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# Prevalence and Associated Factors of Refractive Error Among School Children, Bahir Dar City: A Crossectional Study

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A Thesis Research Submitted To The Department Of Epidemiology And Biostatistics, School Of Public Health, College Of Medicine And Health Science In Partial Fulfillment Of The Requirements For The Degree Of Masters Of Public Health In Epidemiology

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**BAHIR DAR, ETHIOPIA**

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## ABSTRACT

**Background:** Refractive error is a visual impairment condition arising from the decreased ability of the eyes to focus light rays on the retina. Due to its impact on the learning process and educational capacity, children are a more vulnerable group. Limited evidence on its magnitude and factors on the area; So that this study will offer valuable information for decision-makers, health care planners, and medical practitioners

**Objective:** To assess the prevalence and associated factors of refractive errors among school children in Bahir Dar city, Northwest Ethiopia

**Method:** A cross-sectional study design was carried out among school children in Bahirdar city. A sample size of 486 was obtained using a single population proportion formula, and the study participants were selected with a multi-stage random sampling technique. Questionnaire and physical examination using a 6m Snellen's E chart, pinhole test, and an autorefractor were used for data collection. Epidata and SPSS were used for data entry and analysis respectively. Bivariate and multivariable logistic regression analyses were done to sort out associated factors; a P-value <0.05 considered for statistical significance and factors were reported using OR with its 95% CI.

**Results:** 477 study participants were included in the study, accounting 1.85% non-response rate, 256(53.7%) were girls and the mean age of respondents was 13.6years ± 3.8SD. Refractive errors were present in 8.2% (95% CI; 5.7%, 10.6%) of children, and myopia was the dominant type of refractive error (54.1%). Female Sex (AOR=2.7, 95% CI; 1.2, 5.8), higher age(AOR =1.3, 95% CI; 1.1, 1.4), early joining to school(AOR=2.8, 95% CI;1.3, 6.3), and closer working distance on near reading(AOR=6.3, 95% CI; 2.9,12.5,) were factors that have a significant association for the presence of refractive error.

**Conclusions:** The burden of refractive errors is high among school children. Myopia was the dominant type. Female sex, higher age, early joining to school, and closer working distance was the potential risk factors. This study signifies that screening at an early age and reducing near-work activities will reduce the impact of refractive errors.



***Keywords:*** Refractive error, Ametropia, Refractive disorder

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# ACRONYMS AND ABBREVIATION

| | |
|---|---|
| AOR | Adjusted Odds Ratio |
| CI | Confidence Interval |
| CL | Confidence Level |
| D | Diopter |
| EPP | Estimated Pooled Prevalence |
| MSVI | Moderate and Severe Visual Impairment |
| OD | Oculus Dexter (Right eye) |
| OR | Odds Ratio |
| OS | Oculus Sinister (Left Eye) |
| OU | Oculus Uterque |
| RE | Refractive Error |
| SPSS | Statistical Package for Social Sciences |
| SSA | Sub Saharan Africa |
| URE | Uncorrected Refractive error |
| V/A | Visual Acuity |
| WHO | World Health Organization |

# 1. INTRODUCTION

## 1.1. Background

Eye conditions encompass a large and diverse range of morbidities that affect different components of the visual system and visual function. Given their range, classifying eye conditions that do not typically cause vision impairment from those that can is a challenge. Eye conditions that can cause vision impairment and blindness are the main focus of prevention and intervention strategies set by Vision 2020(1, 2).

However, a considerable proportion of people with eye conditions in this category who receive timely diagnosis and treatment will not develop vision impairment or blindness. Preventable vision loss due to cataract (reversible with surgery) and refractive error (reversible with spectacle correction) continue to cause most cases of blindness and moderate or severe vision impairment, contributing 55% of blindness and 77% of moderate or severe visual impairment(MSVI) which is a visual acuity less than 6/18 on the better eye worldwide (1, 2).

Refractive error is one of the major contributing eye conditions, comprise visual impairment arising from the decreased ability of the eyes to focus light rays on the retina. It can appear in 3 common forms (Hyperopia, Myopia, and Astigmatism). Vision impairment has been defined based on distance visual acuity only, and uncorrected distance refractive error (mainly myopia) is the single biggest cause of worldwide vision impairment (1, 3-5).

Although refractive errors (myopia, hyperopia, and astigmatism) can be easily diagnosed and corrected with spectacles or other refractive corrections to attain normal vision; they affect the whole spectrum of the population irrespective of age, gender, and ethnic group(6).

Refractive error can be detected through routine examination of patients who present to ophthalmic clinics, or through vision screening of the population at large. The former approach may work satisfactorily in developed countries, but the latter is necessary for developing countries because a large majority of the population does not have access to

reasonable quality eye care services and also clients may not aware that they have refractive errors(7).

Even if applicability and the need are varied between areas, School screening can be performed with simple visual acuity assessment by trained schoolteachers, students, and paramedical professionals. In developing countries, schoolteachers have been most commonly used for vision screening of school children(7, 8).

Refractive error is a painless visual condition and children with it may live without complaint to parents and may not seek eye care as compared with children with infectious eye disease. And they are a more vulnerable group because an uncorrected refractive error can result in a dramatic impact on the learning process and educational capacity. Most of the children with such diseases are apparent and hence screening helps in early detections and correction of the optical defect before developing amblyopia and/or blindness(3, 9).

If the refractive error is left untreated up to the age of 9-10 years, lifelong uncorrectable visual impairment(amblyopia) has a chance to develop. And early detection and correction will decrease the challenge of its management(10).

### 1.2. Statement of the problem

Blindness due to uncorrected refractive error was the second leading cause next to cataract worldwide in 1990 and 2010 with 20% and 21% respectively, whereas it was the first cause for moderate and severe visual impairment (MSVI) in the year 1990 and 2010 with the percentage of 51% and 53% from the total causes respectively(11, 12).

Although lifestyles changes, differences in ethnic groups, measurement methods, definitions of refractive errors, and age groups of the participants hinder a definite conclusion regarding the pattern of the distribution of refractive errors worldwide, there is an increase in its burden worldwide (especially the case of myopia) and its distribution is not equal in different countries(2). But the blindness and low vision due to uncorrected refractive error were observed to decrease which is explained by improving eye care service delivery(2, 11, 12).

On the systematic review of 11 studies conducted in Sub-Saharan Africa (SSA), 2012, the proportion of blindness due to refractive errors ranged from 1.1% in an urban district of Cameroon to 7.9% in a rural district in Ethiopia. The proportion of moderate visual impairment (VA ≤ 6/60 and > 6/18 on the better eye) due to URE ranged from 12.3% to 57.1%, excluding two studies that included uncorrected aphakia as part of URE, and concluded that although URE is a leading cause of visual impairment, it does not represent a major cause of blindness in SSA(13).

On the national Blindness and Low Vision Survey of Ethiopia, 2006, the prevalence of blindness and low vision (MSVI) was 1.6% and 3.7% respectively with considerable regional variations. And the survey estimated that visual impairment due to refractive error was 33.4% of the total causes and uncorrected refractive error was 7.8% of the total causes of blindness(14).

In the study conducted to determine Visual Impairment among Primary School Children in Gondar town, Northwest Ethiopia, and a similar study in Addis Ababa, Central Ethiopia, the most frequent cause of uniocular and bilateral visual impairment in the study population was a refractive error. More than two-thirds of the proportion of both uniocular and bilateral visual impairments were due to refractive errors found in the study

in Gondar town and 94% of the visual impairment was found in Addis Ababa city(15, 16).

Vision impairment affects the ability to function optimally, school learning, outdoor activity, and the individual's social life or integration. Uncorrected distance refractive error leading to vision impairment can reduce the quality of life and decrease participation in vision-related daily activities. Children are a more vulnerable group because the uncorrected refractive error can result in a dramatic impact on the learning process and educational capacity (3, 5, 12).

Refractive errors also affect the economy of different societies. Potential global productivity loss associated with myopia is larger than the cost of addressing uncorrected refractive error. Even without aiming for myopia prevention or control, simply improving spectacle correction rates for people with myopia is estimated potentially to gain 10-12 billion USD in productivity annually for a 1 USD billion investment. And this signifies that screening of 11– 15 years old children is the most cost-effective intervention in all regions(1, 5, 9, 17).

A study conducted to investigate the relationship between poor eyesight and educational outcomes using data from rural Ethiopia shows that poor eyesight students were a higher probability of dropping out of school and learning achievement is negatively related to poor eyesight(18).

On a systematic review of multi-country refractive error study, the occurrence of amblyopia in refractive error cases was 0.74% with significant variation across ethnic groups: 1.43% in Hispanic, 0.93% in Chinese, 0.62% in Indian, 0.52% in Malay, 0.35% in Nepali, and 0.28% in African children. The most common cause of amblyopia was anisometropia ( refractive power difference between the two eyes)(10).

WHO explains the prevalence of visual impairment and trends over time is crucial for resource allocation, planning, and developing synergies with other programs and to measure the progress of the achievement(19, 20).

Refractive error among school children remains with its impact on the overall development and learning achievement of children. Nevertheless, there was no published

literature found in the city of Bahir dar about the condition of refractive error of children and few were found in the Amhara region as well as in Ethiopia. Limited evidence on the magnitude and factors of refractive error might be one of the reasons for the low coverage of the eye care service in the country. And I, therefore, designed this school-based cross-sectional study to determine the prevalence of refractive error with its subtypes and factors associated with it.

### 1.3. Significance of the study

This study will contribute to the knowledge of the concerned community to find out whether school children were affected with the visual impairing condition, refractive error, and will signify potential factors for the presence of the refractive error. Also helpful in producing applicable recommendations for school administrators, Health and Education bureaus, and non-governmental organizations working at the control and elimination of blindness which is important in designing, intervention, and monitoring for school-based eye health services. Individual students will also be advantaged with the study for getting screened and getting prescriptions.

Besides, it will serve as a benchmark for an interested researcher on the topic and also will be an input for a systematic review to determine countrywide prevalence.

# 2. LITERATURE REVIEW

## 2.1. Prevalence of refractive error

On recent global and regional estimates of the prevalence of refractive errors: Systematic review and meta-analysis conducted in 2018 were reported as estimated pooled prevalence (EPP) with 95% CI from the retrieved studies, the EPP of refractive error in children was 10.4%, and concluding that astigmatism was the most common refractive errors in children and adults(21).

The study on the impact of various types of near work and time spent outdoors at different times of day on visual acuity and refractive error among Chinese school-going children, rural primary schools in Northwest China, 2012, the prevalence of refractive error was 22.5 % (94 % of the total cases of reduced vision on screening). Also in a study done in Western China, the prevalence of refractive error among school-age children was 20.75 %(22, 23).

The study conducted in India to determine the prevalence of refractive errors among school children in the rural field practice area of a tertiary care hospital, Bengaluru, revealed that the prevalence of refractive errors was 10.5%. And on the other study reviewed in India, to find out the prevalence of undetected refractive errors in school children and the factors associated with it shows that 13.4% of the children had a prevalence of undetected refractive errors(24, 25).

A school-based cross-sectional study on the prevalence of refractive errors found in Malaysia, in Malay Primary School Children, on the study of Prevalence and associated factors of uncorrected refractive errors among school children in suburban areas in Bandung, Indonesia, among school children aged 11–15 years in randomly selected schools, and a study on refractive error among male Primary School Students in Jazan, Saudi Arabia: revealed that the prevalence of refractive error was 7%, 15.9%, and 22% respectively(26-28).

On three studies undertaken in Somalia, Ghana, and Burkina Faso on school-age children, one study in Uganda on lower primary school children and one study reviewed

in South Africa school-age children from the community shows that the prevalence of refractive error was 15.7% 13%, 12.4%, 11.6%, and 1.4% respectively(29-33).

National Blindness and Low Vision Survey of Ethiopia, 2006, revealed that the prevalence of blindness was 1.6% and refractive error is one of the major cause of blindness contributing 7.8% of the total causes and the prevalence of low vision was 3.7% and refractive error was contributing the major portion (33.4%) among the causes of low vision. This does not determine the prevalence of the refractive error, but the effect of the case(14).

Two studies found in Addis Ababa, Ethiopia, undertaken on primary school children in 2014 and 2019 with the general objective of determining the prevalence of refractive error and assessing the prevalence of visual impairment and associated factors, discovered that the prevalence of refractive error was 4 % and 4.1% respectively(6, 16).

A community-based cross-sectional study conducted among rural school-age children of the Gurage zone, central Ethiopia**,** 2014**,** and a school-based cross-sectional study among rural school-age children of the Gurage zone, central Ethiopia, 2013 to determine the prevalence of refractive error and visual impairment displays that the prevalence of visual impairment due to refractive error as 3.5% and 6.3% respectively(34, 35).

The study conducted in Debre Markos town, Northwest Ethiopia, 2014, to assess the prevalence of uncorrected refractive error in primary school students showed that the prevalence of refractive error was 10.2%, and myopia was the highest proportion(62.2%) followed by astigmatism(21.6%) and hyperopia(16.2%)(36).

A study conducted in Gondar town, Northwest Ethiopia, 2012, to determine the prevalence of refractive error among children enrolled in elementary schools revealed that 9.4% of the children have visual impairment due to refractive error. And a related previous study (2003) conducted in Koladiba and Debark towns, Northwest Ethiopia, on preschool and primary school children shows that 7.6% of children have visual impairment due to refractive error on either of the eye(6, 16).

- Types of refractive error

On recent global and regional estimates of the prevalence of refractive errors: Systematic review and meta-analysis conducted in 2018 were reported as estimated pool prevalence (EPP) with 95% confidence interval from the retrieved studies, In children, the EPP of astigmatism, myopia, and hyperopia was 14.9% (95% CI: 12.7-17.1), 11.7% (95% CI: 10.5-13.0), and 4.6% (95% CI: 3.9-5.2) respectively. The EPP of myopia ranged from 4.9% in South East Asia to 18.2% in the Western Pacific region, the EPP of hyperopia ranged from 2.2% in South-East Asia to 14.3% in the Americas, and the EPP of astigmatism ranged from 9.8% in South-East Asia to 27.2% in the Americas(21).

A study to investigate the distribution pattern of refractive status and prevalence of refractive errors in school-age children in Western China to determine the possible environmental factors shows that the prevalence of hyperopia, myopia, and astigmatism were 3.26%, 13.75%, and 3.75%, respectively which accounts myopia was 2/3 of the total refractive cases(22).

The study conducted in India to determine the prevalence of refractive errors among school children in the rural field practice area of a tertiary care hospital, Bengaluru, revealed among 10.5% of refractive errors 58.5 percents are myopes, and the remaining 24.4 and 17.1 percents are astigmatisms and hypermetropia respectively. On the other cross-sectional study conducted in urban Etawah, India, among 13.4% of undetected refractive errors, myopia was the most common refractive type error(24, 25).

A school-based cross-sectional study found in Malaysia, Prevalence of Refractive Error in Malay Primary School Children in Suburban Area of Kota Bharu, Kelantan, Malaysia, myopia is the most common type of refractive error among children aged 6 to 12 years with a prevalence of 5.4%( accounting 77% of the total cases of refractive error), followed by hyperopia at 1.0% and astigmatism at 0.6%(27).

The study conducted in Saudi Arabia showed that from the overall prevalence of uncorrected refractive errors, hyperopia was the most prevalent (32.2%) refractive error followed by myopic astigmatism (31%) then myopia (17.2%), and the remaining were hyperopic astigmatism (16.1%) and mixed astigmatism (3.5%)(28).

According to the recently conducted and reviewed studies undertaken in African countries Ghana, Burkina Faso, and Uganda revealed that astigmatism was the leading type of refractive error contributing from 49% to 56.4% of the total causes of refractive error, followed by hyperopia, ranging from 37% to 39.5% of the total visual impairment due to refractive error and Myopia, ranging from 4% to 12.6% of the total causes of refractive error. On contrary, the study conducted in Somalia showed that myopia was the leading(58.2%) type of RE followed by astigmatism(24.9%) and hyperopia(16.9%) respectively (30-33).

In all recent and reviewed studies found in Ethiopia presented that myopia is the leading type of refractive error ranging from 32% up to 95% of the total cases, followed by astigmatism and hyperopia ranging from 7% to 36% and 2.5% to 25% respectively(6, 16, 34-38).

- The proportion of uncorrected refractive error

A school-based cross-sectional study found in Malaysia, Prevalence of Refractive Error in Malay Primary School Children in Suburban Area of Kota Bharu, Kelantan, Malaysia, among students who had refractive errors, 48% of them were wearing corrective lenses, while more than half of them were with uncorrected refractive error(27).

In the study conducted in Indonesia, intending to estimate the prevalence of uncorrected refractive errors and to investigate their associated factors among suburban area school children aged 11–15 years in randomly selected schools, among the prevalence of 15.9% of cases the proportion of uncorrected refractive error was 76%(26)

The study of refractive error and Visual impairment in African children, in South Africa, and Somalia discovered that only 19.0% and 17.6% of the refractive error cases were wearing glasses and the remaining were living with their optical defect(29, 33).

Surprisingly in four recent and reviewed studies found in Ethiopia, Mehari et al. 2013, conducted in primary school children of at Gurage zone, Kedir et al. 2014, conducted in communities of school-age children in the Gurage zone, central Ethiopia, Sewunet et al. 2014, conducted in primary school children of Debremarkos town, North West Ethiopia and Nebiyat et al. 2015, conducted in primary school children of Addis Ababa, Ethiopia,

presented that the proportion of uncorrected refractive error was 99.7%, 100%, 95.4%, 97.7% respectively(6, 34-36).

### 2.2 Factors associated with Refractive error

- Gender:

The study conducted in India to determine the prevalence of refractive errors among school children in the rural field practice area of a tertiary care hospital, Bengaluru, explored that refractive error was significantly associated with gender ($p<0.05$) with increased refractive error on female sex, and in the study conducted in the INK Area, Durban, South Africa, 2016, stated that refractive error in general and the major types (myopia, hyperopia, and astigmatism) were significantly associated with female sex (24, 39).

The study conducted in Debre Markos town, North West Ethiopia, 2014 revealed that being female was 3.9 times (AOR= 3.9, CI: 1.556-10.092) more likely to have a refractive error on their eye (36).

- Age

A study to investigate the distribution pattern of refractive status and prevalence of refractive errors in school-age children in Western China to determine the possible environmental factors shows that, as children's ages increased, the prevalence rate of hyperopia decreased ($P<0.001$) and that of myopia increased significantly ($P<0.001$)(22).

The study conducted in India to determine the prevalence of refractive errors among school children in the rural field practice area of a tertiary care hospital, Bengaluru, explored that refractive error was significantly associated with age($p<0.05$) with increased refractive error on higher age(24).

The study conducted in Somaliland, Somalia, to determine the prevalence of refractive error and visual impairment among school-age children revealed that the prevalence of RE was significantly associated with age ($P = 0.011$) (33).

In the study conducted to determine Visual Impairment among Primary School Children in Gondar town, Northwest Ethiopia, children's age was the sociodemographic variable that showed statistically significant association with visual impairment ($p = 0.044$).

Children age group >15 showed a statistically significant association with visual impairment (OR: 6.18, 95% CI, 1.75–21.9, P=0.005) to be visually impaired than those children aged between 5 to 10 years (15).

- Grade level

A school-based cross-sectional study found in Malaysia, Prevalence of Refractive Error in Malay Primary School Children in Suburban Area of Kota Bharu, Kelantan, Malaysia, children in the Level 2 of primary school compared to level 1 cohort have nearly 4.14 times (AOR 4.14, P< 0.001) higher risk of developing myopia (27).

The study conducted in Debre Markos town, North West Ethiopia, 2014 revealed the association of refractive error with higher grade level (5-8)_with AOR Of 4.8 (95% CI: 1.980-11.474) more likely than in lower grades (1–4)(36).

- Near-work activities

In the epidemiologic study of refractive error and near-work activity in 12-year-old Australian school children, Jenny et al, time spent in continuous reading (>30 minutes) and parental reports of close reading distance (<30cm) were associated with greater odds of myopia (AOR, 1.5 and 2.5, respectively) after adjustment for age, sex, ethnicity, school type, parental myopia, and outdoor activity(40).

The study on the impact of various types of near work and time spent outdoors at different times of day on visual acuity and refractive error among Chinese school-going children, rural primary schools in Northwest China, 2012, revealed that higher grade level, male sex, and > 60min daily use of computer and smartphone were significantly associated (p<0.001 )with reduced vision (23).

In the cross-sectional study conducted in urban Etawah, India, to find out the prevalence of undetected refractive errors in school children and the factors that associated with it was explained that there was a significant association between undetected refractive errors and watching television closely. This was also displayed in the study undertaken on male primary school students in Jazan, Saudi Arabia, there was an association between students watching TV from a close distance and refractive error, with an OR=

0.48 for large distances from the TV as large distances decreased the odds of refractive error(25, 28).

In the study conducted in Debre Markos town, North West Ethiopia, 2014, those using computers regularly were 4.5 times (AOR 4.5, 95%CI; 1.589-12.968) more affected than non-users or irregular users (36).

- Other eye diseases

A study conducted in Addis Ababa, Nebiyat et al, 2015 displays that having other eye diseases remained to be statistically significant predictors of refractive error which explained with an AOR of 0.312 (CI: 0.180-0.540) for not having other eye diseases compared to the participants having other eye diseases(6).

- Residence

In the study of Refractive Error among Male Primary School Students in Jazan, Saudi Arabia: Prevalence and Associated Factors, the students in the rural areas were significantly more than twice (OR= 2.7, CI 1.55, 4.68)as likely to be affected by refractive errors as the students in the urban areas(28).

In population-based studies on children, the prevalence of myopia has been reported to be higher in urban areas and Chinese residence. The regional and racial difference is not so obvious. More time spent on near work, less time outdoor activities, higher educational level, and parental history of myopia have been reported to increase the risk of myopia(41).

- Family history

The cross-sectional study conducted in urban Etawah, India, to find out the prevalence of undetected refractive errors in school children and the factors that associated with it, explained that there was a significant association between undetected refractive errors and a positive family history of wearing glasses in addition to watching television closely, close study and studying in dim light(25).

## 3. CONCEPTUAL FRAMEWORK

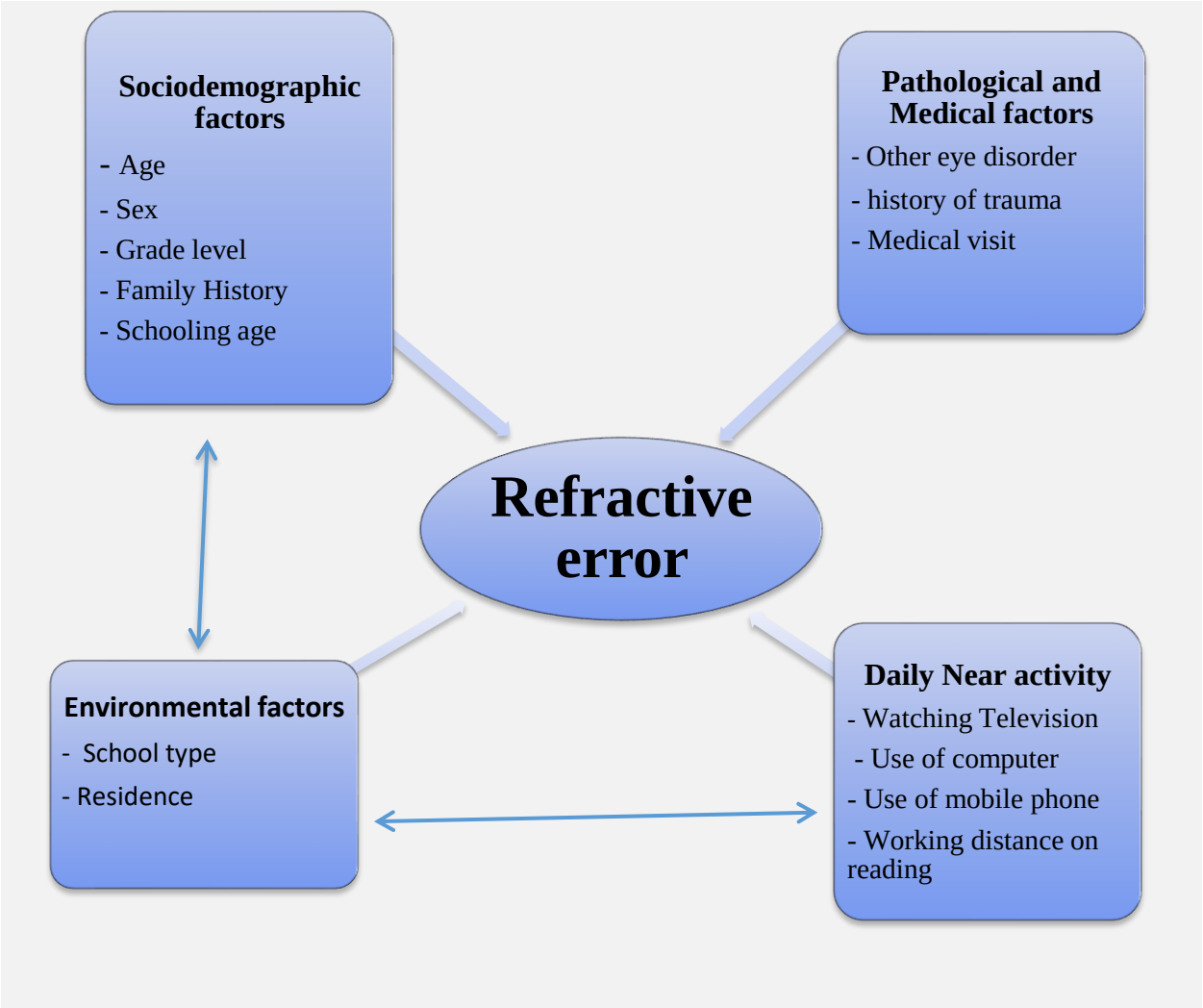



***Figure 1:*** *a schematic presentation of the conceptual framework of factors affecting refractive error*

# 4. OBJECTIVE

## 4.1. General Objective

- To assess the prevalence and associated factors of refractive error among school children in Bahir Dar city, Northwest Ethiopia, 2021

## 4.2. Specific Objectives

- To determine the prevalence of refractive error among school children in Bahir Dar city.
- To identify factors associated with the presence of refractive error among school children in Bahir Dar city.

# 5. METHODS AND MATERIALS

## 5.1. Study Design

An institutional/school-based cross-sectional study was conducted to assess the prevalence and associated factors of refractive error among school children, Bahir Dar city, Northwest Ethiopia.

## 5.2. Study Setting /Area/ Period

This study was conducted in Bahir Dar starting from December 2020 up to January 2021. Bahir Dar is the capital city of the Amhara Region, Northwest Ethiopia. The population of the city is estimated at 389,177 ( Male =183984 and Female = 205,193) in the year 2020/21 based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA)(42). Currently, the city has divided into six sub-cities and three satellite towns. Satelite towns comprise 16% of the total population of the estimate of the city.

According to the city administration's Education office data, in the academic year of 2020/2021, there were 22(twenty-two) 1$^{st}$ cycle primary schools, 55(fifty-five) 2$^{nd}$ cycle primary schools, and 18(eighteen) secondary schools in the city.

According to the city administration's Health office report, the city comprising four (two government and two private) hospitals and two specialty private-owned clinics that provide eye care services including refraction. Currently, there is no government-owned spectacle dispensing unit in the city.

## 5.3. Source Population

The source populations were all school children in Bahir Dar city who enrolled for the 2020/2021 academic year.

## 5.4. Study Population

The study populations were schoolchildren of Bahir Dar city who were enrolled for education and day class attendees during the study period.

## 5.5. Eligibility Criteria (Inclusion, Exclusion)

### Inclusion Criteria

- Children who attend the daytime class of schools in Bahir dar city

### Exclusion Criteria

- Children with active eye disease/inflammation/recent trauma
- Children with an optical media opacity that will mask the presence/absence of the outcome of interest

## 5.6. Variables

### Dependent Variable

- Refractive error(Present/Absent)

### Independent variables

- Factors of socio-demographic;

  Age, Sex, Religion(Muslim/Christian Grade level(first primary/second primary/secondary school), Family history
- Factors of environmental;

  School type(Private/government), Residence(Urban/Rural)
- Factors of medical conditions;

  Other eye conditions, History of eye trauma, Medical visit
- Factors of near work activities;

  Watching television regularly(at least 5 days per week)(Yes/No),

  Use of computer regularly(at least 5 days per week) (Yes/No), Use of mobile regularly(at least 5 days per week) (Yes/No), Working distance on near reading measured with measuring rule(≤30cm/>30cm)

## 5.7. Operational Definition

- **Visual acuity:** is the ability to distinguish letters as measured with Snellens' E chart posted at 6 meters distance from the study subject.
- **Defective vision:** is a visual acuity less or equal to 6/12 on either of the eye
- **Visual impairment (VI**): is a significant loss of vision, clinically defined as presenting distance visual acuity <6/18 in the better eye
- **Blindness:** presenting Visual Acuity of less than 3/60 in the better eye
- **Refractive error**: is an optical system defect on either of the eye with uncorrected visual acuity less than or equal to 6/12 that improved with spectacle.
- **Myopia**: Defined as a spherical equivalent refractive error (SER) with a defect of −0.50D or more in both or either of the eye.
- **Hyperopia**: defined as a spherical equivalent refractive error (SER) with a defect of $\geq$ +0.50D in both or either of the eye.
- **Astigmatism**: defined as a cylindrical refractive error with a defect of $\geq$ ±0.50D in both or either of the eye.
- **Working distance**: a distance measured using measuring rule when the participant puts his reading paper how far from his eyes.

### 5.8. Sample Size Determination

The sample size was calculated for the two objectives as follows.

Objective 1:- Using the prevalence of Refractive error

The sample size was calculated using a single population proportion formula by taking into consideration of a 10.2% prevalence rate from a previous study conducted in Debre Markos, which will give the largest estimate sample size from the studies in Ethiopia (36), with the 95% confidence level, 4% level of precision, and design effect of 2.

$$n = \frac{(Z\alpha/2)^2 \times p(1-p)}{W^2} \times DE$$

*Where; n = sample size;*

*Z = value of z statistic at 95% confidence level = 1.96;*

*P = proportion of children with refractive error = 10.2%;*

*q = 1–p = 89.8%;*

*W = maximum allowable error = 4% and*

*DE= A design effect of 2 for multistage sampling*

And the final sample size will be

$$n = \frac{(1.96)^2 \times 0.102 \times 0.898}{(0.04)^2} \times 2 = \frac{(3.842 \times 0.092)}{0.0016} \times 2 = 440$$

Objective 2:- Factors associated with the refractive error.

In this case, the sample size was calculated by using the EPI Info version 7 software program by using different consistent factors from different studies (considering power; 80%, 95% confidence level, ratio (unexposed: exposed) = 1, the outcome in the unexposed group (%), odds ratio and outcome in the exposed group (%) and DE of 2;

***Table 1:*** *Sample size calculation using Epi info for determinants among school children, Bahir Dar city, 2021*

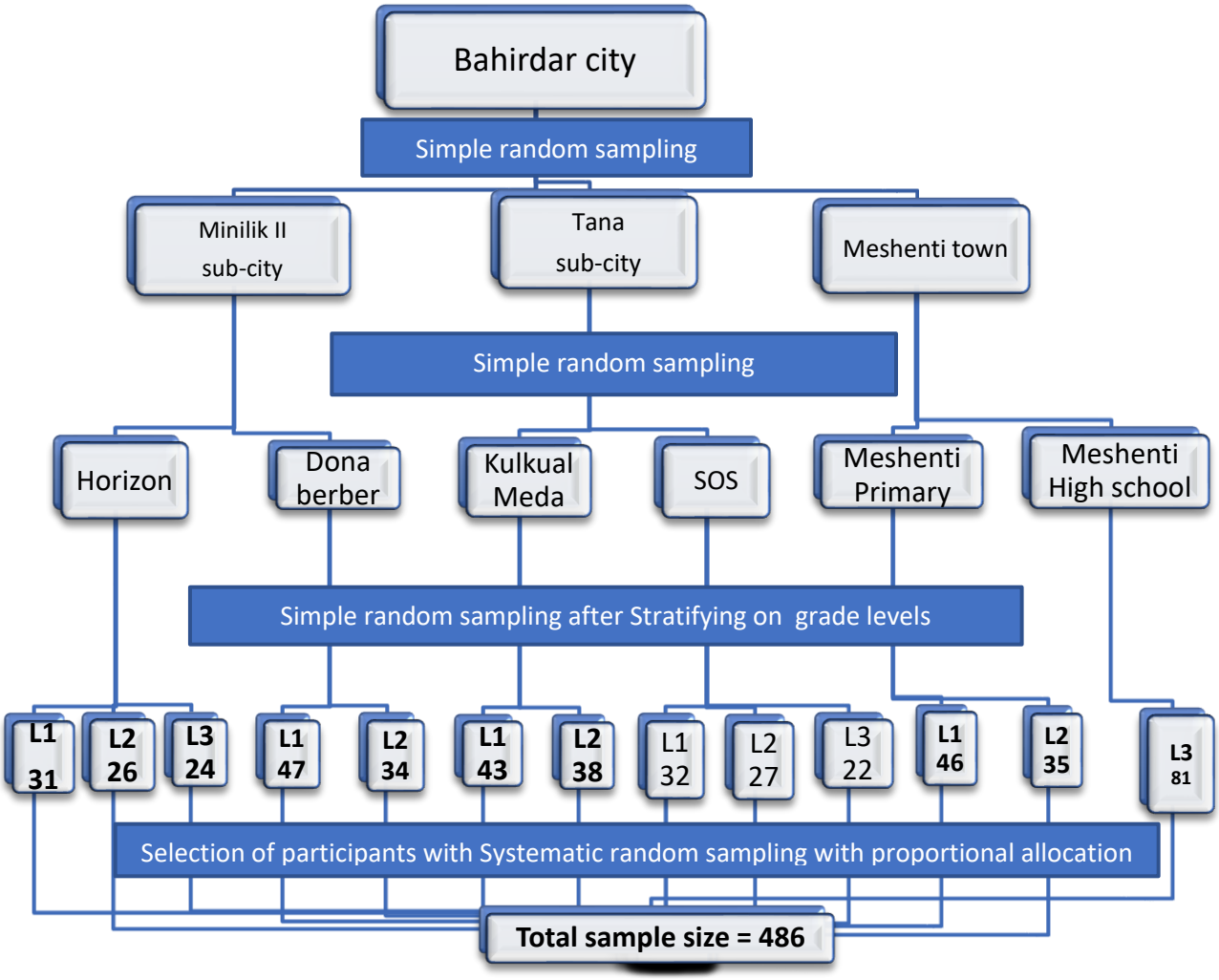
| Determinants | CL | OR | DE | power | Ratio (unexposed/ exposed) | Outcome in Unexposed Group | sample size |
|---|---|---|---|---|---|---|---|
| Near work (25) | 95% | 3.16 | 2 | 80 | 1/1 | 10.8% | 384 |
| Residence (28) | 95% | 2.7 | 2 | 80 | 1/1 | 15.5% | 412 |
| Sex(36) | 95% | 3.9 | 2 | 80 | 1/1 | 6.7% | 380 |
| Grade level (27) | 95% | 4.14 | 2 | 80 | 1/1 | 18.4% | 180 |

From the above sample size determination by using the prevalence and associated factors, the largest sample was 440 which was calculated using a single population proportion formula.

And then, by considering a 10 % non-response rate, the final sample size was 484 participants.

### 5.9. Sampling Methods and Procedures

Study participants were selected with a multi-stage random sampling process. Initially, two sub-cities and one satellite town were selected with simple random sampling among listed 6 sub-cities and 3 satellite towns from the city of Bahir Dar, then 2 schools were selected from a list of schools of each sub-cities with simple random selection, and then after stratifying with their educational cycle and proportional allocation of participants to the size of the students, school sections were selected with simple random sampling from each education cycle. Finally, class students were selected with systematic random sampling.




**L1=1st cycle primary L2 = 2nd cycle primary L3 = Secondary school**

***Figure 2:*** *A Schematic presentation of the sampling technique and procedure among school children, Bahir Dar city, 2021.*

### 5.10. Data Collection and Instruments

After getting a half-day orientation, ophthalmic nurses with the assistance of data recorders were collected the data. Visual acuity of selected students was measured using Snellen's E chart in a well-lighted indoor space or outdoor shade at their school compound to level their visual acuity status and structured questionnaire with physical examination with a magnifying loupe, torch, ophthalmoscope, and near reeding print with measuring ruler was used to explore independent variables and other relevant information, then V/A was repeated with Pinhole for those having VA 6/12 or worsen to screen whether the reduced vision is due to refractive error or not (which will be used to level presence or absence of the variable of interest). Finally, those with the outcome of interest were further examined by an optometrist with an autorefractor in the eye unit of Felege Hiwot Referal Hospital to categorize the type and power of refractive error.

### 5.11. Data quality control

To assure the quality of the data, two data recorders, one ophthalmic nurse, and one optometrist were recruited and trained on the data collection procedure. Pretesting of the questionnaires and materials was conducted on 35 students in one government school around D/Markos town. The completeness, accuracy, and consistency of the collected data were checked during data collection by the principal investigator. The data were entered and cleaned by the principal investigator before analysis.

### 5.12. Data processing and statistical Analysis

After coding the collected information, the data was entered into Epidata Software version 3.1 and exported to SPSS version 23 for analysis. Descriptive statistics were used to summarize the demographic characteristics, proportions, and other descriptions of the studied participants. Bivariate and multivariable logistic regression were used to determine the associated factors after checking the model fitness test with Hosmer and Lemeshow test. The variables that were found with P-value <0.25 on Bivariate logistic regression entered into multivariable analysis to control confounding variables after checking multicollinearity between variables. Variables with a p-value less than 0.05 were considered as statistically significant and factors were reported with OR and its 95% CIs.

### 5.13. Ethical Considerations

The study proposal was presented for approval to the Bahir Dar University and approval was taken from the Institutional review board. Then, the support letter was presented to the Bahir dar city administration office of education. And the office directs the support letter to the selected schools.

On permission gained from the selected school principals, the questionnaire was given to data collectors to collect data. Data collectors clarify the purpose of the study with the consent form and informed written consent was taken from the parents or guardians in addition to the assent of each study subject before the data collection, and the rights to a refusal to answer all or part of questions were respected. Participants were examined and interviewed separately outside their class and their responses and examination results were kept confidential.

Cases those with correctable with refraction were reevaluated with subjective refraction to give a prescription of spectacles.

# 6. RESULTS

## 6.1. Socio-demographic characteristics

In this study, 486 participants were selected from six schools of Bahir Dar city, and 477 study participants were included in the study accounting 1.85% non-response rate. Out of these 256(53.7%) were girls and the mean age of 13.6years (± 3.8SD) ranges from 7yrs to 22 yrs. A total of 320(67.1%) were from government schools and others from private schools. 41.5%, 34%, and 24.5% were the proportion of participants on their grade level (1-4, 5-8, and 9-12) respectively.

***Table 2.*** *Demographic characteristics of study participants among school children, Bahir Dar city, 2021 (n=477)*

| Characteristics | | frequency | Percentage |
|---|---|---|---|
| **Name of schools** | Horizon | 80 | 16.8% |
| | Kulkual Meda | 81 | 17.0% |
| | Donaberber | 79 | 16.7% |
| | Meshenti Junior | 81 | 17.0% |
| | Meshenti Highschool | 79 | 16.5% |
| | SOS | 77 | 16.1% |
| **School type** | Governmental | 320 | 67.1% |
| | Private | 157 | 32.9% |
| **Gender** | Boys | 221 | 46.3% |
| | Girls | 256 | 53.7% |
| **Age of participants** | 6-10 | 130 | 27.3% |
| | 11-15 | 206 | 43.2% |
| | 16-20 | 121 | 25.4% |
| | 21-25 | 20 | 4.2% |

| | | | |
|---|---|---|---|
| **Residence** | Urban | 372 | 78.0% |
| | Rural | 105 | 22.0% |
| **Religion** | Christian | 366 | 76.7% |
| | Muslim | 111 | 23.3% |
| **Grade Level** | 1-4 | 198 | 41.5% |
| | 5-8 | 162 | 34.0% |
| | 9-12 | 117 | 24.5% |
| **Schooling age** | <6 | 213 | 44.7% |
| | 6-8 | 141 | 29.6% |
| | 9-11 | 117 | 24.5% |
| | 12+ | 6 | 1.3% |
| **Family History of wearing spectacle** | Yes | 11 | 2.3% |
| | No | 466 | 97.7% |

### 6.2. Near work activities

Among study participants 337(70.6%) were regularly watching television and 35%, 51% and 14% of this group were having regular sitting distances of <2mts, 2-4mts, and >4mts from the television respectively. The proportion of regular computer users for games, video play, and reading from the study participants were 26(5.5%) and the proportion of regular mobile phone users for games, video play, and reading were 206(43%). The working distance of near reading of the participants was measured and it was found that 22.5%, 52.2%, and 15.3% were using <30cm, 30-40cm, and >40cm distance for near object reading.

***Table 3**. Frequency table on daily near work activities among school children, Bahir Dar city, 2021 (n = 477)*

| Characteristics | | frequency | Percentage |
|---|---|---|---|
| **Watching Television regularly** | Yes | 337 | 70.6% |
| | No | 140 | 29.4% |
| | Total | 477 | 100% |
| **Television Watching distance (n=337)** | <2mt | 117 | 34.8% |
| | 2-4mt | 173 | 51.3% |
| | >4mt | 47 | 13.9% |
| | Total | 337 | 100% |
| **Regular Mobile Users** | Yes | 206 | 43.2% |
| | No | 271 | 56.8% |
| | Total | 477 | 100% |
| **Regular Computer users** | Yes | 26 | 5.5% |
| | No | 451 | 94.5% |
| | Total | 477 | 100% |
| **Near working distance** | ≤ 30cm | 155 | 32.5% |
| | >30cm | 322 | 52.2% |

### 6.3. Eye care service and related conditions:

Among the total of 477 participants, only 33 of them perceived they had reduced vision and 31 of them were visiting an eye care service for their different complaints. Only 4 and 1 participant from the cases of refractive errors had a history of refraction service and observed with spectacles for their refractive error respectively.

***Table 4****. Frequency table on other eye conditions and eye health service among school children, Bahir Dar city, 2021(n=477)*

| Characteristics | | frequency | Percentage |
|---|---|---|---|
| Presence of another eye condition | Yes | 18 | 3.8% |
| | No | 459 | 96.2% |
| | Total | 477 | 100% |
| Presence of Vision reducing conditions other than refractive error | Yes | 4 | 0.8% |
| | No | 473 | 99.2% |
| | Total | 477 | 100% |
| History of injury on either eye | Yes | 30 | 6.3% |
| | No | 447 | 93.7% |
| | Total | 477 | 100% |
| Perception of vision status | Reduced | 33 | 6.9% |
| | Normal | 403 | 84.5% |
| | Don't know | 41 | 8.6% |
| | Total | 477 | 100% |
| History of visiting eye care unit | Yes | 31 | 6.5% |
| | No | 446 | 93.5% |
| | Total | 477 | 100% |

| | | | |
|---|---|---|---|
| History of refraction service (n=31) | Yes | 4 | 12.9% |
| | No | 27 | 87.1% |
| | Total | 31 | 100% |
| Currently using spectacle (n=39) | Yes | 2 | 5% |
| | No | 37 | 95% |
| | Total | 39 | 100% |
| Currently observed with the spec (n=39) | Yes | 1 | 2.5% |
| | No | 38 | 97.5% |
| | Total | 39 | 100% |

### 6.4. Visual acuity and refraction measurements:

Among 477 students, a majority of (92.2% and 93.1% ) participants had normal visual acuity on their right and left eyes respectively. Forty-three(43) participants had a defective vision (visual acuity of 6/12 and lower) on either of the eyes.

The visual acuity was repeated using a pinhole for 43 students either or both of their eyes (37 right eyes and 33 left eyes**);** the proportion of normal vision measurement was improved to 95.0% and 96.0% of the total participants for their right and left eyes respectively. Finally, 37 participants were measured with best correction refraction, and it shows that the proportion of normal vision from total participants' eyes will improve to 99.8% and 99.2% if they wear the best correction spectacle.

***Table 5.*** *Result of Visual Acuity measurements among school children, Bahir Dar city, 2021 (n=477)*

| Visual acuity measurement | Visual acuity range | Unaided n(%) | With Pinhole n(%) | With refraction n(%) |
|---|---|---|---|---|
| **Visual acuity measurment on right eye** | <3/60 | 2(.4%) | 0 | 0 |
| | ≥3/60 & ≤6/12 | 35(7.4%) | 20(4.3%) | 1(.2%) |
| | 6/6– 6/9 | 440(92.2%) | 457(95.7%) | 476(99.8%) |
| **Visual acuity measurment on left eye** | <3/60 | 3(.6%) | 1(.2%) | 1(.2%) |
| | ≥3/60 & ≤6/12 | 30(6.3%) | 18(3.8%) | 3(.6%) |
| | 6/6– 6/9 | 444(93.1%) | 458(96%) | 473(99.2%) |
| **Visual acuity measurement on the better eye** | <3/60 | 0 | | 0 |
| | ≥3/60 & ≤6/12 | 26(5.5%) | | 1(0.2%) |
| | 6/6– 6/9 | 451(94.5%) | | 476(99.8%) |

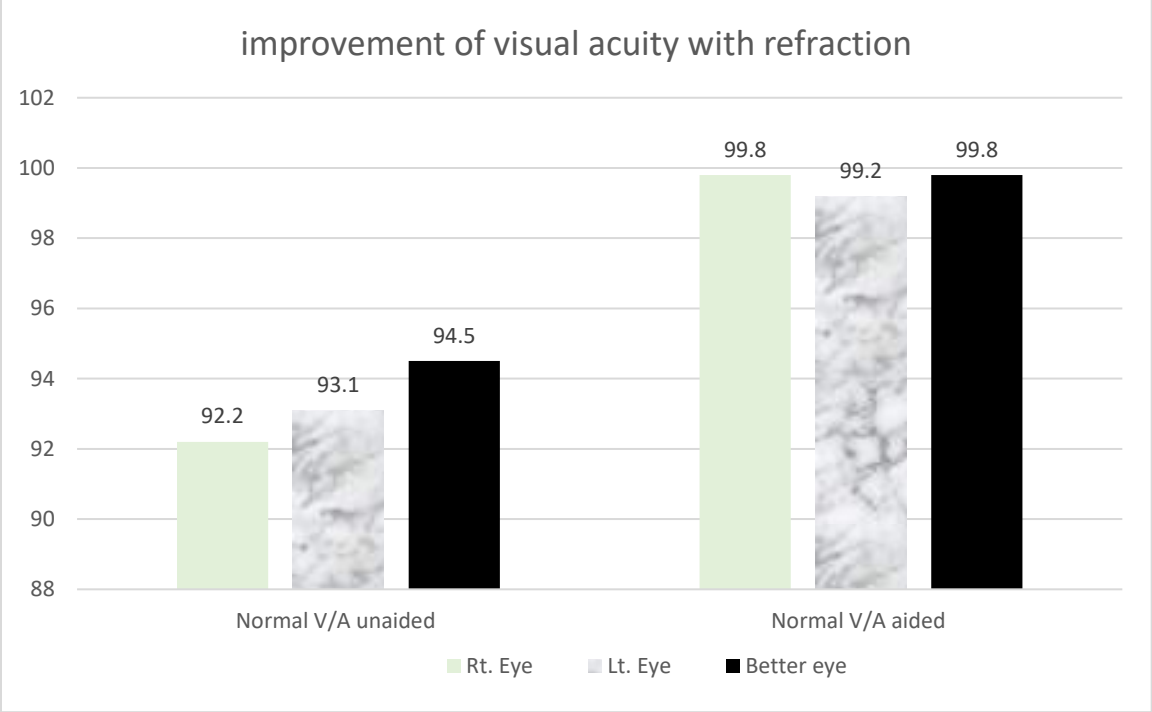



***Figure 3****: Shows the percentage of participants with normal vision before and after refraction among school children, Bahir Dar city, 2021*

### 6.5. Defective vision and type of refractive errors:

Among the study participants, 39 (8.2%) (95%CI; 5.7%,10.6%) were found to have a refractive error and only 4(10.3%) and 1(2.6%) of the cases have got spectacle prescription and currently observed as using spectacles respectively.

On 37 refractive error cases presented to eye clinic 37 right eyes and 36 left eyes were evaluated for type and degree of refractive error with autorefractor and subjective refraction, and it was found that 13.2% of the refractive error eyes had ≥6D refractive power and 86.8% of refractive error eyes had <6D of refractive error. Myopia is a type of refractive error contributing 54.0% followed by astigmatism and hyperopia with 22.0% and 19.0% respectively.

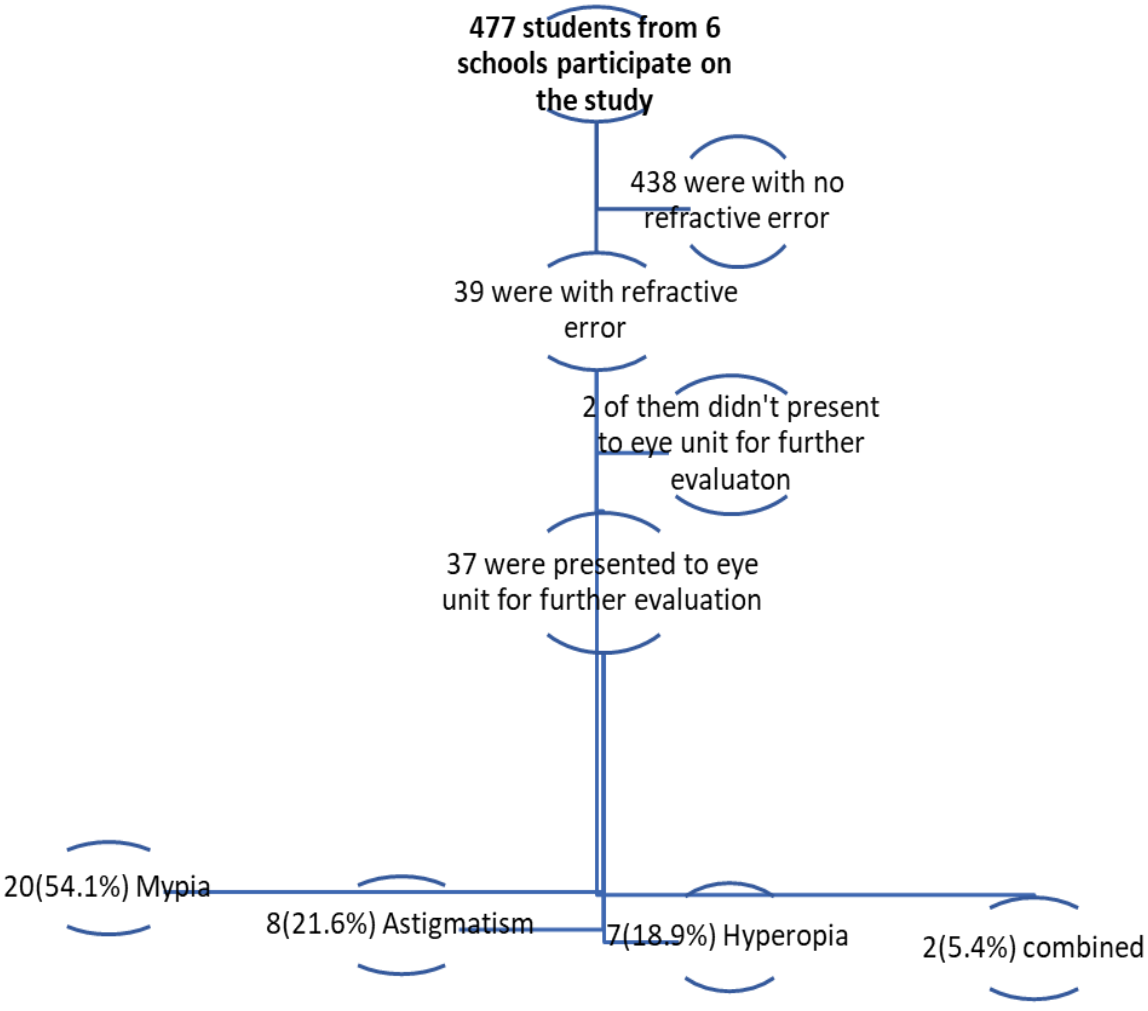



***Figure 4:*** *Refractive error measuring flowchart among school children, Bahir Dar city, 2021*

***Table 6**. Frequency table on defective vision and refraction measurements among school children, Bahir Dar city, 2021(n=477)*

| Characteristics | | Frequency | Percent |
|---|---|---|---|
| **Defective vision on either eye** | Yes | 43 | 9% |
| | No | 434 | 91% |
| | Total | 477 | 100% |
| **Refractive error Present/Absent** | Present | 39 | 8.2% |
| | Absent | 438 | 91.8% |
| | Total | 477 | 100% |
| **Type of refractive error(in person) (n=37)** | Myopia | 20 | 54.1% |
| | Astigmatism | 8 | 21.6% |
| | Hyperopia | 7 | 18.9% |
| | Combined | 2 | 5.4% |
| | Total | 37 | 100% |
| **Power of refractive error in both or either eye (D) (N=61)** | <6.0D | 53 | 86.8% |
| | ≥6.0D | 8 | 13.2% |
| | Total | 61 | 100% |

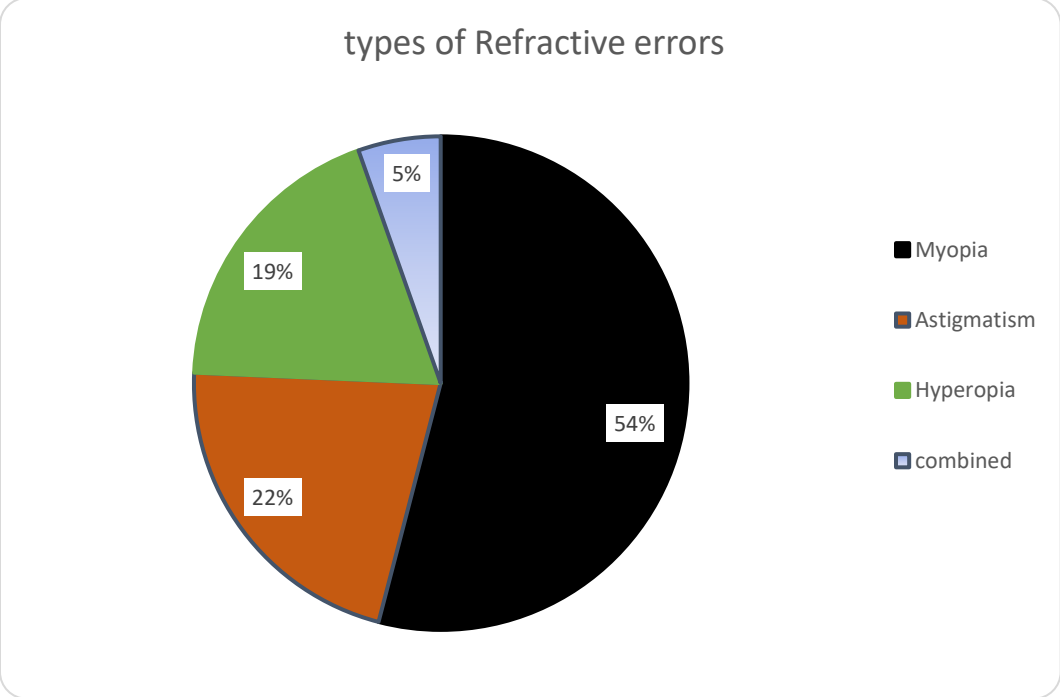



***Figure 5**: Types of refractive error among school children, Bahir Dar city, 2021*

### 6.6. Factors associated with refractive errors

Bivariate logistic regression was performed on each factor and six independent variables; female sex, higher age, higher grade level, regular computer use, eye care service users, and closer working distance for reading were found as potential associated factors for increased occurrence of refractive error.

Accordingly; being female increases the odds of having refractive errors by 2.7 times (COR = 2.7, 95%CI; 1.3-5.7, p = 0.009) as compared to males. Every one year increment in age of participants increases the odds of refractive error by 11% (COR = 1.11, 95%CI; 1.02-1.20, p = 0.015). An increase in the grade level from level II(grade 5-8) to level III(grade 9-12) of participants increases the odds of refractive errors by 2.5 times (COR = 2.50, 95% CI; 1.11- 5.65, p = 0.027) but not significant when we compare grade level I(grade 1-4) and level II(grade 5-8). Regular users of a computer for a game, video play, or reading showed that an increase in odds of refractive error by 2.42 times (COR = 2.42, 95% CI; 1.03-8.19, p = 0.028) compared to the non or irregular users of a computer. Eye care service visitors at least once showed an increase in odds of refractive error by 3

times (COR = 3.00, 95%CI; 1.15-7.69 P=0.025) as we compared to the non-visitors of eye care centers. And this study also revealed that a shorter working distance (<30cm) users for near reading increase the odds of refractive error by 3.37(COR = 3.75, 95%CI; 1.90 -7.35, p <.001) as compared to the longer ( ≥30 cm) working distance users.

Multivariable logistic regression was performed after the model fitness test with Hosmer and Lemeshow's test of model fitness, which shows non-significant(P=.593) to say the model is unfit. And After controlling for the effects of potentially confounding variables using multivariable logistic regression analysis, four variables with the characteristics of Female sex, higher age, early joining to school, and short working distance for reading were found as potential associated factors for increased occurrence of refractive error.

Accordingly; being female increases the odds of having a refractive error by 2.67 times (AOR = 2.67, 95%CI; 1.23 - 5.81, p = 0.013) as compared to males. For every one year increment in age of participants increases the odds of refractive error by 26% (AOR = 1.26, 95% CI; 1.14 -1.41, p < 0.001). Early(≤6yrs of age) joining to school increases the odds of refractive error by 2.8 times (AOR = 2.8, 95%; CI 1.27 - 6.25, p = 0.012) compared to joining to school >6yrs of age. And this study also revealed that a short working distance(<30cm) of near reading increases the odds of refractive error by 6.25 times (AOR = 6.25, 95% CI; 2.86 -12.5, p < .001) as compared to the working distance of ≥30 cm.

Regular use of a computer for reading, games and video play, eye care service utilization, and grade level; which showed statistically significant association with refractive error in bivariate analysis, did not show a significant association in the multivariable analysis.

***Table 7:*** *Hosmer and Lemeshow model fitness test for multivariable logistic regression analysis.*

**Hosmer and Lemeshow Test**

| Step | Chi-square | Df | Sig. |
|---|---|---|---|
| 1 | 11.003 | 8 | .202 |
| 8 | 6.488 | 8 | .593 |

***Table 8.*** *Multivariable logistic regression analysis of associated factors for refractive error among school children, Bahir Dar city, 2021(n=477)*

| Variables | Characteristics | Refractive Error | | COR(95%CI) | AOR(95%CI) | P-value |
|---|---|---|---|---|---|---|
| | | Yes(%) | No(%) | | | |
| **Sex** | Male | 10*(4.5%)* | 211(95.5%) | 1 | 1 | |
| | Female | 29*(11.3%)* | 227(88.7%) | 2.7(1.3,5.7) | 2.67(1.23,5.81) | 0.013* |
| **Age** | Years | 39*(8.2%)* | 438(91.8%) | 1.11(1.02,1.21) | 1.26(1.14,1.40) | <.001* |
| **Grade level** | 1-4 | 11*(5.6%)* | 187(94.4%) | 1 | 1 | |
| | 5-8 | 13*(8.0%)* | 149(92%) | 1.48(0.65,3.41) | 1.05(.33,3.39) | 0.933 |
| | 9-12 | 15*(12.8%)* | 102(87.2%) | 2.50(1.11,5.65) | 1.59(0.08,4.48) | 0.614 |
| **Schooling age** | ≤6yrs | 24*(9.4%)* | 228(90.6%) | 1 | 1 | |
| | >6yrs | 15*(6.7%)* | 210(93.3%) | 0.68(0.35,1.33) | 0.36(0.16,0.79) | 0.012* |
| **Computer use** | Yes | 5*(19.2%)* | 21(80.8%) | 1 | 1 | |
| | No | 34*(7.5%)* | 417(92.5%) | 0.34(0.12,0.97) | 1.50(0.13,1.93) | 0.318 |
| **Eye care service** | Yes | 5*(16.7%)* | 25(83.3%) | 1 | 1 | |
| | No | 34*(7.6%)* | 413(92.4%) | .333(0.13,0.87) | .54(0.16,1.79) | 0.315 |
| ***Working distance*** | ≤30cm | 24*(15.5%)* | 131(84.5%) | *1* | *1* | |
| | <30cm | 15(*6.0%)* | *307*(94%) | .27(0.14,0.51) | *0.16(0.08,0.35)* | <.001* |

* P value less than 0.05, "1" in COR and AOR indicate the reference category,

## 7. DISCUSSION

Refractive error is a visual impairing condition due to light rays not able to focus on the retina. Common types of RE are Myopia, Hyperopia, and Astigmatism. Due to uncorrected RE children suffer from decreased quality of life, related to limitations in learning development and other vision-related tasks. Knowing the magnitude and factors of the disease will help for the plan of action to reduce the impact at individual, community, and country levels through evidence-based implementations. As a result, this study was intended to describe the overall prevalence and associated factors of refractive error among school children in the city of Bahir Dar.

In this study, out of 477 students, 39 (8.2%) (95%CI; 5.7%,10.6%) had a refractive error; and which is a significant burden in school children. This finding was in line with other studies conducted in Northwest Ethiopia; Debremarkos in 2014(10.2%), Gondar in 2012(9.4%), and one study conducted in Malasia, 2008(7%). And this finding also fairly comparable with the global systematic review and meta-analysis conducted in 2018(10.4%)(21, 27, 36, 38).

This finding was higher than the results from the studies of central Ethiopia undertaken in Addis Ababa in 2015(4%) and 2020(4.1%), and the Gurage zone in 2014(3.5%)(6, 16, 34). This variation could be due to the geographical difference and the study group that they use were primary schools, but we use all school levels. On the contrary, this finding is optimally lower than the result produced by the studies undertaken in South East Asian countries; Indonesia in 2020(15.9%), and India in 2018(13.4%) (25, 26, 28), and on the studies of other African countries; Gana in 2010(13%), Somalia in 2020(15.7%) and Burkinafaso in 2014(12.4%) (30, 32, 33); and much lower than the results observed in studies of Chinees 2010(22.5%) and 2019(20.75%) and one study in Saudi Arabia in 2018(22%) (22, 23). This variation could be the geographic and race differences observed in the study areas.

In this study, myopia was found to be the dominant(54%) type of refractive error in both eyes followed by astigmatism (22%) and hyperopia 19%. This indicates that the majority of the refractive error type found in this study is a type that progressively worsening with age that may indicate higher prevalence at higher age groups(43). This finding was in line

with the studies conducted in all reviewed studies found in Ethiopia, which presented that myopia is the leading type of refractive error, followed by astigmatism (6, 16, 34-38). And also this study is in line with the study found in Somalia 2020, China in 2010, and India in 2018(22, 25, 33). This study is on the contrary to the studies undertaken in Ghana, Burkina Faso, and Uganda which revealed that astigmatism was the leading type of refractive error contributing from 49% to 56.4% of the total causes of refractive error, followed by hyperopia, ranging from 37% to 39.5% of the total visual impairment due to refractive error and Myopia, ranging from 4% to 12.6% of the total causes of refractive error(30-32). This difference could be a racial difference between the study populations.

The uptake of refractive service, cases with a history of using spectacle, and cases observed with spectacle were 10%, 5%, and 2.5% from the total cases; which is unpredictable with such result that indicates 97.5% of the total cases of refractive were observed with unmet needs, and it is comparable with other studies conducted in Ethiopia, Mehari et al. 2013, Kedir et al. 2014, Sewunet et al. 2014, Nebiyat et al. 2015, revealed that the proportion of uncorrected refractive error was 99.7%, 100%, 95.4%, 97.7% respectively(6, 34-36). And this finding was much higher than the findings of the studies found in Asian countries Malaysia in 2020, Indonesia in 2008, and other African countries South Africa in 2013, and Somalia in 2020, 52%,76%, 81%, 82.4% respectively (26, 27, 29, 33). This could be due to differences in eye care service or the whole health service coverage, and difference in cost of refraction and spectacles between countries(44).

The present study revealed that being female was 2.67 times(AOR = 2.67, 95%CI; 1.23 - 5.81, p = 0.013) more likely to experience refractive errors than male participants. Which will alarm more intensified application of effort in female children. This was entirely supported by the findings on the studies conducted by Sewunet et al. in Debre Markos town, 2014, and studies conducted in South Africa, 2016, and India, 2018 (24, 36, 39).

In this study as age increases the prevalence of refractive error was observed to increase; which shows that for every one year increment in the age of participant the occurrence of refractive error was increased by 26 percent(AOR = 1.26, 95% CI; 1.14 -1.41, p < 0.001). This finding was supported by the finding of the study result undertaken in India,2018,

and Somalia,2020 which shows that a higher age group was associated with a high occurrence of refractive errors(29, 33).

This study signifies that the near(<30cm) working distance that the children usually use on their near reading showed that a statistically significant association for the higher occurrence of refractive error, which shows 6.25 times higher(AOR = 6.25, 95% CI; 2.86 -12.5, p < .001) in <30 cm working distance for near reading users as compared with the >30cm working distance for near reading users. It was supported with the study undertaken in Australia, 2008, which shows a significant association of near work(< 30 cm working distance) for the occurrence of myopia. Also, time spent in continuous reading has an association with the high occurrence of myopia; which signifies that short working distance with longer time spent on continuous reading will increase the occurrence of refractive error(23, 40).

Schooling age also showed a significant association as a potential factor for refractive error, which shows that early(≤6yrs) joining to school was 2.77 times higher(AOR = 2.8, 95%; CI 1.27 - 6.25, p = 0.012) to develop refractive error as compared to those joining to school at the age of >6yrs. This could be explained by early school joining children were more vulnerable for near-work activities like continuous reading(23, 40).

## 8. LIMITATION OF STUDY

This study was resource-limited and difficult on setup preparation for refraction area to consider onsite refraction service. And also limited to perform refraction using cycloplegic drops (difficulty of getting consent due to its effect on one-day educational activity), which may create a little underestimated in the prevalence (45, 46).

## 9. CONCLUSIONS

Refractive error is a major challenge in school children in the study area; as many children not aware that they have visual problems and may think that they have normal sight. Some students may have trouble reading the board or seeing close objects clearly, which might affect their academic performance and their quality of life.

This study is intended to describe the overall prevalence of refractive errors which was found as a common problem among school children of Bahir Dar city and Myopia was the dominant type of refractive errors. The uptake of eye care service for refraction and usage of corrective spectacle were observed very low. Female sex, higher age, early joining to school and closer working distance for reading were found as potential associated factors. And this study highlights that screening at an early age and reducing near-work activities will reduce the impact of refractive errors.

Although the study found RE is common among school children with uncountable usage of spectacle to correct it, further studies are there fore needed to evaluate the impact of refractive error on education and the reason why cases are living without corrected or high unmet need.

## 10. RECOMMENDATIONS

- **To the Ministry or Bureau of Health**

  Training of school teachers, providing low-cost corrective spectacles and thinking of including spectacles in national drug lists; which will reduce the unmet need for refraction could be considered as strategy for changing the way currently provided for controling the problem.

  Programs of large-scale school-level screening for refractive error need to be developed and integrate with other school-level screening programs.

- **Eye care units and Ophthalmic professionals**

  Eye care units are required considering outreach services in schools in addition to strengthening routine eye care services.

- **To schools and Students**

  Encouraging school health clubs which will improve screening at an early age, highly engagement of female students, and early linkage of cases to eye care services; so that long-term visual disability could be minimized.

- **To the researchers**

  Further community-based cycloplegic refractive error survey is recommended to estimate the population-based prevalence and its factors.

  Evidence is also needed to evaluate why cases with a refractive error are staying uncorrected.

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## 12. ANNEXES

### Annex-I. Information Sheet for the start of the questionnaire(English)

Dear respondent/Parent/Guardian, my name is ……. , I am here as a data collector in this study to assess the prevalence and associated factors of refractive error among school children.

Here are lists of questions and examinations with different sections, which are designed for research work to be conducted in partial fulfillment of a master's degree by Demis Assegie from Bahirdar University. Your responses and result of the examination are completely confidential and will never be used in connection with any of the information you provide. You have a choice either not to answer any question that you do not want to answer or withdraw the participation in the study at any time you want. However, your honest response to the questions and cooperativeness on the examination will help us to better understand the prevalence and its factors.

It will take not more than 20 minutes and there is no benefit or payment that you will get for your participation in this study. But your honest & genuine response to each question will play a major role in the attainment of the objective of the study.

Therefore I thank you in advance and greatly appreciate your understanding and willingness. Do you understand all that has been said so far? If you have questions regarding this study or would like to be informed of the results after its completion, please do not hesitate to contact;

Contact Address of the Investigator:

Name: Demis Assegie

Cell phone: +251967 974839

### Annex II:- Consent form( English)

I, the selected participant heard the information in the study information sheet & understood the purpose and what is required from me if I take part in the study. I understood that all the information and examination will not harm and must not be transferred to a third party. I also understand that I can decide whether to take part in the study or even withdraw from the study at any time. In this regard, I am giving consent to participate in the study.

Participant/Parents/Gardian signature_____Date_____

Data collector's name and Sign._____

**Annex III:- Structured questioner form ( English)**

Code No---------- School Name ----------

***Part I: Socio-Demographic Characteristics***

| S.No | Questions | Alternative answers | Remark |
|---|---|---|---|
| 101 | Sex | 1. Male<br>2. Female | |
| 102 | Age(years) | ---------- years | |
| 103 | Religion | 1. Christian<br>2. Muslim<br>3. Others | |
| 104 | Grade level | 1. Grade 1-4<br>2. Grade 5-8<br>3. Grade 9-12 | |
| 105 | Residence | 1. Urban<br>2. Rural | |
| 106 | Schooling age in years | ---------- | |
| 107 | School type | 1. Government<br>2. Private | |

***Part II Factor related Questions***

| S.No | Questions | Alternative answers | Remark |
|---|---|---|---|
| 201 | Does anyone in your family wear spectacles? | 1. Yes<br>2. No | If the answer is No, skip to Q 203 |
| 202 | If your answer is yes for Q 201, who wears a spectacle among your family? | 1. Father<br>2. Mother | |

| | | | |
|---|---|---|---|
| | | 3. Brother/Sister<br>4. other family members | |
| 203 | Do you use a computer for reading, games, or movies/at least 5 days per week/ | 1. Yes<br>2. No | If the answer is No, skip to Q 205 |
| 204 | If your answer is yes for **Q 203**, how long do you use it per day? | ---------- (hr) | |
| 205 | Do you use mobile phones for reading, game, or movies/at least 5 days per week/ | 1. Yes<br>2. No | If the answer is No, skip to Q 207 |
| 206 | If your answer is yes for **Q 205**, how long do you use it per day/on average/ | ---------- (hr) | |
| 207 | Do you watch Television regularly/at least 5 days per week/ | 1. Yes<br>2. No | If the answer is No, skip to Q 210 |
| 208 | If your answer is yes for Q **207**, how long do you watch it per day /on average/ | ---------- (hr) | |
| 209 | If your answer is yes for Q **207**, usually, How far your seat to look on television/on average/ | 1. < 2 meters<br>2. 2 -4 meters<br>3. > 4meters | |
| 210 | Have you attained a history of eye injury? | 1. Yes<br>2. No | |
| 211 | Have you aware of your reduced vision? | 1. Yes<br>2. No | |
| 212 | Do you have a previous visit for eye care service | 1. Yes<br>2. No | If the answer is No, Stop here |

| | | | |
|---|---|---|---|
| 213 | Have your history of refraction correction or prescription of refraction | 1. Yes<br>2. No | |
| 214 | If your answer is yes for Q 213 do you have spectacle currently | 1. Yes<br>2. No | END of Question |

**Part III: Physical Examination**

| S.No | Questions | Alternative answers | Remark |
|---|---|---|---|
| 301 | Is he/she wearing spectacle | 1. Yes<br>2. No | |
| 302 | Is other eye conditions present on the right eye | 1. Yes<br>2. No | If the result is No for these two questions skip to Q 306 |
| 303 | Is other eye conditions present on the left eye | 1. Yes<br>2. No | |
| 304 | Is the condition vision reducing(right eye) | 1. Yes<br>2. No | |
| 305 | Is the condition vision reducing(Left eye) | 1. Yes<br>2. No | |
| 306 | The working distance on reading | ----------(cm) | |
| 307 | Presenting Visual Acuity measurement with Snellen's E chart | 1. OD ----------<br>2. OS ---------- | If better than 6/12 stop here |
| 308 | Visual Acuity with Pinhole measurement | 1. OD ----------<br>2. OS ---------- | If no improvement stop here |
| 309 | Type of refractive error (right eye) | 1. Myopia<br>2. Hyperopia<br>3. Astigmatism | |

| | | | |
|---|---|---|---|
| 310 | Type of refractive error (left eye) | 1. Myopia<br>2. Hyperopia<br>3. Astigmatism | |
| 311 | Diopter of refraction | 1. OD ----------<br>2. OS ---------- | |
| 312 | Visual Acuity with refraction | 1. OD ----------<br>2. OS ---------- | END of examination |
| | | | |

## Annex IV : Information Sheet for the start of the questionnaire(Amharic Version)

ውድ መልስ ሰጭ/ ወላጅ/ሞግዚት፣

ስሜ ..... ፣ እኔ በትምህርት ቤት በሚማሩ ተማሪዎች መካከል በመነጸር የሚስተካከል ችግር መጠን እና ተያያዥ ሁኔታዎችን ለማጥናት በሚደረግ መረጃ ስብሰባ ላይ መረጃ ሰብሳቢ ነኝ ::

እዚህ ላይ የቀረቡ የመጠይቅ እና የምርመራ ዝርዝሮች ከባህር ዳር ዩኒቨርስቲ አቶ ደምስ አሰጌ የሚባሉ ለ2ኛ ዲግሪ ማሙያ የሚሆን ለምርምር ሥራ የሚረዱ የተለያዩ ክፍሎች ያሉት ናቸው:: ይህ ጥናት እርስዎ በሚሰጡን መረጃ እና በሚደረግለዎት ምርመራ ላይ የተመሰረተ ስለሆነ ፍቃድዎ ከሆነ መረጃውን በመስጠትና ለዐይን ምርመራው ትብብር እንዲያደርጉልን በትህትና እንጠይቃለን::በጥናቱ ላይ መሳተፍ የማይፈልጉ ከሆነ አሁንም ሆነ በሂደት ላይ አለመስማማት ይችላሉ:: ሆኖም ግን ጥናቱ ከትንሽ ጊዜ ከመፍጀቱ ውጪ ምንም አይነት ጉዳት የማያመጣ ስለሆነ እርሶም/ ልጅዎ እንዲሳተፉ እናበረታታለን:: መረጃዎ ምስጢራዊነቱ የተጠበቀ፣ ለጥናቱ ብቻ የሚውል ና ለሌላ ጉዳይ የማንጠቀምበት መሆኑን ልናረጋግጥልዎ እንወዳለን::

ጥናቱ ከ20 ደቂቃዎች ያልበለጠ የሚወስድ ሲሆን፤ በዚህ ጥናት ውስጥ በመሳተፍ የሚያገኝ ጥቅማጥቅም ወይም ክፍያ አለመኖሩን እየገለፅን እያንዳንዱ ጥያቄ ላይ ሐቀኛ እና እውነተኛ ምላሽ መስጠትዎ፤ እንዲሁም ለምርመራ ተባባሪ መሆንዎ የጥናቱን ዓላማ ለማሳካት ትልቅ ሚና ይጫወታል::

ስለሆነም በቅድሚያ ስለመረዳትዎ እና ስለፈቃደኛነትዎ በጣም እያመሰገንሁ፤ እስካሁን የተናገርሁትን ሁሉ ተረድተዋል ብየ በመተማመን ፍቃደኝነትዎን በፊርማ እንዲያረጋግጡልን በትህትና እየጠየቅን ወደ ቃለ መጠይቁና ምረመራው እንሄዳለን::

ማንኛውም ሊያነሱ የሚፈልጉት ጥያቄ ካለዎት የጥናቱን ባለብይት በሚቀጥለው አድራሻ ማነጋገር ይችላሉ::

ስም: ደምስ አሰጌ

ሞባይል ስልክ: +251967 974839

## Annex V:- Consent form(Amharic Version)

<u>ፍቃድ መጠየቂያ ቅጽ</u>

እኔ/ ልጄ ለጥናቱ ተሳታፊ እንድሆን የተመረጥሁ፤ በጥናቱ የመረጃ ወረቀት ውስጥ ያለውን መረጃ አዳምጫ/አንብቤ እና በጥናቱ ውስጥ ከተሳተፍኩኝ/ከተሳተፈ(ች) የጥናቱ ዓላማ ምን እንደሆነና ከእኔ/ከልጄ ምን እንድሚጠበቅ ተረድቻለሁ :: ሁሉም መረጃዎች እና ምርመራዎች እንደማይጎዱ እና ወደ ሶስተኛ ወገን ሊተላለፉ እንደማይችሉ ተረድቻለሁ :: በጥናቱ ለመሳተፍም ሆነ በማንኛውም ጊዜ ከጥናቱ ለማቋረጥ መወሰን እንደምችል ተረድቻለሁ :: በዚህ ረገድ እኔ/ልጄ በጥናቱ ለመሳተፍ ፈቃድ እሰጣለሁ ::

የተሳታፊ/የወላጅ/የተጠሪ ፊርማ _____

ቀን_____

የመረጃ ሰብሳቢው ስም እና ፊርማ _____

**Annex VI:- Structured questionnaire form ( Amharic Version)**

ኮድ ቁጥር---------- የት/ቤት ስም----------ክፍል.----------

**ክፍል፮** : **ማኅበራዊ መረጃ**

| ተ/ቁ | መጠይቆች | የመልስ አማራጭ | ምርመራ |
|---|---|---|---|
| 101 | የተማሪው/ዋ ፆታ | 1. ወንድ<br>2. ሴት | |
| 102 | የተማሪው/ዋ ዕድሜ (በዓመት) | ----------ዓመት | |
| 103 | የተማሪው/ዋ ሃይማኖት | 1. ክርስትያን<br>2. ሙስሊም<br>3. ሌላ | |
| 104 | የተማሪው/ዋ የትምህርት ደረጃ | _____ | |
| 105 | የተማሪው/ዋ የመኖሪያ ቦታ | 1. ከተማ<br>2. ገጠር | |
| 106 | ተማሪው/ዋ ትምህርት ቤት የገባ/ችበት እድሜ በአመት | ----------ዓመት | |
| 107 | የተማሪው/ዋ የትምህርት ቤት አይነት | 1. የመንግስት<br>2. የግል | |

***ክፍል ፯: ስለተያያዥ ጉዳዮችን በተመለከተ***

| ተ/ቁ | መጠይቆች | የመልስ አማራጭ | ምርመራ |
|---|---|---|---|
| 201 | ከቤተሰብ ውስጥ ለእይታ መነጸር የሚጠቀም አለ ? | ነ. አዎ<br>2. የለም | መልሱ የለም ከሆነ ወደ ጥያቄ ቁ **203** ይሂዱ |
| 202 | ለጥያቄ **201** መልስዎ አዎ ከሆነ ከቤተሰብ ውስጥ ማን ነው መነጸር የሚጠቀም? | 1. አባት<br>2. እናት<br>3. ወንድም/እህት<br>4 ሌላ ቤተሰብ | |

| | | | |
|---|---|---|---|
| 203 | ተማሪው/ዋ ለማንበብ፤ ለጫወታ፤ ወይም ተንቀሳቃሽ ምስል ለማየት ኮምፒዩተር ትጠቀማለህ/ሽ ? /ቢያንስ በሳምንት ለ5 ቀን/ | 1. አዎ<br>2. አልጠቀምም | መልሱ የለም ከሆነ ወደ ጥያቄ ቁ **205** ይሂዱ |
| 204 | ለጥያቄ ቁ **203** መልሰዎ አዎ ከሆነ በቀን ለስንት ሰዓት ያክል ይጠቀማሉ?/በአማካኝ/ | ----------(ሰዓት) | |
| 205 | ተማሪው/ዋ ለማንበብ፤ ለጫወታ፤ ወይም ተንቀሳቃሽ ምስል ለማየት ሞባይል ትጠቀማለህ/ሽ /ቢያንስ በሳምንት ለ5 ቀን/ | 1. አዎ<br>2. አልጠቀምም | መልሱ የለም ከሆነ፤ ወደ ጥያቄ ቁ **207** ይሂዱ |
| 206 | ለጥያቄ ቁ **205** መልሰዎ አዎ ከሆነ በቀን ለስንት ሰዓት ያክል ይጠቀማሉ?/በአማካኝ/ | ----------(ሰዓት) | |
| 207 | የተማሪው/ዋ ቴሌቪዥን በየቀኑ ትመለከታለ/ሽ? /ቢያንስ በሳምንት ለ5 ቀን/ | 1. አዎ<br>2. አልመለከትም | መልሱ የለም ከሆነ፤ ወደ ጥያቄ ቁ **210** ይሂዱ |
| 208 | ለጥያቄ ቁ **207** መልሰዎ አዎ ከሆነ፤ በቀን ለስንት ሰዓት ያክል ይመለከታል/ትመለከታለች?/በአማካኝ/ | ----------(ሰዓት) | |
| 209 | ለጥያቄ ቁ **207** መልሰዎ አዎ ከሆነ፤ አብዛኛውን ጊዜ በምን ያክል ርቀት ይቀመጣል/ለች?/በአማካኝ/ | 4. ከ2 ሜትር በቀረበ ርቀት<br>5. ከ2 -4 ሜትር ባለ ርቀት<br>6. ከ4ሜትር የራቀ ርቀት | |
| 210 | ተማሪው/ዋ እስካሁን አይኑን/ኗን የመታው/ት ነገር እንደነበር ታስታውሳለህ/ሽ? | 1. አዎ<br>2. የለም | |
| 211 | ተማሪው/ዋ የእይታ መቀነስ አለበት/ባት? | 1. አዎ<br>2. የለም<br>3. አላውቅም | |
| 212 | ተማሪው/ዋ እስካሁን የዓይን ምርመራ አድርጎ/ጋ ያውቃል/ታውቃለች? | 1. አዎ<br>2. የለም | መልሱ የለም ከሆነ፤ ጥያቄውን ያቁሙ |
| 213 | ተማሪው/ዋ እስካሁን የዓይን ምርመራ አድርጎ/ጋ መነጸር ታዝዞለት/ላት ያውቃል? | 1. አዎ<br>2. የለም | |
| 214 | ለጥያቄ ቁጥር **213** መልሰዎ አዎ ከሆነ፤ ተማሪው/ዋ መነጸር እየተጠቀመ/ች ነው? | 1. አዎ<br>2. አይጠቀምም/አትጠቀምም | የጥያቄ መጨረሻ |

## ክፍል ፫: የዓይን ምርመራ

| S.No | Questions | Alternative answers | Remark |
|---|---|---|---|
| 301 | Is he/she wearing spectacle | 1. Yes<br>2. No | |
| 302 | Is other eye conditions present on the right eye | 1. Yes<br>2. No | If the result is No for these two questions skip to Q 306 |
| 303 | Is other eye conditions present on the left eye | 1. Yes<br>2. No | |
| 304 | Is the condition vision reducing(right eye) | 1. Yes<br>2. No | |
| 305 | Is the condition vision reducing(Left eye) | 1. Yes<br>2. No | |
| 306 | The working distance on reading | ----------(cm) | |
| 307 | Presenting Visual Acuity measurement with Snellen's E chart | 1. OD ----------<br>2. OS ---------- | If better than 6/12 stop here |
| 308 | Visual Acuity with Pinhole measurement | 1. OD ----------<br>2. OS ---------- | If no improvement stop here |
| 309 | Type of refractive error (right eye) | 1. Myopia<br>2. Hyperopia<br>3. Astigmatism | |
| 310 | Type of refractive error (left eye) | 1. Myopia<br>2. Hyperopia<br>3. Astigmatism | |
| 311 | Diopter of refraction | 1. OD ----------<br>2. OS ---------- | |
| 312 | Visual Acuity with refraction | 1. OD ----------<br>2. OS ---------- | END of examination |

**Annex VII- Candidate's Declaration form**

# Declaration

This is to certify that the thesis entitled "*prevalence and associated factors of refractive error among school children, Bahir Dar, Northwest Ethiopia*" submitted in partial fulfillment of the requirements for the degree of Master of masters of public health in Epidemiology, Department of Epidemiology and Biostatistics, Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation have been duly acknowledged.

| | | |
|---|---|---|
| Name of the candidate | Date | Place |

**Annex VIII- Advisor's Approval Form**

# Bahir Dar University

## COLLEGE OF MEDICINE AND HEALTH SCIENCES

## SCHOOL OF PUBLIC HEALTH

## Department of Epidemiology and Biostatistics

### APPROVAL OF THESIS RESEARCH FOR DEFENSE

I hereby certify that I have supervised, read, and evaluated this thesis entitled "*PREVALENCE AND ASSOCIATED FACTORS OF REFRACTIVE ERROR AMONG SCHOOL CHILDREN, Bahir Dar, Northwest Ethiopia*" by Demis Assegie prepared under my guidance. I recommend the thesis research be submitted for oral defense.

| **Advisor name** | Signature | Date |
|---|---|---|
| 1. Berhanu Elfu | _____ | _____ |
| **Co-Advisor name** | Signature | Date |
| 1. Asiya Mohammed | | _____ |

_____

.

**Annex IX: Examiner's approval form**

# Bahir Dar University

## COLLEGE OF MEDICINE AND HEALTH SCIENCES

## SCHOOL OF PUBLIC HEALTH

## Department of Epidemiology and Biostatistics

### Approval of thesis for defense result

We hereby certify that we have examined this thesis entitled "*PREVALENCE AND ASSOCIATED FACTORS OF REFRACTIVE ERROR AMONG SCHOOL CHILDREN, Bahir Dar, Northwest Ethiopia*" by Demis Assegie. We recommend and approve the thesis a degree of "masters of public health in Epidemiology"

### Board of Examiners

| | | |
|---|---|---|
| _____ | _____ _____ | |
| External examiner's name | Signature | Date |
| _____ | _____ _____ | |
| Internal examiner's name | Signature | Date |
| _____ | _____ _____ | |
| Chair person's name | Signature | Date |