

**SIGNIFICANT REFRACTIVE ERRORS AS SEEN IN
STANDARD EIGHT PUPILS ATTENDING PUBLIC
SCHOOLS IN LANGATA DIVISION,
NAIROBI, KENYA**

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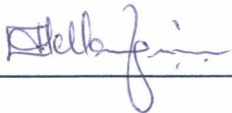
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**A DISSERTATION SUBMITTED AS PART FULFILMENT FOR THE
DEGREE OF MASTERS OF MEDICINE (OPHTHALMOLOGY),
UNIVERSITY OF NAIROBI.**

DECLARATION

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

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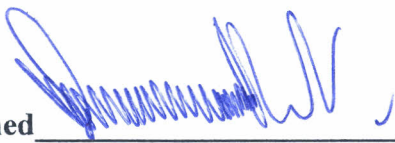
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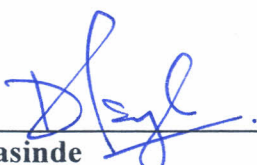
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DEDICATION

With love and gratitude to my family.

LIST OF ABBREVIATIONS

1.	KNH	-	Kenyatta National Hospital
2.	DS	-	Diopter Spheres
3.	DALY	-	Disability Adjusted Life Years
4.	KCPE	-	Kenya Certificate Primary Education
5.	PMMA	-	Polymethyl Methacrylate
6.	HEMA	-	Hydroxyethyl Methacrylate Molecule
7.	LASIK	-	Laser in situ Keratomileusis
8.	PRK	-	Photorefractive keratectomy
9.	RE	-	Right Eye
10.	LE	-	Left Eye
11.	VA	-	Visual Acuity
12.	CC	-	With correction
13.	SC	-	Without correction
14.	FH	-	Family History
15.	PH	-	Pin Hole
16.	SR	-	Subjective Refraction
17.	OR	-	Objective Refraction
18.	SPSS	-	Statistical Package of Social Sciences

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5. ABSTRACT:

A cross sectional community based study of significant refractive errors as seen in standard eight pupils attending public schools in Langata Division, Nairobi Province, Kenya. The objectives of the study were to determine the prevalence of significant refractive errors, the proportions of different types of refractive errors and estimate the proportions of uncorrected significant refractive errors in the study population.

Method: All the children attending public schools in standard eight in Langata Division who were present during the survey were included. Those absent were excluded. The class register was used to estimate the population size. All standard eight pupils in the selected schools were examined. Data was collected on examination sheet that had been prepared (see appendix A). This was stored in a floppy diskette and analyzed later using SPSS.

A case was defined as a pupil with significant refractive error. All students with visual acuity worse than 6/12 who were not improving to a visual acuity of 6/6, cycloplegic refraction was done. Refractive error was determined by taking visual acuity using the Snellens chart.

Results: The total number of students examined was 1253. There were 611 males and 642 females. The population mean age was 14.5 (range 11.9-17.9) years and population median was 14.4 years. The population standard deviation was 0.90 years. The prevalence of significant myopia was 10.2% (128 out of 1253), hypermetropia 0.3% (4/1253) and astigmatism 0.5% (6/1253) students.

Conclusion: Significant refractive errors were found among primary school children aged 11 to 17 years at a prevalence of 10.2%(128/1253).The prevalence of myopia was 9.4% (118/1253) , hypermetropia 0.3% (4/1253) and astigmatism 0.5% (6/1253).

6. INTRODUCTION:

Refractive errors have been recognized in several studies as a common cause of visual impairment. This problem therefore demands special attention and justifies its inclusion in the vision 2020 programme, since it is easily treatable. It is more common in children, hence more important in terms of (DALY) Disability Adjusted Life Years. Refraction is the method of evaluating the optical state of the eye and refractive errors are the anomalies of the optical state.

The precise refractive error an eye demonstrates is denoted by its type and degree. The degree is derived from the strength of the lens required to alter the vergence parallel rays so that the eye focuses on the retina. In myopia a concave lens is required and this makes incident parallel light divergent to the appropriate degree. Conversely in hypermetropia, a lens is needed which gives convergence to incident parallel rays¹. The strength of the lens required is that of the dioptric value of the far point distance. For a myopic condition the far point is a short distance in front of the eye, where as in the case of hypermetropia a theoretical far point exists behind the eye.

Knowledge about the prevalence of refractive errors is desirable for planning, monitoring and evaluation of eye care services. Reviews of vision at schools and parental observation of visual reduction may prompt an examination of the optical state of the eyes.

7. HISTORY:

Steiger who first studied refractive errors scientifically by determining the incidence of the spherical refraction in large numbers of people concluded that hypermetropia, emmetropia and myopia were not separate entities. These refractive errors formed a single series around a common mean such as occurs in the case of many physiological variations in any large group of people with reference to any characteristic such as height and so on. Later research has shown this is not so. Refraction can not be considered as a whole but the various components elements which combine to determine the optical system of the eye¹.

In hypermetropia the possibility of such a condition was first suggested by a mathematician Kastner in 1755. A century later, Donder an ophthalmologist suggested the term hypermetropia in 1855 which means in excess¹The term myopia was introduced from the habit which short sighted people frequently have of half closing the lids when looking at distant objects so that they gain the advantage of a stenopoeic opening¹. Sir, Isaac Newton who himself appears to have been astigmatic, first considered the question of astigmatism in 1727. The Cambridge astronomer, Airy in 1827 was the first to correct the defect by a cylindrical lens. Donders in 1864 impressed the ophthalmological world with the prevalence and importance of this anomaly.¹

8. LITERATURE REVIEW:

Several studies on the prevalence of refractive errors have been conducted in various countries. A study conducted in New Delhi by Murthy, G.V.S et al on prevalence of refractive errors and related visual impairment in school aged children revealed that refractive errors were the cause of visual impairment in 81.7%, amblyopia 4.4% retinal disorder 4.7% others 3.3% and unexplained causes in the remaining 5.9%². A study conducted by Zhao, J. et al on refractive errors in children in China confirmed that prevalence of refractive error was 89.5%, amblyopia 5% and other cause 1.5%; unexplained 4%³. Refractive error study in children from Chile conducted by Maul, E., to assess the prevalence of refractive errors and vision impairment in school aged children in a sub-urban area showed that refractive error was the cause in 56.3% of the 1285 eyes with reduced vision, amblyopia 6.5%; other causes 4.3% and unexplained causes in the remaining 32.9%. Myopia of -0.50 DS or less in either eye was present in 3.4% of 5 year old children increasing to 19.4% in males and 14.7% in females by 15 years⁴. Study done in Nepal conducted by Pothered, G., et al to assess the prevalence of refractive error and related visual impairment in school aged children in the Terai area of the Mechi zone in Eastern Nepal, showed that, refractive error was the cause in 56% of the 2000 eyes with reduced uncorrected vision, amblyopia 9%, other causes in 19% the remaining 16% had unexplained causes⁵.

In a study conducted in United States by Dandona, R., Dandona, L., on refractive error in children designed to assess the prevalence of refractive errors and vision impairment revealed that the prevalence of refractive error can be estimated with reasonable accuracy in the target populations. Myopia of -0.50DS or less in either eye or hyperopia + 2.00DS or greater was observed in less than 3% of the pupils⁶

Refractive errors in an urban population in southern India conducted by Yang ,S., to assess the prevalence distribution and demographic associations of refractive errors in an urban population revealed that in less than 15 years of age prevalence of myopia was 44.4%, *10 – 15 years of age hyperopia 59.37% and astigmatism 6.93%. In subjects less than 15 years of age prevalence of myopia was 19.39% hyperopia 9.83% and astigmatism 12.94%* ⁷. A study done in China on refractive error and amblyopia in children showed that the incidence and degree of hyperopia decreased gradually and those of myopia increased along with the growing up of children ⁷.

A survey to determine the magnitude and aetiology of visual and ocular handicaps amongst standard one primary school children in Nairobi done by Musa W. in 1998, 330 children out of 3206 had reduced vision which accounted for 10% in the study. Visual acuity of 16 of the children i.e. 4.8% of the 330 children examined, the reduced vision improved with pin hole test indicating refractive error.⁸ In Botswana, a survey of children in schools and in the community showed that 1.5% of children aged 5 to 15 years had a VA of less than 6/18 in the better eye. 78% of the children had a refractive error of less than ± 2.00 DS (spherical equivalent).¹²

The prevalence and distribution of corrective lenses among school age children conducted by Kemper A. R. found that among children 6 –18 years of age an estimated 25.4 % of the 52.6million children had corrective lenses. Girls were more corrected than boy's .¹⁴ Epidemiology of refractive disorders as seen in study conducted by Coroi M. on prevalence and incidence of refractive errors among children 7-11 years old showed that hypermetropia was 89.8%, myopia was 1.4%, astigmatism was 4.9% and anisometropia was 4%. Myopia and emmetropia were more common in the group of children of 16years.¹⁵

A survey on the prevalence of refractive errors among children in lower primary school in Kampala district conducted by Kawuma, M., Makeyu found that seventy three children had significant refractive error of ± 0.50 DS or worse in one or both eyes. The prevalence of refractive error was 11.6% out of which astigmatism was 52% with few cases of hypermetropia and myopia.¹⁶ Prevalence of myopia among 12 – 13 year old school children in Northern Mexico conducted by Villarreal G. M. found a prevalence of myopia of (≥ -0.5 DS) of 44%. High myopia was 1.4%. The prevalence of myopia was significantly higher in girls. Only 20% of children with bilateral myopia used prescription glasses; 8% had prescribed glasses but did not use them. Hyperopia was present in 6% and astigmatism in 9.5%.¹⁷

Myopia in secondary schools in Mwanza city, Tanzania conducted by Wedner S.H. found that 6.4% students had significant refractive errors; myopia was 5.6%, amblyopia 0.4% and strabismus 0.2%. Only 30.3% of students with significant refractive errors wore spectacles before the survey.¹⁸ A mystery of myopia study conducted by Goldschmidt E. found that myopia is rare before school age and gradually increases during school life¹⁹. Parental myopia, near work, school achievement and children refractive error study conducted by Mutti D. O., found that children with myopia were more likely to have parents with myopia.²⁰

Occurrence of myopia among Polish students aged 6 to 18 years old conducted by Czepita D., found that 15% of students aged 6 to 18 years suffer from myopia. A major increase in the frequency of myopia occurrence among students over the age of 14 years was found. There was no significant difference between prevalence of myopia among boys and girls.²¹ Refractive error and visual impairment study in African children in South

Africa study conducted by Naidoo K.S., found that refractive error was the main cause of poor vision and myopia was present in 2.9%. There was an upward trend at 14 years of age and the prevalence reached 9.6 % at 15 years. Hypermetropia was present in 1.8% of the children examined.²² The progression of refractive error in school age children in Shunyi district China conducted by Zhao J. found an increased incidence in six fold to seventh fold between 5 and 12 years, before decreasing at 13 years of age.²³

A study conducted by Junghans B.M. on prevalence of myopia among primary school children in eastern Sydney found that there was no significant difference between boys and girl's .There was a significant shift towards increasing myopia with age.²⁴ Epidemiology study of refractive errors in school children in Tunisia found that 57.2% of the children examined had refractive errors, of which 31.6% were hyperopic and 9.1%were myopic astigmatism was in 16.4%.The prevalence of myopia was significantly higher after the age of fourteen. There was no significant difference regarding sex.²⁶ A study on interactions of genes and environment in myopia conducted by Feldkamper, M., and Schaeffel F., found that myopia is inherited since myopic parents are more likely to have myopic children.²⁷

VARIATIONS OF REFRACTIVE STATE:

When parallel rays strike a physiologically normal eye, they are refracted so as to converge upon the retina where they focus forming a circle of least confusion. When this ideal optical condition occurs with the eye in a state of rest, the condition is termed emmetropia. This depends on exactitude to within a fraction of a millimeter of such measurement as the length of the eye, the shape of the cornea and the lens. Optical perfection demands mathematical accuracy nowhere realized in the constitution of living organism¹. When parallel rays of light are not focused exactly upon the retina with the eye in a state of rest, such an eye is said to have a refractive error and this condition is referred to as ametropia.

Routine measurement of vision tests patient ability to recognize progressively smaller letters or forms referred to as optotypes. The angle that the smallest recognizable letter or optotypes subtends on the retina is a measure of visual acuity. For clinical measurement of static visual acuity the snellen acuity is generally equated to visual acuity¹⁰. Defective vision may occur in subjects known to have refractive errors who may already be using optical correction. A spectacle correction may be indeed inadequate; it may be wrong giving rise to poor vision on its own account.

The relative distribution of refractive errors is nearly the same at all ages with the mean of +0.25 of hypermetropia. There is a slight shift of the whole curve towards hypermetropia until seven years. The refractive state starts shifting towards myopia until puberty then slowly towards myopia by the time maturity is reached. The refractive problem of the eye are determined more by genetic than by environmental factors¹⁰.

9.1 DESCRIPTION OF REFRACTIVE ERROR:

There are 3 main types of refractive errors:

- 1) Myopia
- 2) Hypermetropia
- 3) Astigmatism

By description a principal focus may be formed by the optical system of the eye, but instead of being situated on the retina, it may be situated either behind it or in front of it. In the first case, the axial length of the eye is relatively too short, and the condition is called hypermetropia, while in the second case the axial length of the eye is relatively too long, and this is termed myopia. When no single focus is formed, the refractive error is termed astigmatism.

9.1.1. HYPERMETROPIA:

It is the commonest of all refractive anomalies. It is a stage in normal development. At birth most eyes have hypermetropia to the extent of +2.50 to 3.00 DS. In 50% of population, emmetropia is not reached and some degree of hypermetropia persists¹. The formation of a clear image is impossible unless the converging power of the optical system is increased. This may be done in two ways i.e. accommodation and artificial means by using a convex lens¹. Under the normal age of variation 90% of children at 5 years and 50% of children at the age of sixteen have hypermetropia.¹ The hyperopic eye uses a portion of its available accommodation in order to overcome the weakness of its dioptric system so that incoming rays of light will be focused on the retina.

The dioptric system does not possess sufficient converging power for the axial length of the eye. Therefore, image of an infinite object would be located behind the retina¹. Hypermetropia is physiological in children and represents an imperfectly developed eye which persists into adult life¹. Most children are born about +3.00DS hyperopic usually resolving by 12 years.¹³

9.1.2. MYOPIA :

Aetiology of pathological myopia is obscure. The changes in the fundus are due to a genetic developmental defect which affects the posterior segment of the eye. It is probable that the primary fault is usually an aberration of development. Simple myopia is a physiologic variant of the normal.¹⁰ Different subtypes of myopia have been identified. Physiological myopia (school myopia) is associated with normal growth of each of the refractive components of the eye. Pathological (malignant myopia) is caused by excessive growth in axial length while other component of the eye exhibit normal growth.¹⁰ Juvenile onset myopia has an onset between 7 to 16 years of age. Myopia progression of 1DS or more has been reported in 15 % to 25 % of children 7 to 13 years of age. The largest increase in prevalence of myopia in girls is at 9 to 10 years while in boys is 11 to 12 years. Myopia starting after 16 years is less severe and less common. For most individuals myopia progression stops in the middle teen years at about 15 years for girls and about 16 years for boys. Most teenagers stabilize their refractive errors.¹⁰ The dioptric system possesses too much convergence power for a given axial length. If a point on the retina is considered as the object the image of that point will be

somewhere in front of the eye but closer than infinity, by definition the far point of the eye.

Simple myopia is a physiological variant of the normal. It is a condition of limited progress. Progressive myopia is usually due to a genetic defect which affects the whole posterior segment of the eye¹. As changes of refractive state takes natural courses, decrease in hypermetropia is the usual condition and many cases end up in simple myopia. The error can progress rapidly in early youth and in these progressive causes the most rapid period is usually from fifteen to twenty years¹⁰

9.1.3. ASTIGMATISM:

In this form of refractive errors, the refracting power of the lens is not the same in all meridians. The curvature of the cornea or the lens may vary in different meridians thereby producing astigmatism. The refractory power is not the same for all meridians. Astigmatism may either be error of curvature; centring or refractive index¹Curvature astigmatism is frequent in the cornea. The vertical curve is greater than the horizontal and this is physiological. Curvature astigmatism of the lens also occurs causing a certain amount of decentring. Index myopia occurs physiologically in the lens.¹

9.2 AETIOLOGY OF REFRACTIVE ERRORS:

Refractive anomalies can be caused by various conditions:

9.2.1. Position

9.2.1.1. Axial hypermetropia:

This form of hypermetropia, the antero-posterior diameter of the eye is too short and the retina is near the optical system.

9.2.1.2. Axial myopia:

In this form of myopia, the antero-postero diameter of the eye is too long and the retina is too far away from the optical system.

9.2.1.3. Lenticular displacement:

The displacement of the crystalline lens determines the refractive state of the eye. If dislocated forwards, myopia will exist if backwards hypermetropia occurs.

9.2.2. Refractive surface:

9.2.2.1. Curvature hypermetropia:

The curvature of the cornea or the lens may be too small. An increase of 1mm in radius of curvature produces hypermetropia of 6D. In curvature myopia, the curvature of the cornea or the lens may be too great.

9.2.2.2. Astigmatism:

This is a situation where irregular refractive surfaces vary in different meridians.

9.2.3. Obliquity

9.2.3.1. Lenticular Obliquity

This occurs when the lens is obliquely placed or subluxated. Astigmatism is present.

9.2.3.2. Retinal Obliquity

The posterior pole of the eye may be placed obliquely as in staphyloma in high myopia thus producing astigmatism.

9.2.4. The media

9.2.4.1. Index hypermetropia:

Refractive index of the aqueous humor may be too low or that of vitreous humour too high, or refractive index of the lens as a whole too low.

9.2.4.2. Index myopia:

Refractive index of aqueous humour is too high and vitreous too low or if refractive index of the lens as a whole is too high.

9.2.5. Lens Absence.

Aphakia is absence of the lens from the pupillary axis and produces hypermetropia¹.

CONSEQUENCES OF REFRACTIVE ERRORS:

10.1. Loss of Visual Acuity

Visual acuity is determined by the smallest retinal Image the form of which can be appreciated¹.

10.2. Anisometropic Amblyopia

This type of amblyopia is caused by a difference in refractive error as little as 1.0 D sphere between the two eyes¹⁰.

10.3. Isoametropic Amblyopia

This is caused by a bilateral decrease in visual acuity that results from large approximately equal uncorrected refractive errors in both eyes of a young child¹¹.

10.4 Alternating Viewing

The relatively more myopia eye is used for near and the other for distance viewing.

10.5 Meridional Amblyopia

Meridional amblyopia commonly occurs in high cylinders.

10.6 Myopic Maculopathy

These are degenerative changes in the retina and choroid occurring due to progressive elongation of the globe. The effects of degenerative myopia occurs during young adulthood.⁹

CORRECTION OF REFRACTIVE ERRORS:

11.1. Correction with spectacle lenses

11.1.1. The myopic eye:

When correcting myopia, low degree of myopia up to -6.00DS can be given optical correction. High myopes should be given lenses with best visual acuity without distress. In young subjects the defect should never be over corrected, they should be ordered full correction and advised on constant use to stimulate accommodation.

For high myopia a full correction may not be tolerated. Such subjects are prescribed the lens with which the greatest visual acuity is obtained without distress. Most pronounced cases especially those with pathological changes in the fundus, such patients may be helped by low visual aids.

11.1.2. Astigmatism:

It is a rule to attempt to correct the cylindrical defect fully since young subjects accept the full astigmatic correction to avoid amblyopia¹. Provided the astigmatism is not giving rise to symptoms of asthenopia and eye strain the smaller astigmatic errors do not require correction. Cylindrical lenses are used to correct astigmatism.

11.1.3. Hypermetropia:

In children less than 6 years some hypermetropia is physiological and correction needs to be given only if the error is high, strabismus is present or visual acuity is reduced. In children between 6 and 16 years working strenuously at school, small errors may require correction. Refraction should be conducted under cycloplegia¹.

11.2 Contact Lenses:

Contact lenses are mainly used for the correction of refractive errors. There are two types of contact lenses:

- ❖ Rigid
- ❖ Soft

11.2.1. Rigid Corneal contact lenses:

These are constructed of polymethyl methacrylate (PMMA), and essentially do not absorb water. Semi soft rigid contact lenses are gas permeable. They can correct corneal astigmatism by several dioptries. .

11.2.2. Soft Contact Lenses:

Soft contact lenses have increased hydration. They are made of 2 Hydroxyethyl Methacrylate Molecule (HEMA) which is hydrophilic. A soft contact lens, molds itself to the shape of the cornea, thus corneal astigmatism is reflected by the creation of a toroidal anterior lens surface which produces a residual astigmatic error.¹¹

11.3. Intraocular Lens:

This is an alternative in management of aphakia. Aphakia is the absence of the crystalline lens from the pupillary area.

11.4. Refractive surgery:

11.4.1. Radial Keratotomy:

This form of correction decreases myopia by flattening the cornea through a series of deep radial incisions¹⁴.

11.4.2. Laser in situ keratomileusis (Lasik)

This can correct myopia up to minus 16.00 DS¹⁴.

11.4.3. Excimer Laser photorefractive keratectomy

Photorefractive keratectomy (PRK) with the excimer laser involves the reshaping of the anterior cornea for correction of refractive errors. It is indicated in myopia up - 6.00DS with astigmatism up 3.00 DC and hypermetropia up to plus 2.50 DS¹².

11.5 Drugs

It has been suggested that topical use of atropine may prevent the progression of myopia. By placing the ciliary muscle at rest, accommodation is relaxed and the tension that produces elongation of the eye may be reduced.²⁵

RATIONALE:

Data is lacking on the prevalence of significant refractive errors in children attending public primary schools in Kenya. We do not know the proportions of different types of significant refractive errors in the study population. This could be a serious health problem and the results of this study could possibly encourage appropriate screening of patients with refractive errors. Uncorrected refractive errors are an important cause of visual impairment in many countries. The magnitude of visual and ocular problems amongst standard one school children was determined by Musa W⁹. Pre school children aged between three and five years were also examined by Onsomu M.¹² Normally, children will not complain of visual impairment unless severe and bilateral. Quite often, unilateral visual impairment is totally ignored. Parents may not notice this visual impairment since it does not cause cosmetic deformity. This can be revealed through screening. Teachers however, may be instrumentive in identifying children with refractive errors. Ideally, all classes should have been examined, but the sample size would have been quite big for the limited resources available for the study. Not all children get admitted into secondary school. Refractive errors could be the main cause of poor vision in children. Majority of children with myopia will have presented by the time they are sitting for standard eight examinations. This is also important in creating awareness amongst the population.

Since refractive errors is a major cause of poor vision and the number of patients seen is large, this study may provide baseline data and help children who might otherwise proceed with school while being antagonized by curable condition like refractive error.

METHODOLOGY:

15.1. Study Population

Standard eight pupils in public schools in Langata Division, Nairobi Province, Kenya.

15.2. Study Area

Public primary schools in Langata Division, Nairobi Province. Langata division has two zones i.e. Karen and Nairobi West zones. There are fourteen public primary schools with a population of about one thousand three hundred pupils in standard eight. All students were to be examined.

15.3. Study design

Cross-sectional community based study.

15.4. Sample size

Minimum sample size required= n

$$n = \frac{t^2 PQW}{E^2} + \frac{t^2 PQW}{N}$$

n =minimum sample size required

P =assumed population prevalence

$$Q = 1 - P$$

E =maximum tolerable random sampling error

W =design effect

N =population size

$t=1.96$, to give 95% probability of not exceeding E

(table value for standard normal distribution with 95% confidence)

$$n = ?$$

$$P = 50\%$$

$$Q = 1 - 50/100$$

$$W=1.5$$

$$E=5\%$$

$$N=16 \times 80 \times 15$$

$$n = \frac{1.96 \times 1.96 \times 50 \times 1^{-50/100} \times 1.5}{16 \times 80 \times 15}$$

$$= \frac{3.84 \times 50 \times 50 \times 1.5}{25 + 3.84 \times 50 \times 50 \times 1.5}$$

$$\approx 600$$

Therefore minimum number of students required ≈ 600

15.5. Sampling method

All the standard eight pupils in Langata Division public primary schools were examined.

15.6. Inclusion Criteria

All pupils attending standard eight in Langata Division public primary schools, who were present during the survey.

15.7. Exclusion Criteria

Children who were absent on those days.

15.8. Data Collection

Data was collected on examination sheet that had been prepared. (appendix A). This data was stored in a floppy diskette and analyzed later using statistical package for social sciences (SPSS). Where appropriate, statistical comparison was done.

15.9. Case definition

A case was defined as a standard eight pupil with significant refractive error. The children with difficult refraction and any other ocular or adnexal disease were referred to KNH (appendix B).

15.10. Materials

1. Examination sheet. (appendix A).
2. Stationery pen, rubber, pencils
3. Torch with batteries and spare bulbs
4. Snellens Chart
5. Direct Ophthalmoscope,
6. Retinoscope
7. Cyclopentolate
8. Refraction set and trial frame
9. Vehicle/Transport
10. A curtain for darkening the room.

15.11. Procedure:

Permission was obtained from the school head teacher before students were recruited in the study. Demographic data was taken (name, age, sex, and serial number). History of correction with spectacles was also taken. The refractive error was detected by taking the visual acuity. The normal working visual acuity of the subject was recorded at six meters by using a snellens chart. For subjects who wore spectacles, visual acuity was taken without correction and with correction too. All the students with visual acuity worse than 6/12 without spectacle were included in the study. Pupils with visual acuity worse than

6/12 whose vision did not improve on subjective refraction, cycloplegic refraction were done. The type of refractive error was grouped after refraction in to either: hypermetropia, myopia or astigmatism. The pupils with difficult refraction or other ocular conditions were referred to KNH.

ETHICAL CONSIDERATIONS:

1. Confidentiality of pupil's records was observed by maintaining two separate registers .One register contained names against serialized numbers and the other the serialized numbers against clinical findings. I used the second register for analysis while the first was for reference.
2. Correction with recommended follow up advised for all study subjects found to have refractive error.
3. Non invasive examination was carried out on the children. Any medication used during the refraction was given with the parents consent.
4. The investigations to be carried out were those done routinely on patients. For those referred to KNH, most investigations carried out where those done routinely on patients with refractive errors and this posed no extra risk to the study subjects. The side effects of the medications used were clearly explained to the parents and guardians.
5. Consent from the Office of the President and the Ministry of Education.
6. Subjects found to have other ocular diseases or disorders were treated or referred where appropriately.(appendix B)

17. **STUDY POPULATION:**

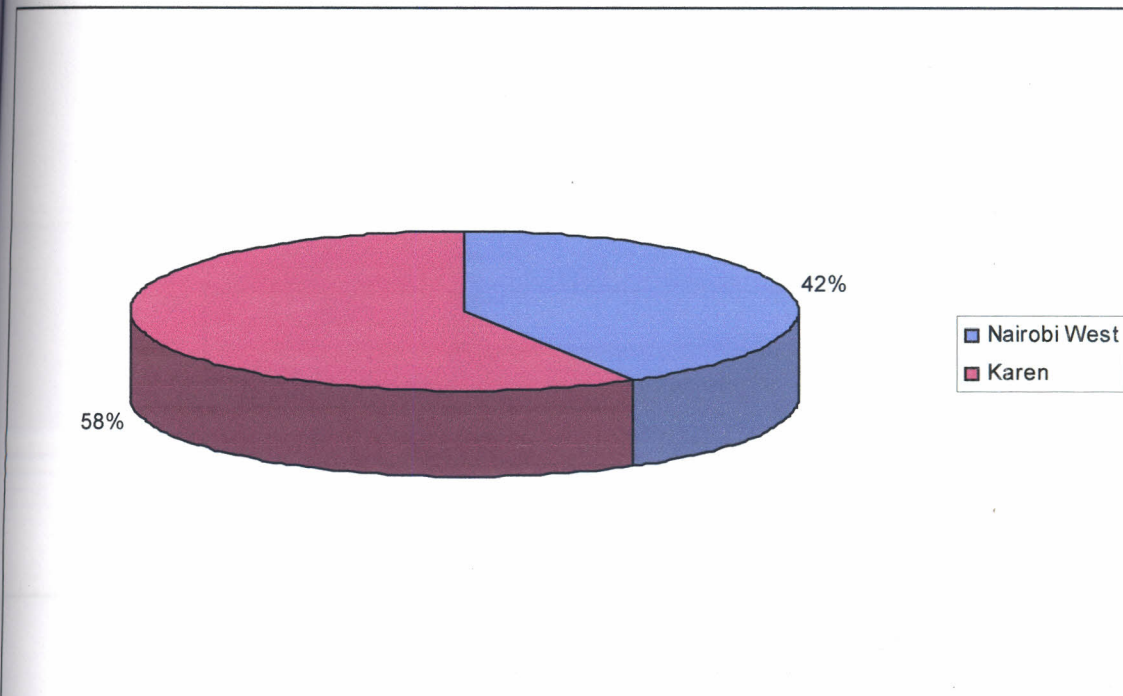
Table 1:

Distribution of standard eight pupils by zone:

Zone	No. of students	Percentage
Nairobi West	530	42
Karen	723	58
Total (Langata Division)	1253	100

Figure. 1

Distribution of standard eight pupils by zone



Karen zone had more students. 1253 students were examined.

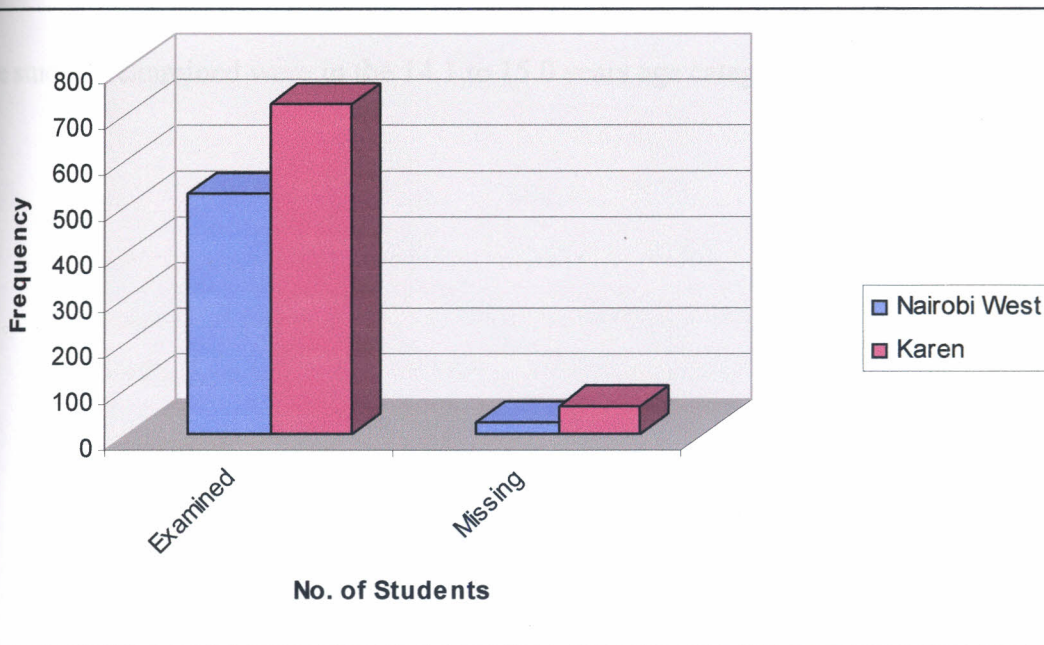
Table 2:

Study Participation Rate:

Area	Examined	Missing	Total
Nairobi West	530	27	557
Karen	723	60	783
Total (Langata Division)	1253	87	1340
Percentage examined	93.5	6.5	100

Figure 2:

Study Participation Rate:



The overall study participation rate was 93.5%, this was statistically satisfactory.

Table 3:

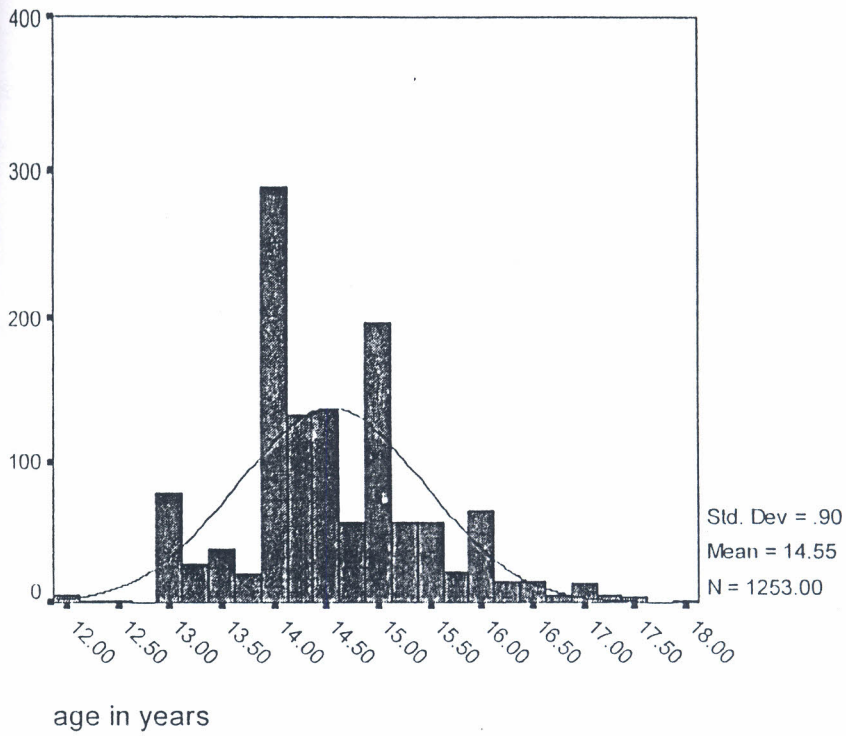
Age distribution of study population

Age in years	No. of students	%
≤ 12	21	1.7
12.1-13.0	55	4.3
13.1-14.0	331	26.4
14.1-15.0	552	44.1
15.1-16.0	231	18.4
16.1-17.0	47	3.8
≥ 17	16	1.3
Total	1253	100

Most of the students examined were in the 14.1 to 15.0 years age category

Fig. 3:

Distribution by study population



population range was 11.9 to 17.9 years with a population mean of 14.55 years and population standard deviation of 14.4 years. The standard deviation was 0.90 years

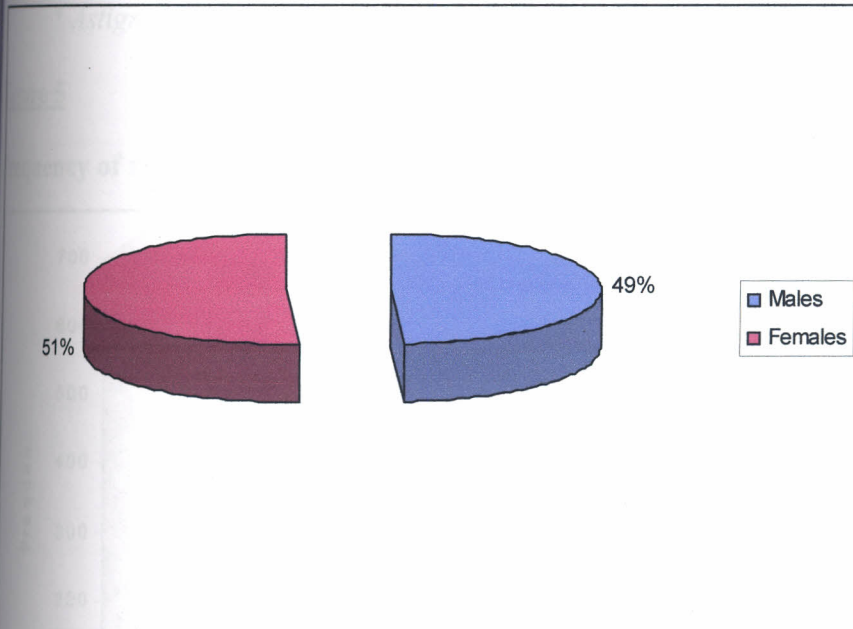
Table 4

Distribution of the study population by sex:

Sex	Frequency	Percentage
Males	611	49
Females	642	51
Total	1253	100

Figure 4

Distribution of the study population by sex:



More female students were examined 51% (642/1253) compared to male students 49% (611/1253).

17.2 REFRACTIVE STATUS

Table 5

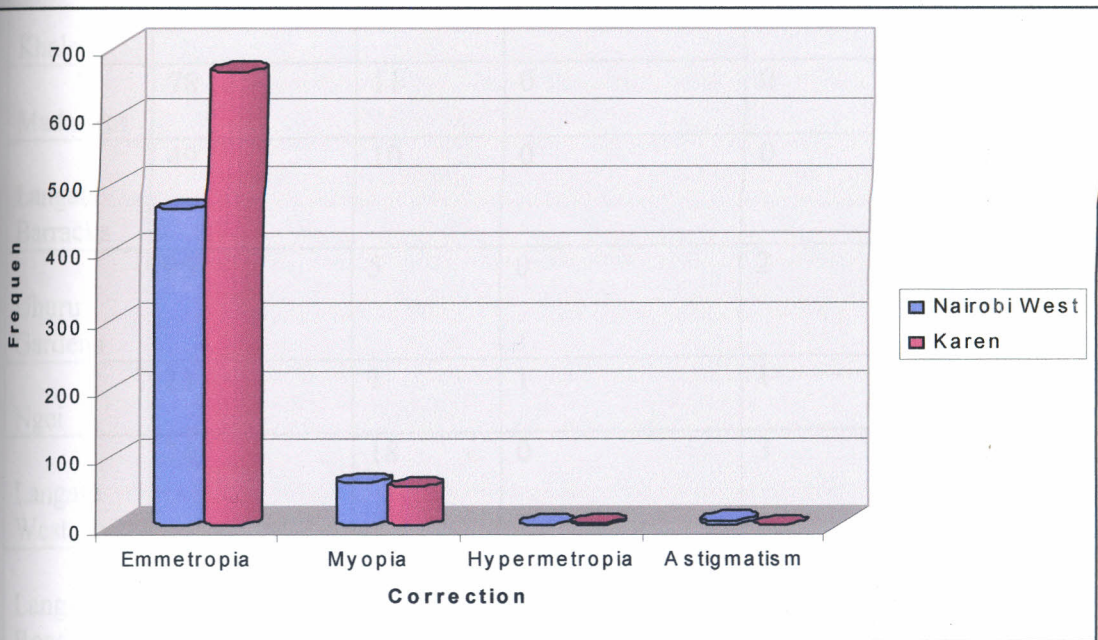
Refractive status of study population by zone:

Refractive state	Nairobi West		Karen	
	No.	%	No.	%
Emmetropia	461	87	664	92
Myopia	62	12	56	7.7
Hypermetropia	1	0.2	3	0.4
Astigmatism *	6	1.1	0	0
Total	530	100	723	100

* Astigmatism included both myopic and hypermetropic astigmatism

Figure 5

Frequency of refractive errors in study population by zone:



Myopia was the most frequent refractive error. The highest proportion was from Nairobi West 12 (62/530). This was statistically significant, (P=0.006).

Frequency of refractive errors in study population by schools:

School	Emmetropia	Myopia	Hypermetropia	Astigmatism	Total
Ngong Forest	75	6	1	0	82
Karen C	117	13	0	0	130
St Mary's	80	6	1	0	87
Ayany	122	2	0	0	124
Olympic	141	19	1	0	161
Kibera	129	10	0	0	139
Kongoni	58	8	0	0	66
Khalsa	40	6	0	0	46
Madaraka	78	11	0	0	89
Langata Barracks	49	10	0	0	59
Uhuru Gardens	95	5	0	2	102
Ngei	23	1	1	1	26
Langata West	74	18	0	3	95
Langata Road	44	3	0	0	47
Total	1125	118	4	6	1253

Olympic had the most number of myopic cases (19) with a student population of 161. Ayany with a student population of 124 had 2 cases of myopia. Ngei with 26 students had one case of myopia.

MYOPIA

Table 7

Distribution of myopia by age

Age in years	Number of children with significant myopia
12.1	1
13.0	8
13.1	2
13.2	4
13.3	2
13.4	1
13.5	2
13.6	3
13.7	2
13.8	1
13.9	7
14.0	17
14.1	6
14.2	5
14.3	6
14.4	8
14.5	2
14.6	7
14.7	5
14.8	3
14.9	8
15.0	4
15.1	1
15.2	3
15.3	1
15.5	1
15.8	4
15.9	4
16.4	1
16.9	1
17.2	1
Total	118

118 students had myopia .

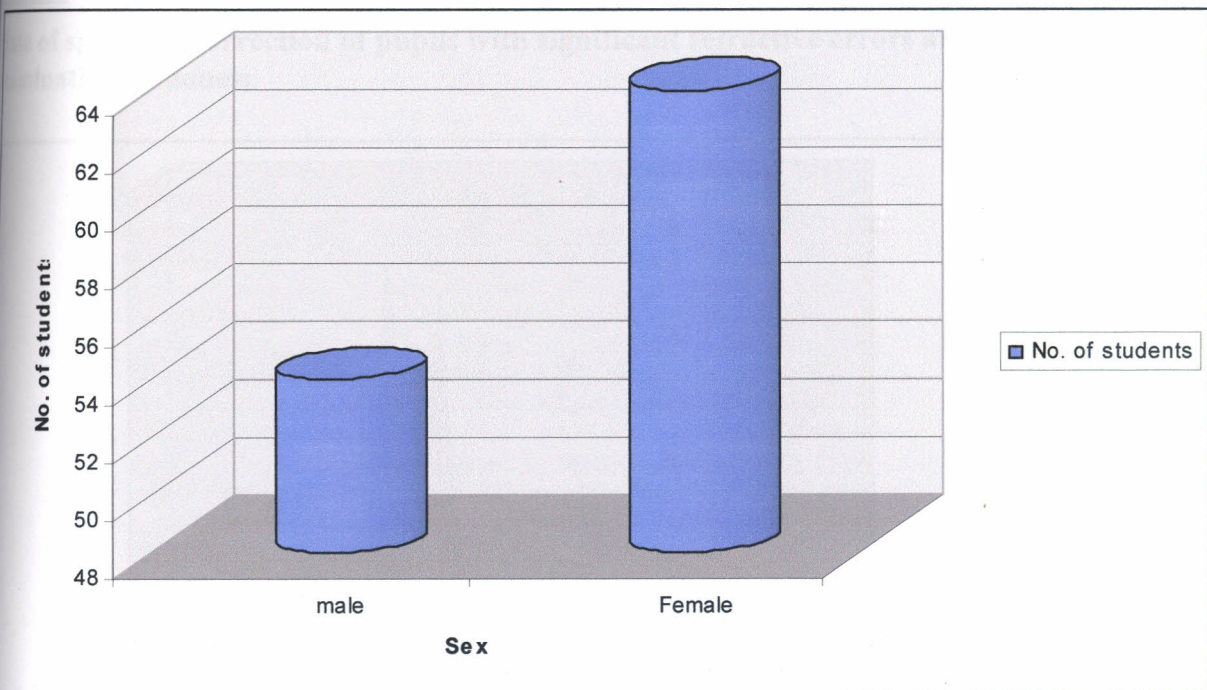
Table 8:

Distribution of myopia by sex

Sex	Number of students	Percentage
male	54	46%
Female	64	54%
Total	118	100%

Figure 6

Distribution of myopia by sex



There were more female students with myopia 54% (64/118 students).

Myopia in girls was 10% (64/642) while boys were 9% (54/611). There was no significant difference.

7.3 SPECTACLE CORRECTION:

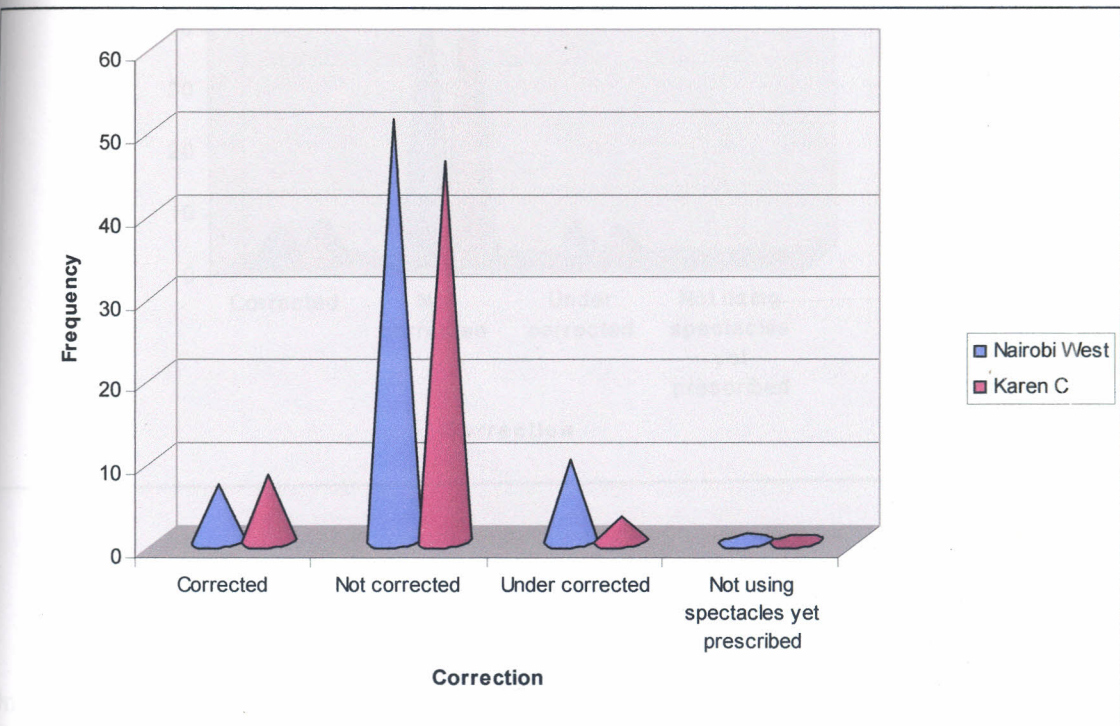
Table 9: n= 128

State of spectacle correction of pupils with significant refractive errors at time of examination by zones:

Spectacle Correction	ZONE		Total
	Nairobi West (%)	Karen (%)	
Fully corrected	7 (10%)	8 (13.8%)	15 (11.7%)
Not corrected	52 (7.4%)	47 (81.0%)	99 (77.3%)
Under corrected	10 (14%)	3 (5.2%)	13 (10.2%)
Not using spectacles	1 (1.4%)	0 (0%)	1 (0.8%)
Total	70 (54.7%)	58 (45.3%)	128 (100%)

Figure 7

State of spectacle correction of pupils with significant refractive errors at time of examination by zones:



greater number of students with refractive errors were not corrected at the time of examination.

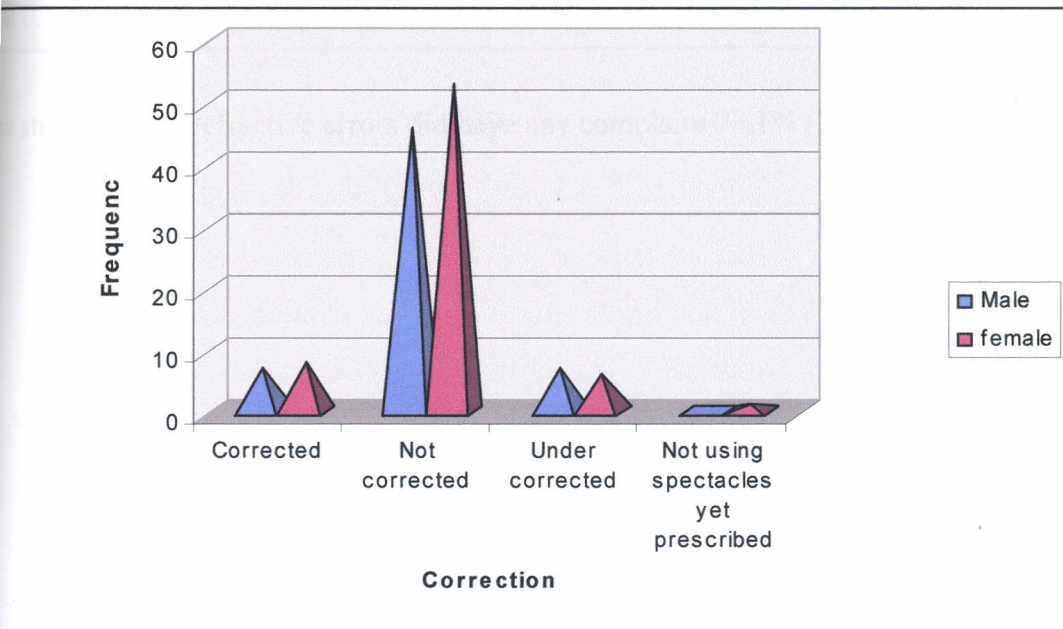
Table 10:

Rate of spectacle correction at examination by sex:

Correction	Male	%	female	%	Total	%
fully corrected	7	46.7	8	53.3	15	12
not corrected	46	76.7	53	77.9	99	77
under corrected	7	53.8	6	46.2	13	10
not using spectacles yet prescribed	0	0	1	1.5	1	1
Total	60	46.9	68	53.1	128	100

Fig. 8

Rate of spectacle correction at examination by sex:



only 12% (15/128) of students with significant refractive errors were fully corrected.

REASONS FOR NOT USING SPECTACLES

n=104

Reasons for not wearing full spectacle correction

Reason	Male	%	Female	%	Total	%
Not aware of problem	38	84.4	38	64.4	76	73.1
They did not need spectacles	2	4.5	2	3.4	4	3.8
Cannot afford	1	2.2	6	10.2	7	6.7
Broken/lost	1	2.2	5	8.5	6	5.8
Never examined	3	6.7	6	10.2	9	8.7
Wants spectacles	0	0	2	3.3	2	1.9
Total	45	100	59	100	104	100

Some students with refractive errors did have any complaint 73.1% (76/104).

6 FAMILY HISTORY OF SPECTACLES

Table 12

Refractive status and family history of wearing spectacles:

Family members	Presumed emmetropia	Refractive errors	Total	%
None	721	67	788	62.9
Father alone	121	15	136	10.9
Mother alone	84	11	95	7.6
Brother	87	13	100	8.0
Sister	26	5	31	2.5
Others	34	4	38	3.0
Parent & one sibling	43	10	53	4.2
>One sibling	3	1	4	0.3
All	6	2	8	0.6
Total	1125	128	1253	100

Out of the students with myopia 52% (67/118) were myopic with no family member wearing spectacle.

18.2 REFRACTIVE STATUS:

The prevalence of significant refractive errors in this study population was 10.2% (128/1253 students) with myopia at 9.4 % (118/1253), hypermetropia 0.3% (4/1253) and astigmatism 0.5%(6/1253). Many studies conducted found a high prevalence of refractive errors in childhood ^{3,4,5,8,15,16}. Kawuma study found the prevalence of refractive errors of 11.6% this compares well with the results of this study.¹⁶

18.2.1 MYOPIA:

There were 118 cases of significant myopia giving a prevalence of 9.4% (118/1253) students. Myopia in females was 10% (64/642) while in males it was 9 % (54/611). According to literature there is an increase in prevalence of myopia in girls at around 9 to 10 years of age while in boys it occurs at 11 to12 years.^{10,25}. In this study all age groups were not considered, therefore, we can not use this as inference to draw conclusion on increase of myopia. In Gold Schmidt E., study on the mystery of myopia, myopia was noted to increase during school life and this compared well with this study¹⁹. Along with age the prevalence of myopia increases^{21,22}. In Czepita study the prevalence of myopia was 15%among 6-18 year olds ²¹. In this study, the prevalence was slightly lower 10.2%. This could be because only those students with significant refractive errors were included. The prevalence of myopia was slightly higher in females than males. This compares well with Villarreal study which found a higher prevalence in girls¹⁷. Naidoo K.S. study found an upward trend at age 14 years; myopia prevalence reached 9.6% at 15 years ²². There were four students found to have myopia greater than -4.00DS. Out of these, one student had high myopia -6.00DS. This was the highest degree of myopia that was encountered. This student had been corrected and his visual acuity improved from 2/60 BE to 6/9 RE and

6/12 LE. There was one student who had been under corrected with -2.00DS, improving her vision from 4/60 to 6/36. A spectacle correction of -4.00 DS improved her visual acuity to 6/6.

18.2.2. HYPERMETROPIA:

Out of the students examined, 0.3% (4/1253 students) had significant hypermetropia. From literature the prevalence of hypermetropia is high^{1,17,22,23} In this age group, a low prevalence was found. This is because the examined age category could accommodate and attain good distant vision and as such did not have significant hypermetropia. The low prevalence can be explained by the case definition of the study, only students with significant refractive errors were included. According to Epidemiology of refractive disorders study, hypermetropia was 89.8% myopia was 1.4% and astigmatism was 4.4%. More cases of hypermetropia were found since cycloplegic refraction was done and the age group studied was 7 to 11 years¹⁵. In this study we looked at significant refractive errors and that explains why the prevalence of hypermetropia was low.

50% of the cases who had hypermetropia had surgery in childhood. These students had aphakic correction. One student had aphakic correction of +11.00DS both eyes while the other student had an aphakic correction of +12.00DS both eyes. Visual acuity for these students improved to 6/9. One student had a spectacle correction of +3.00DS with a visual acuity of 6/18. She had been on follow up at KNH Paediatric Ophthalmology Clinic. There was one student with chorioretinal scars and could barely improve with correction. Retinoscopy findings for this student were +2.00 both eyes and this improved his VA to 6/36 and 6/12 for LE and RE respectively.

18.2.3 ASTIGMATISM:

Out of the examined students 0.5 % (6/1253 students) had astigmatism. Only those students who had vision worse than 6/12 and could not see 6/6 without a cylinder were considered to have astigmatism in this study. The low prevalence in the results may be due to failure to do cycloplegic refraction in all the students. Astigmatism might also have been affected by accommodation.

Out of the students who needed astigmatic correction, the highest cylinder prescribed was -3.00DC at 26° for the right eye and -4.00DC at 168° for the left eye. This was a male student from Langata West primary school who had been under corrected with -1.00DS-1.00DC x 45° both eyes. The visual acuity for this student was 6/60 without correction. This student improved with a spectacle correction of RE -1.00 DS -4.00DC x 26° and LE -2.75 DS -3.00DC x 168° giving him a VA of 6/6 RE and 6/9 LE. He was comfortable and did not complain of distortion. The final correction for another student with astigmatism remained unknown. This student was from Uhuru Garden Primary school. He had presented with a VA of 6/60 BE. A retinoscopy finding of -2.00DS -2.00DC x 90° RE and -1.75DS -2.50DC x 90° LE did not improve his VA. He was booked for a cycloplegic refraction in KNH and a slit lamp examination but he absconded.

Ayany primary school with 9.9% (124/1253) registered students had only 1.7% (2/118) cases of myopia. Langata West primary school with 7.0% (95/1253) registered students had 15.3% (18/1253) cases of myopia. This was significant (P=0.001). In my opinion the number of registered students a school had was not in tandem with number of refractive errors (table 6). May be this can be explained by social economic status. Out of the examined students, there were 49 % (611/1253) male and 51% (642/1253) female

students. There was no significant difference observed within the females and males (P=0.145 males and P=0.120 females).

Villarrel study found the prevalence of astigmatism at 9.5%.¹⁷ In epidemiology of refractive disorders study by Coroi, M. a higher prevalence of hypermetropia was found; 89.8 % and only 1.4% had myopia while astigmatism was 4.9%. Other studies also found a higher prevalence of astigmatism.^{16,17,15,25} However, in Kawuma study, only few cases of hypermetropia were found¹⁷. These results compare well with Kawuma study which also studied significant refractive errors. In this study hypermetropia was 0.3% (4/1253), myopia 10.2% (128/1253) and astigmatism was 0.5% (6/1253). Coroi study the population range which was 7 and 11 years. Much of the myopia had not presented by that age and majority were hypermetropic¹⁵. In this study, the range was 11.9 to 17.9 years, in which case most children had manifested their myopia.

CORRECTION:

18.4.1. SPECTACLE CORRECTION

A total of 11.7 % (15/128) students had full spectacle correction (table 9). There was no significant difference between the two zones. 99 students were not fully corrected. Out of these 74.3 % (52/70) were from Nairobi West and 81% (47/58) were from Karen. Out of the 13 students who were under corrected 14.3 % (10/70)) were from Nairobi West and 5.2 % (3/58) were from Karen respectively. There is no reason to explain the difference in spectacle correction between the two zones. Only one student 1.4 % (1/70) from Nairobi West was not using spectacles yet prescribed, this student whose uncorrected visual acuity was 6/36 both eyes, had the false believe that spectacles would damage her eyes. (P=0.262. There were 11.7 % (1/128) students fully corrected. Out of these 46.7 % (7/15) and 53.5% (8/15) were males and females respectively, there was no significant difference. A total of 99 students were not corrected with a male to female ratio of 1:1. There were 13 students whose correction was not adequate. Out of these 53.8% (7/13) and 46.2 % (6/13) were males and females respectively (P =0.767). The number of students fully corrected was 12 % (15/128) 8.5% (10/118) students with uncorrected refractive error had visual acuity worse than 6/60. 35 students 29.7% (35/118) had VA=6/36. 18 students 15.3% had VA = 6/24 and 60 students 51.8% (60/118) VA= 6/18. This study found reduced visual acuity in children many of whom where not corrected (table12).

In Kemper R. study the percentage of students fully corrected was 25.4% amongst students aged 6 to 18 years.¹⁴ According to Wedner study in Tanzania, students with significant refractive errors who were fully corrected at time of examination were 30.3%¹⁸. In Villarreal study, 20% of children with bilateral myopia used spectacles while 8% had

been prescribed glasses but did not use them¹⁷. The difference in correction with spectacles in my opinion could be due to lack of awareness of refractive errors. In this study only one case 0.8% (1/128) had been prescribed for spectacles but not using.

18.4.2 CONTACT LENS CORRECTION

There was only one student wearing contact lenses. This was a male student from Khalsa Primary school. His vision was 6/36 and 6/60 for right eye and left eye respectively. He gave a positive history of ocular allergy and further examination entertained a diagnosis of keratoconus. The cyclopegic refraction was $-2.00DS -3.00DC \times 45^{\circ}$ and $-2.25DS -5.00DC \times 145^{\circ}$ His corrected vision was 6/9 and 6/12. This student was referred to KNH for review but he absconded.

18.4.3 INTRAOCULAR LENSES:

There were two students with hypermetropia due to aphakia. Visual acuity for both of them was 6/9 with spectacle correction. In this study there was no student found with intraocular lens correction.

REASONS FOR NOT USING SPECTACLES:

Out of the 128 students who needed correction, 46.9% (60/128 students) and 53% (68/128 students) had spectacles for males and females respectively. A total of 59.4% (76/128 students) did not have problem of whom both males and females were 38 (50%) each. Out of the students who were not using spectacles 4 students felt that they did not need spectacles with 50% for males and females. 7 students could not afford spectacles contributing to a total of 85.7% (6/7 students) and 14.3% (1/7 students) for females and males respectively. There were 4.7% (6/128 students) who had either broken or lost their spectacles with 16.7% (1/6 students) 83.3% (5/6 students) for males and females respectively. There were 7% (9/128 students) who had never been examined. Out of these 33.3% (3/9 students) and 66.7% (6/9 students) were males and females respectively. There were 2 who hated spectacles and both of them were females ($P = 0.113$) which was not significant.

In Villarreal G. study, 8% had been prescribed glasses but did not use them¹⁷ In this study only one student 0.8% had been prescribed glasses but never used. I have no reason to explain the difference on use of spectacles.

6 FAMILY HISTORY OF SPECTACLES WITH AGE:

Out of the 128 students with refractive errors, 48%(61/128) students found myopic had first degree relatives wearing spectacles (table 12). 1.6 %(2/128) all immediate family members wore spectacles. 52% (67/128) had refractive errors without any family member wearing spectacles. There is no doubt myopia is inherited²⁷. It was however difficult to determine the reason for correction amongst parents. It is possible that many of the parents had reading glasses.

CONCLUSION:

- 1 Significant refractive errors occur among primary school children aged 11.9 to 17.9 years at a prevalence of 10.2%. There is need to have regular vision testing in Primary schools so as to detect those who may suffer from these disability.
- 2 A large number of students with myopia do not have, or do not use prescription glasses. There is great need to create awareness on use of corrective lenses since correctable visual impairment is the most common treatable chronic condition of childhood.
- 3 The prevalence of uncorrected significant refractive errors is high enough to justify a regular school eye screening program in Primary schools in Kenya.
- 4 The number of spectacles needed to eliminate significant refractive errors in Langata Division can be estimated.

RECOMMENDATIONS:

1. If conditions are favorable, children should be screened once during the primary school years (6-11 years) and once during early adolescence (12-14 years). If vision testing is undertaken to detect myopia in 12-14 years old those with early onset myopia will have many years of poor vision and many may have dropped out of school due to poor vision. If resources are limited it is best to start screening in early adolescence, because most children would have manifested their myopia.
2. Visual screening of children at schools should also be encouraged to net those who could not be examined for various reasons.

PENDIX A

STUDY PROJECT EXAMINATION SHEET

Study: Refractive errors as seen in standard 8 pupils attending Public Schools in Langata Division, Nairobi, Kenya.

Principal Researcher: Dr. Helen Nzuki.

Date:

School:

Zone:

Serial No:

Name: _____

Age:

Sex:

M/F

Residence:

History of wearing spectacles:

Father: Yes/No

Mother: Yes/No

Sister: (s) Yes/No

Brother:

Yes/No

Others:

Complaint:

Have you ever worn spectacles? Yes/No

If yes, duration _____

Why (a) Not help

(b) Not beautiful

(c) Make vision worse

If no, why, (a) No problem

(b) No need

(c) Can not afford

Refraction code below

RE

LE

Eye Examination:

RE

LE

A.s.c

Lids

A.c.c

Conjunctiva

H

Pupils

M.R

Media

D.R.

Retina

Glasses prescription : RE : _____

LE : _____

Diagnosis :- 1. Emmetropia 2. Myopia 3. Hypermetropia 4. Astigmatism

ments : _____

1. Corrected

2. Not corrected

3. Under corrected

Right Eye
With correction
Family history

LE- Left Eye
PH - Pin Hole.
SR – Subjective Refraction

SC - Without correction
VA - Visual acuity
OR – Objective Refraction

APPENDIX B

PATIENT REFFERAL FORM

ATTENTION: DR. HELEN NZUKI

DATE

Dear Parent,

Please note that your child

.....

Who had an eye examination today was found to have

.....

Please bring him /her to the Eye Clinic No. 35.

KNH. (KENYATTA NATIONAL HOSPITAL) for review.

Thank you.

Dr. Nzuki.

APPENDIX C

OPHTHALMIC PRESCRIPTION:

Date

School screening study project by Dr. Helen Nzuki

Dear Parent,

Please note that your child.....

Who had an eye examination today was found to have a refractive error. Please organize for him/her to get spectacles with the

Following prescription;

Right eye:

Left eye:

You may contact me at the Kenyatta national hospital eye clinic on

Thursdays.

Sincerely,

Dr. Nzuki

APPENDIX D

CONSENT FORM

NAME OF PARENT/GURDIAN.....

Name of child..... Age

Name of school.....

Date.....

Dr. Helen Nzuki of UON has requested me to allow my child to participate in a study on eye assessment. The study is non invasive and will pose no risk to my child.

Having understood what the study involves,

I.....agree that my child takes part in the study.

Sign/Thumb print.....

Date.....

Witness (Head teacher).....

APPENDIX E

KUKUBALI

Jina la mzazi.....

Jina la mtoto.....

Jina la shule.....

Tarehe.....

Daktari Helen Nzuki kutoka Chuo kikuu cha Nairobi ameniomba nikubali mtoto wangu apimwe macho.

Mimi.....kutoka.....

nimekubali mtoto wangu apimwe macho.

Sahihi.....

Tarehe.....

Sahihi (Mwalimu mkuu).....

ENDIX F

in years	Number of students	%
	1	0.1
	2	0.2
	1	0.2
	1	0.1
	1	0.1
	69	5.5
	10	0.8
	18	1.4
	10	0.8
	10	0.8
	13	1.0
	15	1.2
	11	0.9
	10	0.8
	17	5.7
	162	12.9
	55	4.4
	79	6.3
	55	4.4
	38	3.0
	43	3.4
	56	4.5
	41	3.3
	17	1.4
	98	7.8
	70	5.6
	29	2.3
	30	2.4

5	28	2.2
4	19	1.5
5	16	1.3
6	23	1.8
7	11	0.9
8	11	0.9
9	48	3.8
0	16	1.3
1	2	0.2
2	8	0.6
3	7	0.6
4	7	0.6
5	4	0.3
6	4	0.3
7	4	0.3
8	1	0.1
9	8	0.6
0	2	0.2
1	4	0.3
2	4	0.3
3	2	0.2
4	1	0.1
6	3	0.2
9	2	0.2
total	1253	100

ENDIX G

LIST OF NAIROBI CITY COUNCIL PRIMARY SCHOOLS

GORETTI DIVISION

GORETTI ZONE

1. Mbagathi Road
2. Shadrack Kimalel
3. Jamuhuri
4. Gichagi
5. Toi
6. Dagoretti
7. Gatina
8. Kawangware
9. Riruta H.G.M.
10. Riruta Satellite
11. Kabiri
12. Joseph Kangethe

DAKORRETTI ZONE

1. Dagoretti Special
2. Gitiba
3. Kirigu
4. Mukara
5. Mutuini
6. Ndararua
7. Nembu
8. Dr. Muthiora
9. Ruthimitu
10. Kagira

LANGATA DIVISION

LANGATA ZONE

1. Ngong Forest
2. Karen C
3. St. Marys
4. Ayany
5. Olympic
6. Kibera

LANGATA WEST ZONE

1. Kongoni
2. Madaraka
3. Langata
4. Uhuru Gardens
5. Ngei
6. Langata West
7. Khalsa South
8. Langata Barracks

WESTLANDS DIVISION

KILIMANI ZONE

1. Kilimani
2. Milimani
3. St. Georges
4. State House Primary
5. Nairobi Primary
6. Kileleshwa
7. Lavington Kilimani Zone
8. Muthangari
9. Kangemi
10. New Kihumbu ini
11. Kihumbu ini
12. Kabete Vet Lab

MEDICAL LIBRARY
UNIVERSITY OF NAIROBI

ARKLANDS ZONE

1. Hospital Hill
2. Aga Khan
3. High Rigde
4. North Highridge
5. Visa Oshawal
6. Westlands
7. Bohra Road
8. Karura Forest
9. Loresho
10. Lower Kabete
11. Farasi Lane
12. Muguga Green
13. Cheleta

TAREHE DIVISION

UJA ROAD ZONE

1. Huruma
2. Kiboro
3. Mathari
4. Nduru Runo
5. Salama
6. St. Teresas Girls
7. Daima
8. Valley Bridge
9. Ainsworth
Muslim Girls
11. Ngethu Water Works
12. Juja Road
13. Parkroad
14. Muslim
15. Pangani
16. Race course

CENTRAL ZONE

1. C.G.H.U.
2. Catholic Parachial
3. Islamia
4. City Primary
5. Moi Avenue
6. Arya
7. St. Peters Clavers
8. S.S.D.
9. River Bank
10. St. Brigids
11. Muranga Road
12. Parklands
13. Pumwani
14. Dr. Arggrey
15. Khalsa Race Course

MAKADARA DIVISION

BURUBURU

1. Bidii
2. Baraka
3. Canon Apolo
4. Harambee
5. Jogoo Road
6. Martin Luther
7. Ofafa Jericho
8. Rabai Road
9. St. Michaels
10. St. Annes
11. St. Patricks
12. St. Pauls
13. Dr. Krapf
14. Nile Road Special School

WANDA ZONE

- | | |
|-------------------|-------------------------------|
| 1. Joseph Apudo | 7. O.L.M. Nairobi South |
| 2. Kaoleni | 8. Plainsview |
| 3. Makongeni | 9. St. Johns |
| 4. Mariakani | 10. St. Catherine |
| 5. Mukuru Kaiyaba | 11. St. Bakhita |
| 6. Nairobi South | 12. St. Elizabeth Lunga Lunga |

KASSARANI DIVISION

UWARAKA ZONE

- | | |
|-------------------|------------------|
| 1. Baba Dogo | 7. Mathare North |
| 2. M.M. Chandaria | 8. Mathare 4A |
| 3. Kariobangi | 9. Thika Road |
| 4. Korogocho | 10. G.S.U |
| 5. Ngunyumu | 11. Drive - in |
| 6. Marura | 12. Muthaiga |

KAHAWA ZONE

- | | |
|------------------------|---------------|
| 1. Garden Estate | 8. Kahawa |
| 2. Roysambu | 9. Mahiga |
| 3. Githurai | 10. Kamiti |
| 4. Kahawa Garison | 11. Njathaini |
| 5. Kassarani | 12. Kiwanjá |
| 6. Murema | 13. Marurui |
| 7. Kenyatta University | |

EMBAKASI DIVISION

KAYOLE ZONE

- | | |
|----------------------|-------------------|
| 1. Utawala | 10. Kifaru |
| 2. Bondeni | 11. Mwangaza |
| 3. Donholm | 12. Tumaini |
| 4. Edelvale | 13. Unity |
| 5. Embakasi | 14. Maua |
| 6. Embakasi Garrison | 15. Kwa Njenga |
| 7. Imara | 16. A.F. Reuben |
| 8. Thawabu | 17. O.L. Nazareth |
| 9. Kayole | |

DANDORA ZONE

- | | |
|------------|--------------|
| 1. Busara | 8. Ruai |
| 2. Dandora | 9. Tom Mboya |

3. James Gichuru
4. Kariobangi South
5. Peter Kibukosya
6. Ngundu
7. Ronald Ngara

10. St. Dominics
11. Umoja
12. Wangu
13. Ushirika

MUKUNJI DIVISION

EASTLEIGH ZONE

1. Eastleigh Airport
2. Moi Air Base
3. Zawadi Primary
4. New Eastleigh

5. St. Teresa Boys
6. New Pumwani
7. Moi Forces Academy

UHURU ZONE

1. Buruburu
2. Dr. Living Stone
3. Heshima Road
4. Kimathi
5. Morrison

6. Muthurwa
7. Nairobi River
8. O.L.M. Shauri Moyo
9. Uhuru Primary
10. Bahati

APPENDIX G BUDGET

Budget distribution	unit cost	Units	Total
ation of thesis proposal			
al			
oad prints/draft review/reprints			6,000
committee submission fee			500
community awareness tour			
port			2,000
port			10000
ials and equipment			
ary			
boards	130	2	260
pads	30	5	150
and pencils	20	5	100
ment			
	120	10	1200
ries-pair	50	30	1500
spirit-5L	600	1	600
ionnaire formulation			650
ionnaire -reprints	3	1300	3900
n wool	70	6	420
	550	10	5500
ns chart			
iatric cocktail	20	20	400
rt			
entry and proofing			10000
ing analysis and data			
ing/statistician			10000
l printing and binding			15,000
etarial services			10000
ingencies			10,000
AL			65,310

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