on the Snellen's chart until normal vision is attained.

2.10 Testing of vision in children

Vision testing is the process of detecting vision problems and is usually undertaken to improve prognosis and reduce disability (Wormald, 1999). If the aim is to detect and treat uncorrected significant refractive errors and eye conditions causing visual impairment, consideration is given to older children, particularly those in teenage life (Wormald, 1999). The frequency of vision testing needs to be linked to availability of resources and if favourable, children should be screened at specific times to meet specific needs. For example, in the pre-school age of six years and below, significant refractive errors are uncommon. However, the few if undetected and untreated, can lead to amblyopia. At an early school age of six to eleven years, the period at which myopia starts to develop, untreated refractive errors may make the treatment of amblyopia impossible because the child's eye requires to develop vision from birth. At twelve years, the age at which the eye reaches maximum growth, those children with existing myopia progress and then stabilises later in life. At this age (twelve years) the refractive errors which had developed at a younger age are still present.

2.11 Screening programmes for refractive errors in schools

Uncorrected refractive errors are an important cause of visual impairment in many countries. In developing countries, however, it is often difficult to provide an efficient refraction service for a variety of reasons. Some constraints include lack of appropriate personnel and equipment. The proportion of children who are blind or visually impaired due to refractive errors can be used to assess the level of development of eye care services in a region. The word 'screening' has a very precise meaning in public health and there are clearly defined criteria, which should apply before any screening programme is established. When considering the detection of refractive errors and other causes of visual impairment in older children, the term 'screening' does not really apply but rather, 'vision testing' (Murthy, 2000).

There are a few data available on the prevalence and type of refractive errors in children in developing countries (Murthy, 2000). In USA, the prevalence of visual impairment in children is estimated to be 5 to 10%, while that of amblyopia is 1-5% (Murthy, 2000). A study in Australia on factors associated with under corrected refractive errors in an older population reported that, 10.2% of the respondents had under-corrected SRE, which was associated with increasing age, socioeconomic disadvantage and isolation (Thiagalingam *et al.*, 2002). Case finding for refractive errors in China found that although some of the underlying clinically significant visual impairment was found to have already been corrected with spectacles, an essentially equal amount of correctable refractive error remained uncorrected (Ellwein 2002). In India, 5.1% of school children had visual acuity of $<6/12$ in the better eye (Murthy, 2000). A survey conducted in Botswana showed that

1.5% of children aged 5-15 years had a visual acuity of $<6/18$ in the better eye (Wormald, 1999). Out of these children, 78% had refractive error of less than $\pm 2.00D$ sphere or spherical equivalent. Globally, at least 2000 per million persons have refractive errors greater than $-1.00D$ in the better eye. Most of these are children who should be the focus of attention in any school-testing programme (Murthy, 2000).

It can be stated that newborn children are usually hypermetropic (the mean refractive error under cycloplegia has been reported to be about 2 dioptres). Low-grade hypermetropia is the usual refractive state that is maintained throughout infancy and childhood, despite great alteration in the apparatus of the refractive system (Negrel and Ellwein, 2000). In subsequent years, the anterior-posterior axis of the eye elongates, with thinning of the crystalline lens and flattening of the cornea, which leads to emmetropia in children by age eight to ten years. There is often a slight increase in the amount of measurable hypermetropia during the first seven years, but this gradually diminishes before puberty.

Myopia is a common and important cause of visual impairment, which is usually acquired and nearly always progressive. It rarely occurs before the age of five years and new cases appear throughout childhood and adolescence, particularly between the ages of six to fifteen years. Thereafter, the prevalence of myopia appears to level off (Negrel and Ellwein, 2000). In general, emmetropia is the most common condition in the adult population, although this depends on the population studied. Almost 100% of medical

students in Taiwan were myopic and the figure was very nearly as high in Japan (Negrel and Ellwein, 2000).

A study to assess the prevalence of refractive error and visual impairment in school-age African children in Durban, South Africa revealed that the prevalence of uncorrected, presenting, and best-corrected visual acuity of 20/40 or worse in the better eye was 1.4% for myopia, 1.2% for hypermetropia and 0.32% astigmatism (Naidoo *et al.*, 2002). Refractive error was the cause of visual impairment in 63.6% of the eyes with reduced vision; amblyopia contributed 7.3%, retinal disorders 9.9%, corneal opacity 3.7%, other causes 3.1% and unexplained causes were responsible in the remaining 12.0%. Exterior and anterior segment abnormalities were observed in 10.8% of the children, mainly corneal and conjunctival. Myopia (at least -0.50 D) in one or in both eyes was present in 2.9% of the children when measured with retinoscopy and in 4.0% measured with auto refraction.

Beginning with an upward trend at the age of 14 years, myopia prevalence with auto refraction reached 9.6% at age 15 years. In the study, myopia was also associated with increased parental education and hypermetropia ($+2.00$ D or more) in at least one eye was present in 1.8% of the children when measured with retinoscopy and in 2.6% when measured with auto refraction (Naidoo *et al.*, 2002). There were no significant predictors of hypermetropia risk. The study concluded that the prevalence of reduced vision is low in school-age African children, and is mostly because of uncorrected refractive error. The high prevalence of corneal and other anterior segment abnormalities are a reflection of the wanting primary eye care services in this area. In Malawi, a population-based survey

of refractive errors (urban and rural groups) reported low prevalence of myopia (2.5%) (Lewallen *et al.*, 1995). The mean refractive error in the urban student group was +0.52D compared to +0.62 D in the rural group. Literacy was associated with refractive errors and was therefore a predictor in both groups (Lewallen *et al.*, 1995).

In a study done in secondary schools in Tanzania, it was revealed that the overall prevalence of significant refractive errors with VA worse than 6/12 was 6.1% and myopia was responsible for 91.6% of the SRE (Wedner *et al.*, 2002). Majority of these school children were between ages 14-19 years. When objective refraction was done on them, eyesight improved at least in one eye to 6/12 or better in 97% of the students. Even though eye services are relatively widely available in Mwanza city and spectacles are affordable, health seeking behaviour was poor, with only one fifth of the students having consulted an eye professional (Wedner *et al.*, 2002). The prevalence of uncorrected significant refractive errors was 4.2%. Given the high prevalence of significant refractive errors, the accessibility of most secondary schools (which are mainly situated in urban centres), and the acceptability and affordability of spectacles among secondary school students, an eye-screening program for significant refractive errors was indicated in this population.

Furthermore, regular eye screening would also lead to increased awareness of myopia in school age children and may increase the proportion of children seeking appropriate correction. The great majority of significant refractive errors were due to myopia, with a prevalence of 5.6% (Wedner *et al.*, 2002). Among risk factors in this Tanzanian

secondary school population include female gender, education, ethnicity, family history of myopia and father's education. These factors were similar to those reported in European, North American, and Asian populations (Wedner *et al.*, 2002). In this study, an association with near work could not be shown but many students struggled to estimate the number of hours they spent on reading. In another study of eye diseases in primary school children in rural Tanzania involving children of 7-19 years, significant refractive error was found in 1.0% or less (Wedner *et al.*, 2000). All the 14 pupils with refractive errors were myopic. Refractive errors were responsible for 9 out of 10 pupils with poor bilateral eyesight (VA <6/12). In all 10 pupils with poor bilateral eyesight, visual acuity was improved to normal (VA ≥6/12) in at least one eye by providing appropriate glasses for refractive errors (Wedner *et al.*, 2000).

There is very little information from population based studies available particularly in East Africa for refractive errors on magnitude and pattern (MOH, 2005). In Kenya, refractive errors are estimated to be responsible for 13% of all significant vision loss in the country, ranking them third after cataract and trachoma (Schwab and Steinkuller, 1995). Most of those with decreased binocular vision due to refractive errors of ≤ 6/12 are children aged 11-15 years (MOH, 2005). The available refractive services are found mainly in cities and urban centres, leaving a vast majority with refractive errors uncorrected. Promotional activities have created awareness and encouraged the use of eye care services (Banzi, 2007).

In a study on significant refractive errors in standard eight pupils attending public schools in Langata, Kibera Division of Nairobi city, Kenya, the overall prevalence of significant refractive errors was 10.2%. Myopia was the leading cause (9.4%), followed by hypermetropia (0.3%) and astigmatism was last (0.5%). Of these, only 11.7% of students had spectacles with the correct power (Nzuki *et al.*, 2006). The study concluded that about 10.2 % of class 8 pupils attending public primary schools in Langata needed spectacles but only a few had them. It was recommended that there is need for a school screening programme offering low cost spectacles so that children who may be having learning difficulties due to lack of spectacles can be identified and assisted promptly. Inaccessibility to services was a major barrier to utilization of eye care in Kibera slum of Nairobi (Ndegwa *et al.*, 2005). This means that there is a great need to create awareness on the prevalence of refractive errors among school going children and the existence of refractory services. It has been shown that screening for refractive errors is more cost-effective than primary eye care in school-age children in India (Lester, 2007).

A study on magnitude and pattern of refractive errors reported that the prevalence of SRE was 5.2%, being responsible for 92.6% of all causes of poor eye sight (<6/18) among primary school pupils. Hypermetropia accounted for 3.2%, myopia 1.7%, and astigmatism 0.3%. Myopia was more likely to be present in the pupils aged 14-15 years than those 12- 13 years. Only 1.3% of the pupils with refractive errors had full spectacle correction. Lack of spectacles among the pupils was attributed to the fact that they could not afford them and lack of refractive services (Muma *et al.*, 2007).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

The study was done within Meru Municipality, Meru Central District, in Eastern province of Kenya (Appendix I). This is on the eastern side of Mt Kenya at an altitude of about 5000 metres above the sea level. Both public and private schools are found in the area. All public boarding schools are not mixed, but most of day secondary schools are. All private schools, whether mixed or not, are boarding schools. Transport services are well served by all weather roads. The economy of the area is sustained by horticulture and agricultural activities. The main cash crops in the region are coffee, tea, and wheat. Food crops include maize, beans and potatoes. Dairy farming is also a common activity in both small and large scales. There is a food and a milk processing plant owned by the indigenous community. The population of secondary students is about 3012, drawn from 16 schools. The study was conducted at Meru School and Kaaga Girls.

3.2 Study design

This was a cross-sectional study where students in selected secondary schools underwent an eye screening process. This type of study was done to assess the magnitude of significant refractive errors as the problem at that point in time. Its advantage was that it was cost effective and did not cause fatigue to both the investigator and the study subjects.

3.3 Target population

The target population was secondary school students in Meru Municipality who were of high school age (13-18) years. This is the age bracket at which myopia peaks.

3.4 Study population

These were male and female students in two selected secondary schools in Meru Municipality.

3.5 Sampling techniques

All the schools for boys and girls in the study area were separately listed down and random sampling technique was used to select two schools, one for boys and the other for girls. The Form four students were not available for screening at the time of the study. Therefore Form one was selected to represent the lower secondary and Form three to represent upper secondary. Since the selected schools had four streams each, another simple random technique was used to select two representative streams among the Form ones and two streams among the Form threes. In each stream, a class was selected and all students screened for refractive errors.

3.6 Sample size determination

Sample size was determined according to the formula used by Fisher *et al.* (1998). Since no data was available showing the prevalence of significant refractive errors in Meru Municipality, Kenya's population estimate was used, which is 13% (Schwab and Steinkuller, 1995).

The formula used by Fisher *et al.* (1998) is:

$$n = \frac{Z^2 pqD}{d^2}$$

Where:

n = desired sample size

z = 1.96 (normal standard deviation for 95% confidence)

p = proportion of target population with SRE
= 0.13 {Kenya population estimate for RE (Schwab and Steinkuller, 1995)}.

q = 1-p = 0.87

d = 0.05 (level of significance)

D = design effect (1).

Therefore:

$$n = \frac{(1.96^2) \times (0.13 \times 0.87) \times 1}{0.05^2}$$

$$= \frac{3.84 \times 0.1131}{0.0025}$$

$$= \frac{0.4345}{0.0025}$$

$$= 173$$

Since the target population for this study was less than 10,000, the modified formula for populations less than 10,000 was used to determine the sample size:

$$nf = \frac{n}{1+n/N}$$

Where: nf = desired sample size for population less than 10,000 (n < 10,000)

$$\begin{aligned}
 N &= \text{Target population (the total number of students in Meru Municipality)} \\
 &= 3012
 \end{aligned}$$

$$\begin{aligned}
 nf &= \frac{173}{1+173/3012} \\
 &= 164
 \end{aligned}$$

Therefore, 82 boys and 82 girls were screened for significant refractive errors.

3.7 Materials and instruments for examination

3.7.1 Materials

Data questionnaires (Appendix II) were administered to those students who had SRE and were filled with the help of the investigator. The questionnaires contained questions regarding the data needed for the study.

Equipment

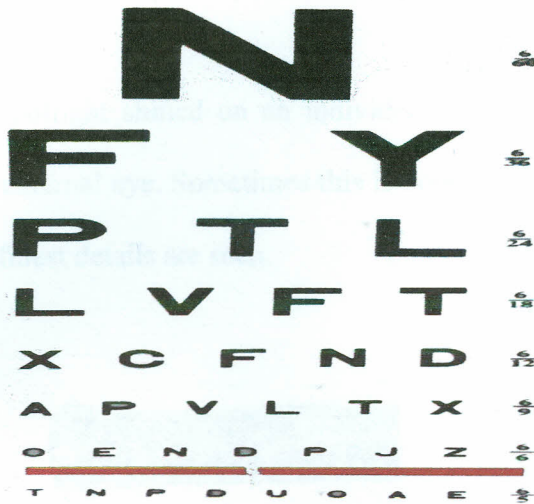
These are various ophthalmic instruments for carrying out specific tests in order to detect the problems.

Visual testing

Visual acuity testing identifies those with visual impairments and need further examination in detail to establish their actual problem. Each eye was tested separately because it is not always that they have an identical problem. The visual acuity level, that denotes “failure” had to be identified. The common failure level for school going children on Snellen’s chart is visual acuity of $\leq 6/12$.

Snellen's chart

This is a specially designed chart for determining the visual acuity level of an individual. The person being tested sits or stands at six meters away from the chart and then is asked to identify letters of different size which are drawn in lines.



Snellen's chart

Pinhole

This is a very small hole through which a person who is unable to read smaller letters on Snellen's chart reads through to find out if he or she has refractive error. If the person improves in vision when reading through the pinhole, he or she has refractive error.



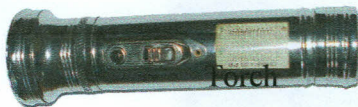
Pinhole

3.7.2 Physical examination

This involves examining the details of the eye using specific instruments. The most appropriate method is to examine the eye from the exterior to the interior and then recording the various findings.

Torch

An ordinary spotlight shined on an individual's eye so that the examiner can see the details of the external eye. Sometimes this is done together with the magnifying loupe so that even the finest details are seen.



Torch

Direct ophthalmoscope

This is an instrument for examining the posterior pole of the eye that includes the retina, optic nerve, macula and blood vessels. It is held by the examiner close to the eye being examined in order to get finer details. There are many companies which manufacture ophthalmoscopes but the most common in Kenya is Heine, made in Germany.



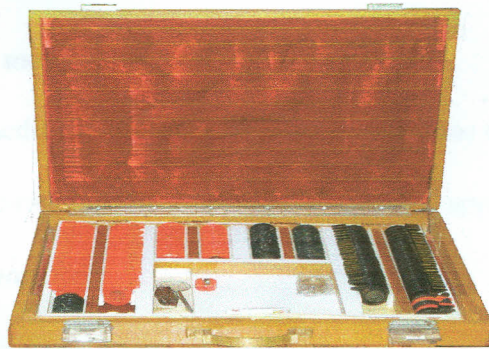
Direct Ophthalmoscope

3.7.3 Objective and subjective refraction

Refraction is an examination process that identifies the power of the lens an individual with refractive error needs to sharpen the blurred images. Several instruments are required to perform the examinations which include:

Refraction box

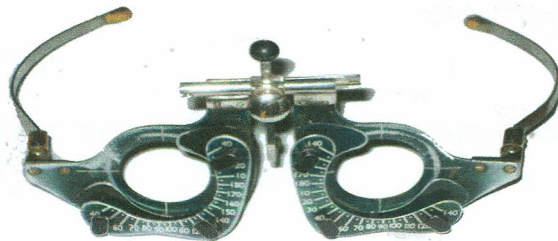
This is a container with a series of different power of lenses, which are arranged from the lowest to the highest. The bigger the refractive error a person has the greater the power of the lens that the eye needs for clarity of images.



Refraction Box

Trial frames

This is a specially designed frame worn by a person in the same way as spectacles, for holding the lenses in position during refraction process.



Trial Frames

Retinoscope

This is an instrument for determining the required power of the lenses needed in an individual with refractive error.



Retinoscope

3.7.4 Basic diagnostic eye medications

These are chemicals and medications that facilitate the examiner to make the appropriate diagnosis during the examination of the eye. They are applied according to the examination needed. They include:

Fluoresceine strips

These are paper stripes containing a dying substance at one end that is used for detecting corneal epithelial defects. If the cornea of an individual has defects the dye turns from red to green in colour.

Amethocaine 0.5% eye drops

This is a topical anaesthetic eye medication used for suppressing pain during eye examination.

Cyclopentolate eye drops

This is a topical eye medication for dilating the pupils in order to allow examination of the posterior pole of the eye.

3.8 Pilot study

This was done in one mixed secondary school within the study area in order to evaluate SRE in boys and girls. This was a single stream school of about 90 students. One class of 30 students was randomly selected and all the students from it were screened for refractive errors. This was done to ensure validity and reliability of the study through standardization and pre-testing of the material and equipment.

3.8.1 Standardization

Relevant training and orientation was carried out before the survey to all the personnel who participated in the study on the proper use of the data collection materials, instruments and appropriate recording. This would ensure uniformity during the screening process and thus ensuring the accuracy of the data.

3.8.2 Pre-testing

Pre- testing of the materials and equipment for the study was done two days before the actual survey was conducted. The purpose of this exercise was to assess whether the equipment and materials were suitable for the study and also check whether standardised protocols were observed. The instruments and materials were found to be fit for the study.

3.9 Case definition

The classification for significant refractive error which was considered was where the study subject failed to read the $\geq 6/12$ level on Snellen's chart in at least one eye but improved with an appropriate lens power or pinhole test. This cut off level of visual acuity decreased the sensitivity of refractive error but increased the positive predictive value of SRE among the study subjects.

3.10 Inclusion criteria

All students from the randomly selected classes, of the two selected schools for boys and girls, who were in Form one and three and who consented to be screened.

3.11 Exclusion criteria

Students in the selected schools who did not consent for screening procedures and those not in the selected schools at the time of the survey were not included in the study.

3.12 Measurement scales

Both qualitative and quantitative measures were used to describe characteristics of variables when analysing the data. Nominal and ordinal scales were applied as necessary to describe the variables in this study. The assumption of the study was that the ratio of boys to girls was 1:1 with equal participation.

3.13 Data quality

Data quality was guaranteed by ensuring that the measuring tools were accurate and reliable. This was done through standardization and pre-testing of materials and equipment.

3.14 Data collection procedure

A two-stage examination procedure was used. At stage one, visual acuity from all the study subjects was done from a distance of six meters. All the students who read better than 6/12 on Snellen's chart for visual acuity were exempted from further examination. At stage two, the pinhole test was performed on students who read the $\leq 6/12$ level, and those who improved in vision were subjected to both objective and subjective refraction. The findings of the significant refractive errors were recorded on a specially designed form (Appendix III). Alongside this were semi-structured questionnaire forms which were filled by only those identified to have SRE. The model for examination procedure is shown below (Figure 5).

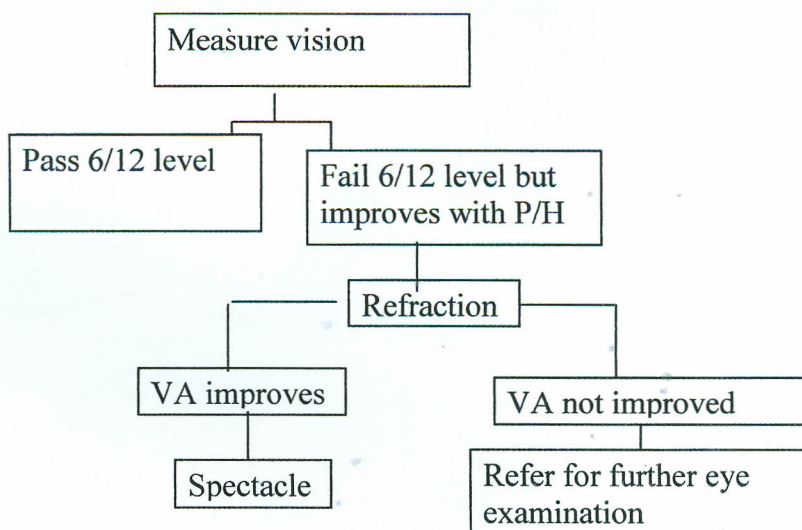


Figure 5: Model for examination procedure

CHAPTER FOUR

RESULTS

4.1 Demographic characteristics of the study respondents

4.1.1 Composition by sex and class

A total of 164 students participated in this study, out of which 50.0% were boys and 50.0% were girls, drawn from Form one and Form three classes of the two selected secondary schools. Of those selected from Form one, 48.8% were boys and 51.2% were girls (n=84), while those in Form three comprised 51.2% boys and 48.8% girl (n=80) (Table 1).

Table 1: Distribution of the study population by class and sex

Class						
Form 1			Form 3		Total	
Sex	Frequency	%	Frequency	%	Frequency	%
Boys	41	48.8	41	51.2	82	50.0
Girls	43	51.2	39	48.8	82	50.0
Total	84	100.0	80	100.0	164	100.0

4.1.2 Age characteristics of study respondents in the lower classes by sex

The age range for Form one classes was 13-16 with a mean of 14.3 years. In the age 13 category, girls were more with 66.7% compared to boys 33.3% while in the 14 years group; girls were majority with 56.0% while boys were 44.0%. In the 15 years group,

boys were more with 66.7% while girls represented 33.3%. In the 16 years group girls comprised of 57.1% and boys 42.9% (Figure 6).

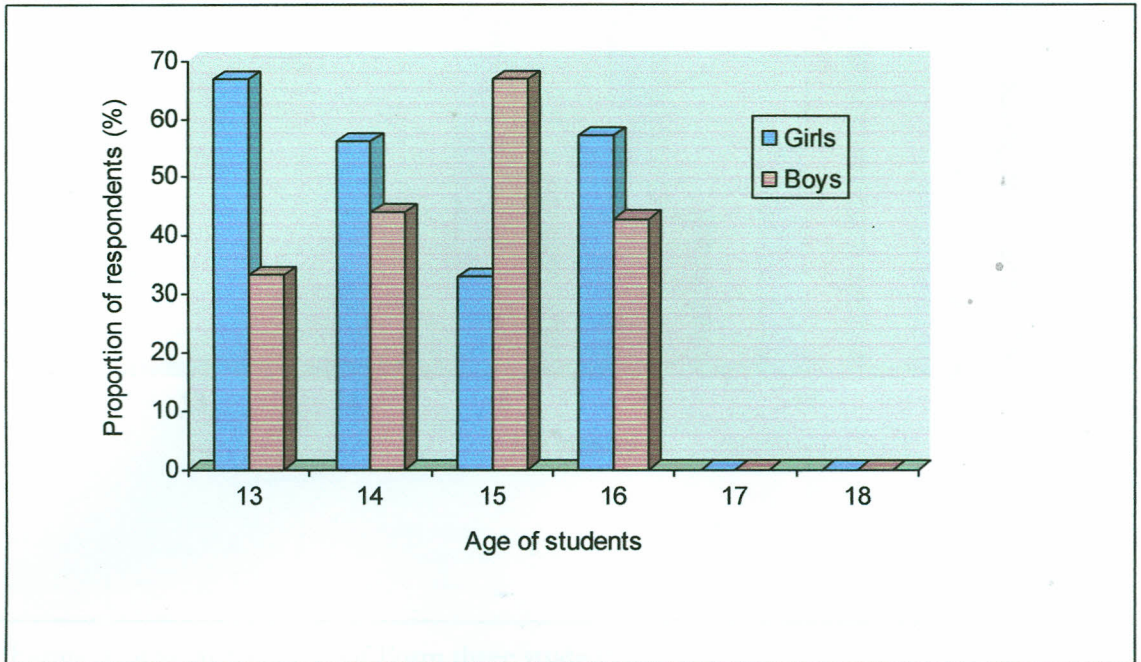


Figure 6: Age distribution of Form one students by sex

4.1.3 Age characteristics of the study respondents in the upper classes by sex

The total number of students screened from the Form three classes was 80, the age range being 15-18 years, with a mean of 16.7 years. A majority of those in the 15 year age category were girls, representing 66.7% while boys were 33.3%. In the 16 year category, girls were still more with 72.7% compared to 27.3% for boys. For those in the 17 year category, majority were boys representing 61.5% while girls were 38.5%. Those of 18 years comprised 66.7% boys and 33.3% girls (Figure 7).

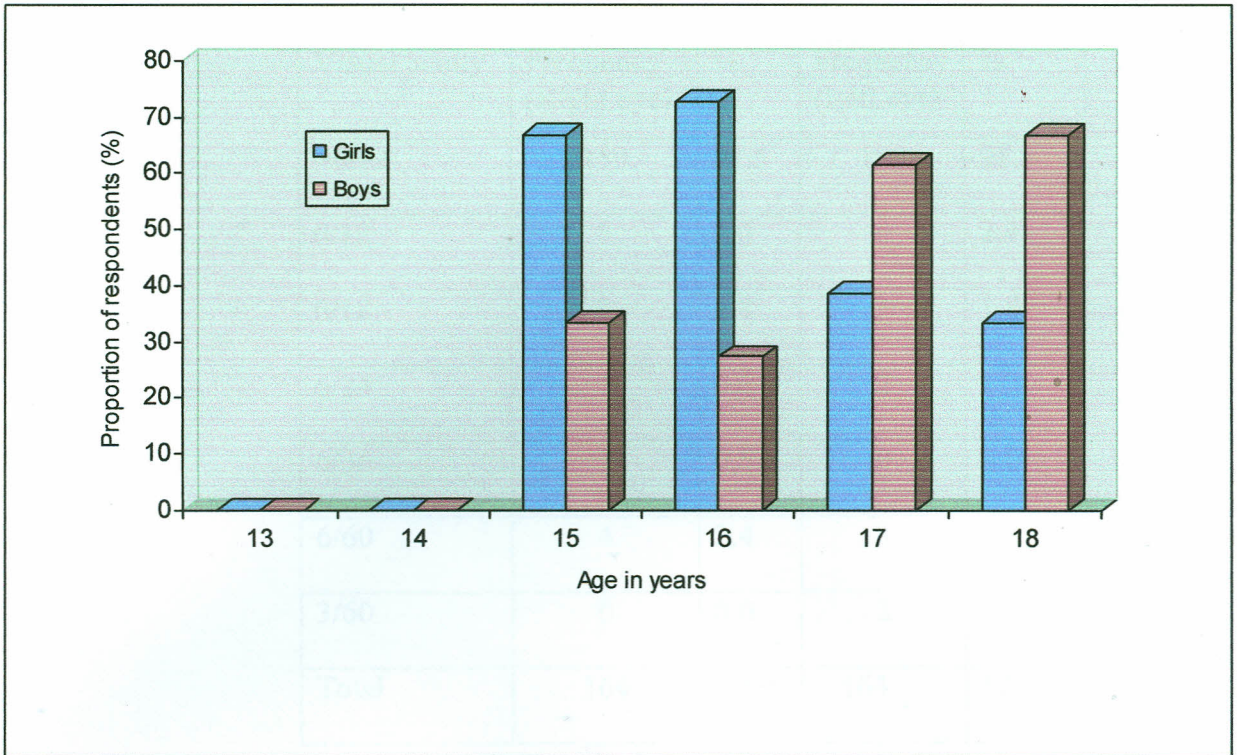


Figure 7: Age distribution of Form three students by sex

4.2 Visual acuity of study subject's eyes on Snellen's chart

Out of 164 students screened, 150 (91.5%) had no SRE. Of those with decreased VA of 6/12 on the Snellen's chart, 3.0% was in the right eye and 2.4% in the left eye. At 6/18 level both eyes were equal with 1.8% each, while at 6/24 level only the left had decreased VA, contributing 0.6%. At the 6/36 level, only the right eye had decreased VA representing 0.6%. At the 6/60 level, the right eye contributed 2.4% compared to the left with 1.8%, and at 3/60, reduced VA was found in the left eye only, representing 1.2% (Table 2).

Table 2: Frequency distribution of visual acuity on the Snellen's chart in right and left eyes of the study subjects

Visual acuity	Frequency (Right eye)	%	Frequency (Left eye)	%
>6/12	150	91.5	150	91.5
6/12	5	3.0	4	2.4
6/18	3	1.8	3	1.8
6/24	1	0.6	2	1.2
6/36	1	0.6	0	0.0
6/60	4	2.4	3	1.8
3/60	0	0.0	2	1.2
Total	164	100.0	164	100.0

4.3 Prevalence of SRE among the study subjects

Out of the 164 students screened for SRE, 14 (8.5%) were found to have SRE, of which 5.5% were girls and 3.0% were boys. Among those who had no SRE 47.0% were boys and 44.5% were girls (Table 3). The prevalence of SRE among the students appear to be greater in girls than boys, but this sex disparity in SRE prevalence did not show any significant statistical difference ($\chi^2 = 1.24$, d.f=1 $p>0.05$).

Table 3: Prevalence of SRE in the study population by sex

Study subjects	With SRE	%	Without SRE	%	Total	%
Boys	5	3.0	77	47.0	82	50.0
Girls	9	5.5	73	44.5	82	50.0
Total	14	8.5	150	91.5	164	100.0

4.4 The pattern of SRE among the study subjects

Three types of refractive errors were identified among the study subjects. Myopia was the leading cause of significant refractive error among the students representing 78.6% (n=14) (Figure 8). Astigmatism followed with 14.3% and hypermetropia was last with 7.1% (n=14).

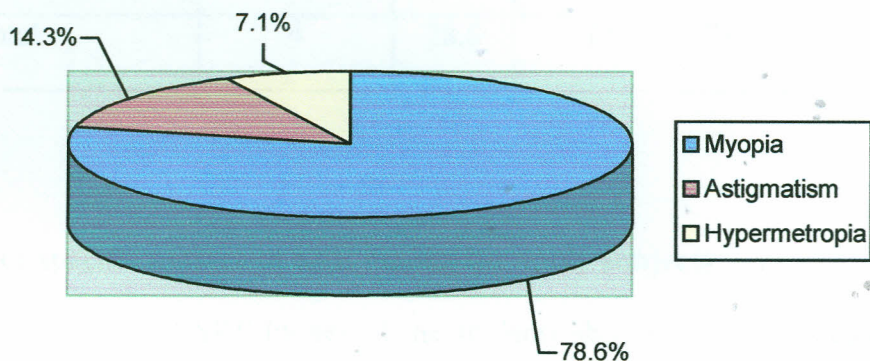


Figure 8: Percentage distribution of SRE among the study subjects by type

4.5 Frequency of occurrence of SRE in the study subjects by class

Among the students with SRE, myopia was more prevalent in the upper class (Form three) (50%), compared to lower classes with 28.6% (n=14) (Table 5). Astigmatism and hypermetropia were only found in the upper class, at 14.3% and 7.1% respectively (n = 14). Only myopia was present in the lower classes (Form one) while in the upper classes students (Form three), all the three of types significant refractive errors were present. Also a higher percentage of Form three students had SRE (71.4%) compared to the lower class (28.6%).

Table 4: Distribution of SRE among the students by class

Refractive error	Class					
	Form 1		Form 3		Total	
	Frequency	%	Frequency	%	Frequency	%
Myopia	4	28.6	7	50.0	11	78.6
Astigmatism	0	0.0	2	14.3	2	14.3
Hypermetropia	0	0.0	1	7.1	1	7.1
Total	4	28.6	10	71.4	14	100.0

4.6 Sex specific pattern of SRE among the study subjects

The distribution of SRE by sex of the students showed that in the category of myopia, girls were more with 54.0% compared with boys 46.0% (n=11) (Figure 8). There were no boys reported to have hypermetropia or astigmatism; only one girl had hypermetropia and

two were found to have astigmatism. Although myopia was the leading cause of visual impairment in both sexes, there was no statistically significant difference between them ($\chi^2 = 2.05$, d.f=1, $p>0.05$).

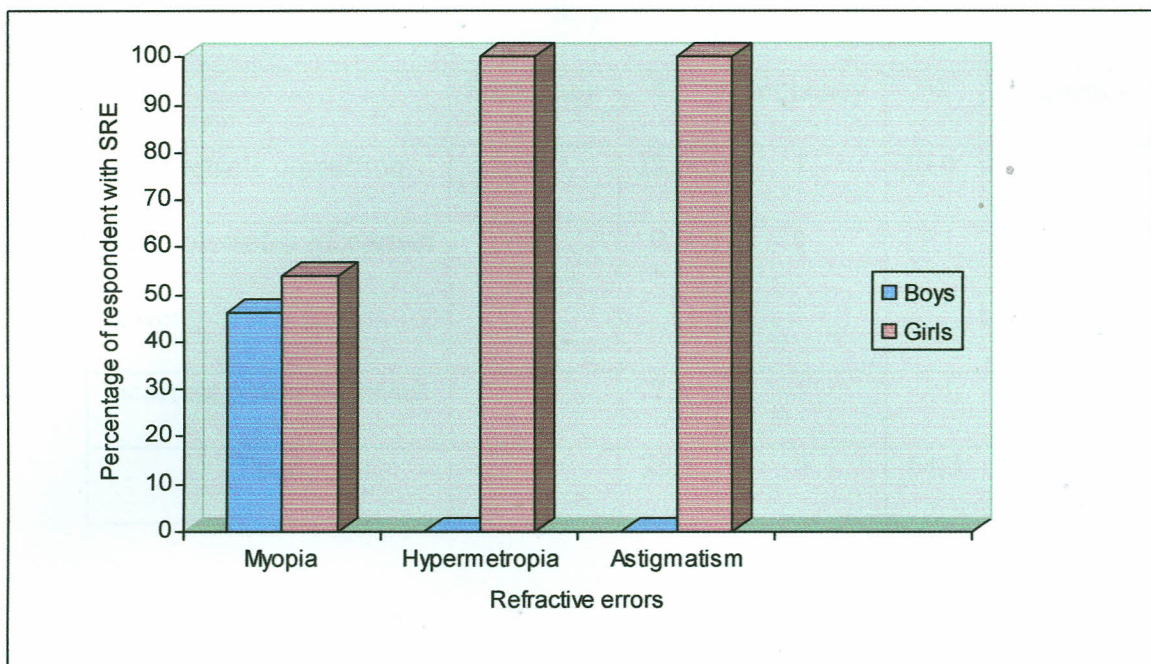


Figure 9: Percentage distribution of SRE among the study subjects by sex

4.7 Refractive status of the students with SRE

Among the students with SRE, 21.4% had sought spectacle correction. 50% of the girls and 28.6% boys (n=14) had no spectacle correction (Table 5). However, only 7.1% comprising of girls only had spectacle correction with correct power of lenses. About 7.1% of the boys and an equivalent percentage of the girls (n=14) had spectacle correction but the power of the lenses was not correct. Of those who had not sought spectacle correction, 50% were girls while 28.6% were boys. More girls had sought

spectacle correction than boys, but there was no significant difference between them ($\chi^2 = 0.04$, d.f = 1, $p > 0.05$).

Table 5: Proportion of respondents (%) representing different SRE status

Status	Boys		Girls		Total	
	Frequency	%	Frequency	%	Frequency	%
No spectacle correction	4	28.6	7	50.0	11	78.6
Had spectacles of correct power	0	0.0	1	7.1	1	7.1
Incorrect power of lenses	1	7.1	1	7.1	2	14.3
Total	5	35.7	9	64.3	14	100.0

4.8 Family history of spectacles

For most of the students, there was a history of wearing spectacles by close relatives (Table 6). Among those whose parents used spectacles, 10.6% had their fathers with them compared to 7.9% whose mothers had. About 5.3% had brothers with spectacles while 10.5% had sisters with them. There was a history of grandparents using spectacles, with 13.1% of the respondents reporting that their grandfather had spectacles, and 15.8% giving history of their grandmother. There was almost an equal proportion of those who had a history of uncles and aunts having spectacles at 18.4% and 18.5% respectively (Table 6).

Table 6: Proportion of respondents (%) with SRE in relation to family history of wearing spectacles

Relation	Boys		Girls		Total	
	Frequency	%	Frequency	%	Frequency	%
Father	2	5.3	2	5.3	4	10.5
Mother	1	2.6	2	5.3	3	7.9
Brother	0	0.0	2	5.3	2	5.3
Sister	0	0.0	4	10.5	4	10.5
Grandfather	1	2.6	4	10.5	5	13.1
Grandmother	1	2.6	5	13.2	6	15.8
Uncle	1	2.6	6	15.8	7	18.4
Aunt	2	5.3	5	13.2	7	18.4
Total	8	21.0	30	79.0	38	100.0

4.9 Factors affecting the correction of SRE among the students

All the students with SRE were aware of their visual problems yet 50.0% of them had never been examined (Table 7). Among those never examined, 28.6% were boys and 21.4% were girls (n=14). The percentage of boys who had never been examined was slightly higher than that of girls. However, there was no statistically significant difference between them ($\chi^2 = 1.852$, d.f=1 p>0.05). The factors contributing to students with SRE remaining uncorrected included in-affordability by parents (21.4%), dislike for the spectacles (7.1%), perception that the problem was not serious (7.1%) and those with discomfort from the spectacles (14.3%; Table 7).

Table 7: Factors affecting the correction of SRE among the study subjects

Factors affecting correction						
Reasons	Boys		Girls		Total	
	Frequency	%	Frequency	%	Frequency	%
Lack of awareness	0	0.0	0	0.0	0	0.0
Parent couldn't afford	0	0.0	3	21.4	3	21.4
Broken spectacles	0	0.0	0	0.0	0	0.0
Never examined	4	28.6	3	21.4	7	50.0
Do not like spectacles	0	0.0	1	7.1	1	7.1
Think problem not serious	1	7.1	0	0.0	1	7.1
Lost spectacles	0	0.0	0	0.0	0	0.0
Discomfort with spectacles	0	0.0	2	14.3	2	14.3
Total	5	35.7	9	64.3	14	100.0

4.10 Symptoms cited among students with SRE

The most frequent symptom that the students complained of was blurred vision for distant objects contributing 50.0% (Table 8). About 42.9% had associated headache and only 7.1% of the student had a near visual problem (n=14).

Table 8: Complaints by students with SRE

Complaint	Frequency	%
Distant visual problem	7	50.0
Headache	6	42.9
Near vision	1	7.1
Total	14	100.0

4.11 Health seeking behavior among the students

Half of the students (50%) n=14) with SRE had visited a hospital for check up. Out of these students, 7.1% were boys and 42.9% were girls (n=14) (Table 9). Of those who did not attend any hospital for eye check up, 28.6% were boys and 21.4% were girls (n=14). There was no statistically significant difference in hospital attendance between boys and girls ($\chi^2 = 2.8$ d.f = 1 ($p > 0.05$)).

Table 9: Proportion of students with SRE (%) who visited or did not visit the hospital for eye check up

	Visited		Did not visit		Total	
	Frequency	%	Frequency	%	Frequency	%
Boys	1	7.1	4	28.6	5	35.7
Girls	6	42.9	3	21.4	9	64.3
Total	7	50.0	7	50.0	14	100.0

4.12 Category of hospital preferred by the students with SRE

Of the students who had visited hospital for eye check up, 57.1% (n=7) preferred government health care services and 42.9% preferred private health care centers. All the 57.1% who preferred government hospitals were girls but among those who visited private health care centers, 14.3% were boys and 28.6% (n=7) were girls (Table 10).

Table 10: Distribution of students with SRE by type of hospital preferred for refractive services

Type of hospital visited						
	Government		Private		Total	
Sex	Frequency	%	Frequency	%	Frequency	%
Boys	0	0.0	1	14.3	1	14.3
Girls	4	57.1	2	28.6	6	85.7
Total	4	57.1	3	42.9	7	100.0

4.13. Action taken students following hospital visit

Of those students examined for refractive errors, 85.7% were girls and 14.3% were boys (n=7) (Table 11). Among those who bought spectacles after their importance was explained, 14.3% were boys and 28.6% were girls. About 57.1% of the respondents, who were all girls, did not buy spectacles.

Table 11: Distribution of students with SRE who bought or did not buy spectacles after the hospital visit

Action taken by the students						
Sex	Bought spectacles		Did not buy spectacles		Total	
	Frequency	%	Frequency	%	Frequency	%
Boys	1	14.3	0	0.0	1	14.3
Girls	2	28.6	4	57.1	6	85.7
Total	3	42.9	4	57.1	7	100.0

4.14. Visual acuity outcome of objective refraction on the eyes of students with SRE

All students found with decreased $VA \leq 6/12$ and who improved with the pinhole test were subjected to both objective and subjective refraction. About 96.4% ($n=28$) of eyes refracted by retinoscopy improved to $VA \geq 6/6$ (Table 12). Only 3.6% of the eyes did not improve with objective refraction, due to amblyopia of the left eye that was caused by the high difference in the dioptric power (anisometropia) of two eyes in the study subject.

Table 12: Visual acuity improvement of right and left eyes on Snellen's chart

Visual improvement on students' eyes with objective refraction						
VA	RE	%	LE	%	Total	%
$\geq 6/6$	14	50.0	13	46.4	27	96.4
$< 6/6$	0	0.0	1	3.6	1	3.6
Total	14	50.0	14	50.0	28	100.0

4.15 Other eye diseases identified during examination of students with SRE

The students who had SRE were also examined for other existing eye conditions but majority (92.9%) (n=14) were found to have no other eye defects (Table 13). Only one (7.1%) of the students (n=14), who was a girl, had a squint on the left eye.

Table 13: Frequency of other eye conditions among students with SRE

Other eye conditions identified on examination of students eyes						
Sex of student	Other conditions		No other conditions		Total	
	Frequency	%	Frequency	%	Frequency	%
Boys	0	0.0	5	35.7	5	35.7
Girls	1	7.1	8	57.1	9	64.3
Total	1	7.1	13	92.9	14	100.0

CHAPTER FIVE

DISCUSSION

5.1 Age characteristics of students and SRE

There was equal participation in this study between boys and girls out of the 164 participants. Most of the Form one students were of age 14 years and those in Form three were of 17 years. Significant refractive error was more (71.4%) in the upper classes with a mean of 16.7 years than the lower (28.6%), with a mean age of 14.3 years. SRE was more prevalent in the older age group compared to the lower one. This is because most SRE, particularly myopia sets in at age 12 and progresses throughout teenage life (Wormald, 1999). This finding is consistent with the report, where the prevalence of myopia was higher in the older group of students (Muma *et al.*, 2007).

5.2 Gender characteristics of students and SRE

Significant refractive errors were more frequent among girls (5.5%) compared to boys (3.0%). Although no specific reason has been attributed to this finding, a similar study in Tanzania found female sex to be a risk factor (Wedner *et al.*, 2002). Astigmatism and hypermetropia were found in girls only in this study, contrary to the study in Langata Division, Nairobi, where the two conditions cut across both sexes (Nzuki *et al.*, 2006). Most likely, this is due to the fact that study sample size was large in Langata and was therefore able to capture the two refractive errors.

5.3 Prevalence and pattern of significant refractive errors

The overall prevalence of significant refractive errors among the study population was 8.5%, which is lower than Kenya's population estimate of 13% (Schwab and Steinkuller, 1995). This prevalence was comparable to other reports where the problem of SRE was estimated to be 5-10% of the school children in USA (Murthy *et al.*, 2000). Within Africa, the prevalence of SRE in Mwanza, Tanzania, among secondary school students was reported to be 6.1% (Wedner *et al.*, 2002).

The prevalence reported here was comparable to that for Langata division of Nairobi city, among standard eight pupils which was 10.2% (Nzuki *et al.*, 2006). The difference in percentage between Langata and this study could be attributed to the difference in the sampled study populations. This study was dealing with secondary school students in Meru, which is a rural town while the one in Langata Division dealt with standard eight pupils in city set up. The prevalence of myopia was 6.7% and was the leading cause of decreased visual acuity among the students with SRE. The prevalence of myopia in this study is comparable to that reported for secondary school children in Tanzania, where the leading cause of decreased vision in adolescent was mainly, due to myopia (Wedner *et al.*, 2002).

The prevalence in the current study was less than that found among primary school pupils in Makuani Division which was 1.7% (Muma *et al.*, 2007). This could be attributed to the difference in population setting, with Meru being urban and Makuani rural. Comparable reports elsewhere have demonstrated higher proportions in urban populations than rural.

This finding is similar to the one reported in Tanzania of 5.6% (Wedner *et al.*, 2002). The study showed that all boys with SRE were myopic. This similarity is also illustrated in the Taiwan study where all the study subjects were myopic (Negrel and Ellwein, 2000). The high prevalence of myopia is due to the fact that it sets in during teenage life, which was our target population. Sex specific prevalence showed more girls had myopia than boys, but without significant statistical difference between them. This finding is similar to one reported in Makueni study, where the prevalence was 1.8% for girls and 1.7% for boys though the two studies were conducted in different population set ups (Muma *et al.*, 2007). The target population in the latter study consisted of rural primary school pupils while this study dealt with urban secondary schools.

Astigmatism was the second most prevalent cause of decreased vision, contributing 1.2%. This prevalence was higher than that found in primary school pupils in Langata Division, at 0.3% (Muma *et al.*, 2007). This difference could be attributed to the high cutoff visual acuity of 6/18 in primary school pupils, while that in the current study was $\geq 6/12$. In a related study in Tanzania, the prevalence of astigmatism was much lower, at 0.1% (Wedner *et al.*, 2002). Astigmatism was found in girls only in the present study. Female gender has been found to be a risk factor for SRE (Wedner *et al.*, 2002). Other studies have reported astigmatism in both sexes (Nzuki *et al.*, 2006; Muma *et al.*, 2007).

Hypermetropia was the least cause of reduced vision among the study subjects, representing 0.6%. This trend in pattern of SRE was similar to that reported among the population in Langata where astigmatism and hypermetropia were 0.5% and 0.3%

respectively, behind myopia (Nzuki *et al.*, 2006). The two studies reported same visual acuity cutoff on Snellen's chart of $\geq 6/12$. The low prevalence of hypermetropia was because this refractive error diminishes as the eye reaches maximum growth, just before puberty (Negrel and Ellwein, 2000).

5.4 Family history of SRE

The influence of family history on SRE in this study showed that all the students recorded a history of at least a close relative using spectacle, which was a risk factor. This finding is supported by results of a study of genetics and refractive error that showed strong correlation between refractive error in parents and siblings (Hammond *et al.*, 2001). Thus refractive error is an inherited condition and runs in families. This finding is also consistent with the one in Tanzania where family history of spectacles was associated with refractive error (Wedner *et al.*, 2002). This is a good indicator in that those parents wearing spectacles should have their children undergo eye screening process to establish the refractive state of their eyes. The proportion of girls who reported history of relatives wearing spectacles was higher than boys. This could be attributed to the fact that more girls were found to have SRE in the study population. Female gender has been reported to be a risk factor in SRE (Wedner *et al.*, 2002).

5.5 Refractive status and SRE

The study showed that majority of the students with SRE had not taken action to correct their visual problem despite the high level of awareness. This means that the level of understanding of the need to have spectacles by those with SRE may be low. Wearing of

incorrect power of lenses was found in 14.2% of the study subjects, which compares with the reported value of 10.2% in Australia (Thiagaligham *et al.*, 2002). This could mean that either the students were not having regular refractive service or they had obtained spectacles from unqualified personnel. Regular eye check up is necessary because as the eye progresses in refractive error, it will need new lens power. The study did not find any study subject, having but not wearing a pair of spectacles; therefore compliance on the use was not an issue.

5.6 Health seeking behavior and SRE

On the health seeking behavior of the students with SRE, the study showed all were aware of their visual problem but more girls (42.9%) had visited hospitals for refractive services compared to boys (7.1%), which reflect better health seeking attitude by girls. This could be attributed to the fact that majority of those with SRE were girls. There were no school screening programs in the area, so accessibly to refractive services was a challenge, with 50% of the students with SRE having never been examined. This concurs with the report where, only one fifth of secondary students with SRE had consulted an eye professional (Wedner *et al.*, 2002). Affordability, dislike for spectacles, perception that the problem was not serious and discomfort were other reasons for students continued stay without spectacles.

5.7 Visual outcome after refraction

Most of the eyes attained normal vision after objective refraction by use of retinoscope, which was further confirmed subjectively by use of optical lenses. This indicates that

visual impairment from significant refractive error is easy to treat. This visual outcome compares with the one in Tanzania where all 10 pupils with SRE improved to normal vision with objective refraction (Wedner *et al.*, 2000). In the current study, one student with SRE did not improve in vision after refraction in the left eye. This is because she had developed amblyopia, 'lazy eye' in her left eye, which was attributed to a big difference in the refractive state in the two eyes (anisometropia). The same eye had also developed a squint which results when the brain switches off the bad eye so as to give chance to the better eye to visualize objects clearly. It is therefore important to detect SREs and treat early or make appropriate referrals.

CHAPTER SIX

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 Summary

a) The study found the prevalence of significant refractive errors to be 8.5% in secondary schools in Meru Municipality. The proportion of students with significant refractive errors was higher among girls (5.5%) compared to boys 3.0%. However, there was no statistically significant between them.

b) The pattern of SRE showed that myopia was the leading cause of decreased VA among the students, contributing 78.6%, followed by astigmatism at 14.3% and lastly hypermetropia at 7.1%. On pattern of SRE by class, the study showed that more students (71.4%) were found in upper classes compared to lower classes (28.6%). Sex specific pattern of SRE showed girls having more (54.0%) significant refractive errors compared to boys (46%).

c) Despite the high level of awareness of SRE, many students (78.6%) remain in schools with uncorrected SRE. Inaccessibility to refractive services was associated with a state of uncorrected SRE. This is because there are no school screening programs for refractive errors in the area. Half of the students (50.0%) with SRE had never been examined despite the high level of awareness. The study has shown that among those with SRE, more girls (42.9%) had sought refractive services compared to boys (7.1%). This reflects better health seeking behavior among girls. Family history of wearing spectacles was associated with students having refractive errors and was therefore a risk factor.

6.2 Conclusions

a) Significant refractive errors are a common cause of visual impairment in secondary schools in Meru Municipality. These are the students who need urgent attention to correct their visual impairment.

b) Myopia was found to be the leading cause of decreased (VA \leq 6/12). This means that myopia should be the focus of interest by stake-holders, while looking for possible ways of solving the problem.

c) Most of the students had not sought correction for the impaired vision from SRE although all were aware of their refractive state. This reflected a high degree of ignorance about the problem and its correction by the students and their parents. Inaccessibility to refractive services was the main reason for the students continued stay with uncorrected SRE.

6.3 Recommendations

a) There is need for the Government to start school screening programmes through primary eye care services that can provide cheap spectacle correction within Meru Municipality. This can be done through the existing primary health care services by the District Health management team.

b) Educational training on visual testing by eye professionals, such as ophthalmologists, ophthalmic clinical officers, optometrists and other auxiliary eye care workers should be

started to selected high school teachers, for early detection and appropriate referral. This is a cost effective way of solving the problem.

c) There is need to increase awareness for students and parents on the importance of having spectacles for those who require them, to avoid complications that may be caused by refractive errors. Students can be educated through school health visits by Public Health officials. Awareness among parents can be conducted through public gatherings by chiefs and church leaders. Health talks by primary health care teams to the students during routine visits would be very helpful.

6.4 Suggestions for further studies

a) This study was done in an urban set up; it is recommended that another study be conducted in rural secondary schools in the same region for comparison.

b) Use of a larger population to establish the impact of SRE on academic performance of the students and determinants of their health seeking behaviour.

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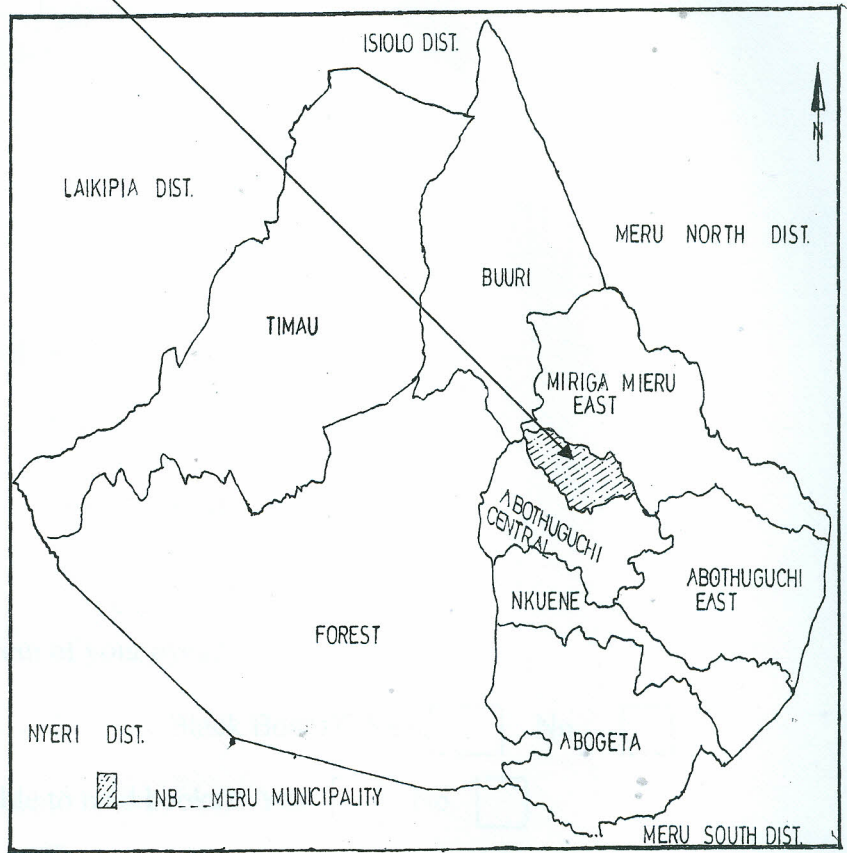
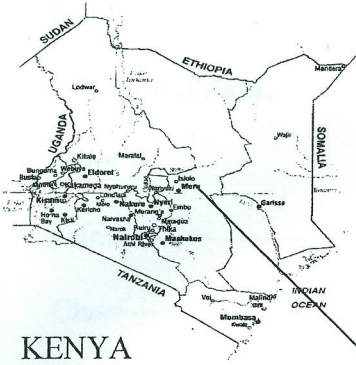
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APPENDIX I: LOCATION OF THE STUDY AREA



MERU CENTRAL

APPENDIX II: STUDENTS QUESTIONNAIRE

Date: _____

1 Personal data:

Mark ✓

Name -----

Class-----

Sex Male

 Female

Age in years

Date of birth-----

2. History of the problem.

i) Are you aware of any eye problem?

Yes No

ii) What is the problem of your eyes?

a) Distant vision (unable to see Black Board)? Yes No

b) Near vision (unable to read books)? Yes No

c) Headache Yes No

d) Fatigue Yes No

Any other? State

3. Family history

i) Does any family member wear spectacles?

Father Mother Brother Sister

Grandfather Grandmother Uncle Auntie

4. Treatment history

i) Have you ever visited a hospital due to eye problem?

Yes No

ii) What category of hospital did you visit?

Government Private

iii). Was it explained to you that your problem needed spectacles?

Yes No

iv). If yes above did you buy the spectacles?

Yes No

v). If you did not buy the spectacles, what was the reason?

vi) My parent could not afford them. Yes No

vii) Don't like the glasses? Yes No

viii) Thought the problem is not serious? Yes No

ix). Do you wear your spectacles always as was explained to you, by the

Optician? Yes No

x). If no, why?

xi) Lost them? Yes No

xii) Discomfort? Yes No

xiii) Spectacles broken? Yes No

5. Eye Examinations

i. Visual acuity	Right eye	Left eye	P.H (pinhole)
	6/	6/	Re 6/ Le 6/
With glasses	6/	6/	
Without glasses	6/	6/	

ii. Objective refraction

Retinoscopy Re -----	Le-----
Best corrected Re-----	Le-----
Best Vision Re 6/	Le 6/

iii. General examination

	Right eye	Left eye
Lids	-----	-----
Conjunctiva	-----	-----
Cornea	-----	-----
Iris	-----	-----
Lens	-----	-----
Fundus	-----	-----

