

## **PREVALENCE AND FACTORS ASSOCIATED WITH REFRACTIVE ERROR AMONG PRIMARY SCHOOL CHILDREN IN ADDIS ABABA, ETHIOPIA**

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### **ABSTRACT**

*Introduction: - Refractive errors (myopia, hyperopia and astigmatism) affect the whole spectrum of the population irrespective of age, gender, race and ethnic group. Such refractive errors can be easily diagnosed, measured and corrected with glasses or other refractive corrections to attain normal vision. In the last few years, considerable attention has not been given to the contribution of refractive errors to global cause of visual impairment and blindness. Ethiopia is one of the least developed countries in Africa, with relatively poor health service coverage especially of eye health care and is believed to have one of the world's highest rates of blindness. Refractive error is the second leading cause of low vision in Ethiopia accounting for 33.4%, and the leading cause of blindness accounting for 7.8%. Objectives:-To assess prevalence and associated factors of refractive error among primary school children. Methods: - An institution based cross sectional study of 1800 students in four elementary schools in Arada and Gullele sub cities was conducted from February 29- April 15, 2014. Subjects were selected by multistage random sampling. Data was collected by pretested questionnaire. Data collected was cleaned, coded and entered to SPSS version 20.0 for analysis. Bivariate logistic analysis using odds ratio was made to assess predictor variables. Beside, multivariate analysis was applied to control confounding variables. A confidence interval, which does not contain one, is significant. Result: - This cross sectional study was comprised of 695 male and 1105 female, from 4 randomly selected elementary schools with a response rate of 99.4%. Refractive errors in either eye or both were present in 71 students (4%). Of these myopia was diagnosed in 19(26.7%), 12(17%) of them have Astigmatism, 10(14%) of them were with Myopic astigmatism, 6(8.4%) of them had Hyperopia, and 3(4.2%) of them had Hyperopic astigmatism on both eyes, 21(29.6%) participants had Anisometropia. Being male and not having visual impairment decreases the odds of refractory error with odds of [(95%AOR.573 (.331-.994) and 95%AOR.312 (.180-.540)] respectively. Conclusion and recommendation: - Refractive error among children is a common problem in school age and they should be screened at least once in their stay in the elementary school.*

**Keywords:** Refractory error, School children, Prevalence, Factors associated.

## Contribution/ Originality

As to the knowledge of the authors, no such study is conducted in the urban central part of Ethiopia. Most studies were done in the northern and rural central part of the country. Therefore, this study investigated prevalence and factors associated with refractory error in the urban central part of the country.

## 1. INTRODUCTION

Refractive errors (myopia, hyperopia and astigmatism) affect the whole spectrum of the population irrespective of age, gender, race and ethnic group. Such refractive errors can be easily diagnosed, measured and corrected with glasses or other refractive corrections to attain normal vision. Uncorrected or under corrected refractive errors have severe consequences for the individual, family and society. Previously significant attention has not been given to the contribution of refractive errors to global cause of visual impairment and blindness. This resulted from the realization that previous global estimates of blindness and visual impairment have underestimated the contribution of refractive errors, because many definitions of blindness have been based on best-corrected distance visual acuity [1].

Refractive error, and particularly myopia, places a considerable burden on the individual and on society. Myopia can have impending negative impact on career choice, ocular health, and sometimes self-esteem. School-age children constitute a particularly vulnerable group, where uncorrected refractive error may have a remarkable impact on learning capability and educational potential, as well as economic cost to the family and government [2].

Ethiopia is one of the least developed countries in Africa, with relatively poor health service coverage especially of eye health care and is believed to have one of the world's highest rates of blindness. Refractive error is the second leading cause of low vision (33.4%) and also the second leading cause of blindness (7.8 %) in Ethiopia [3].

The World Health organization (WHO), in its most latest global statistics has revealed that, there are 39 million blind people, including 1.4 million children under the age of 15, and 125 million with severely impaired vision, resulting in a total of over 160 million visually impaired people [4].

There are about be 153 million people with visual impairment due to uncorrected refractive errors, of whom eight million are blind and 145 million have low vision because of lack of adequate refractive correction. Among the 153 million,13 million are children and 45 million working age adults, 90% of these are living in low and middle income countries [5].

Refractive error has been ignored in previous estimates that were based on best-corrected vision. Combined with the 161 million people visually impaired estimated in 2002 according to best-corrected vision, 314 million people are visually impaired from all causes. Uncorrected refractive errors become the main cause of low vision and the second cause of blindness [6].

The burdens of undetected and uncorrected refractive errors are serious especially in school children. Poor vision and an inability to read material on the chalkboard due to refractive error can greatly affect a child's participation in education, different activities and other social

participations. In other hand, adults are excluded from productive working lives, with severe economic and social consequences. Because of their inability to see well, individuals and families failed to fulfill their economic need [7].

According to the 2006 National Survey Report in Ethiopia 7.8 per cent of blindness was due to uncorrected refractive errors and it is the second major cause of low vision accounting for 33.4 % [3]. In a study done in Debarik and Kola Diba towns, northern Ethiopia, the prevalence of visual impairment due to refractive errors in schoolchildren was 7.6 percent.[2].

Childhood blindness is among the priorities of WHO and the impact of blindness due to refractive errors is considered in terms of blind person-years. A person becoming blind due to refractive error at a young age and which is not corrected, would suffer many more years of blindness than a person becoming blind from cataract in old age and would place a greater socio-economic burden on society. Therefore, WHO recommends a regular visual screening program and provision of free spectacles for schoolchildren [8].

In Ethiopia over 80% of blindness and visual impairment is preventable, but a lots of people continue to lose their sight simply because they do not have access to the basic eye care that is so easily available in the developed world [3].

Previous studies indicated that prevalence of refractive error is far above what we think and estimate. Ethiopia is among developing countries where refractive error prevalence is high and also where young population is dominant in number. Therefore, this study will assess the prevalence of refractive error in primary school children in Addis Ababa.

## 2. OBJECTIVES

The general objective of this study was to assess prevalence and associated factors of refractive error among primary school children in Addis Ababa and the specific ones included;

- To determine the magnitude of refractive error.
- To identify the type of refractive error which is significant cause of low vision
- To assess factors associated with refractive error.

## 3. METHODOLOGY

This study was done in randomly selected primary schools in Addis Ababa from February 29 to April 15, 2014. Addis Ababa is the capital city of Ethiopia with around 3 million populations. There are about 730 primary schools in Addis Ababa City Administration; these schools are owned by government, private, church, mosque, foreign community, mission and others. Among these government primary schools account only 16%. There are 104 primary schools, among these; government owns 22 schools in Addis Ababa [9].

A cross-sectional study design was conducted in primary schools of Addis Ababa, Ethiopia. The source populations for the study were all primary school children in the city and the study populations were primary school children in Arada and Gullele sub cities from selected primary schools.

The sample size was calculated using the formula for estimation of a single proportion. The sample size was determined by assuming refractive error proportion of 9.4% taken from a study done on prevalence of refractive error among school children in Gondar town [10] giving any particular outcome to be within 2.5% marginal error and 95% confidence interval of certainty. The actual sample size for the study was computed using one-sample population proportion formula as indicated below.

$$n = \frac{(z/\alpha/2)^2 P(1-P)}{d^2}$$

Where: n = Sample size z = critical value 1.96

p = 9.4% taken from study conducted on prevalence of refractive error among schoolchildren in Gondar town [10].

d = maximum allowable error = 0.02, a design effect of 2 for multistage sampling, thus the sample size was

$$n = \frac{(1.96)^2 \times 2 \times 0.094(1-0.094)}{(0.02)^2} = 818$$

A design effect of two for multi stage sampling, and 10% non-response rate and the final sample size was 1800.

A multistage sampling technique using three stage of the sampling process was used. Initially, from Addis Ababa two sub cities were selected randomly. Four schools out of 22 government primary schools were selected in Arada and Gullele sub cities using computer generated random numbers. The number of students for each school was assigned according to the proportion to size of students in the respective schools. Proportional allocations of samples were made for each sex in each school. A systematic random sampling was finally used to identify study subjects from each of the selected grades.

Children who are physically and psychologically capable of having their eyes refracted and attending elementary schools of Arada and Gullele sub cities in day time education were included in the study. Schoolchildren enrolled for evening classes and those sick during study period that were physically unable to perform the tasks necessary for the study were excluded.

The presence or absences of refractive error are dependent variables while the independent variables in this study included;

- |             |                              |                         |
|-------------|------------------------------|-------------------------|
| ➤ Sex       | ➤ Level of education (grade) | ➤ Pinhole examination   |
| ➤ Age       | ➤ Educational performance    | ➤ Slit lamp examination |
| ➤ Religion  | ➤ Visual acuity              | ➤ Retinoscopy           |
| ➤ Address   |                              |                         |
| ➤ Ethnicity |                              |                         |

### 3.1. Operational Definitions

**Presence of refractive error:** - visual acuity of <6/12 in either eye or both, which can be corrected by spectacle.

**Absence of refractive error:-** visual acuity of >6/12 in both eyes.

**Myopia-** visual acuity is less than 6/12 in either eye or both, that can be corrected by concave minus (spherical) lens.

**Hyperopia:** - visual acuity is less than 6/12 in either eye or both, that can be corrected by convex plus lens.

**Astigmatism:-** visual acuity is less than 6/12 in either eye or both, that can be corrected by cylindrical plus or minus lens [2, 11-13].

Pretested, structured questionnaire were used to collect data. The questionnaire had three sections (socio-demographic characteristics, ophthalmic history and eye examination)

All details of participant were recorded in the appropriate format and the student undergone ophthalmic examination, and all findings were registered. The study parameters were visual acuity (VA) measurement and ocular examination. Visual acuity was measured in the school compounds in well lighted class rooms using the Snellen E chart. Ocular examination, including pin hole and retinoscopy were performed by an optometrist for those who have visual acuity <6/12. Moreover, detailed eye examinations were done by ophthalmologist for those with poor vision.

To assure quality of the study, two nurses and two optometrists were recruited as data collectors and supervisor. The selected supervisor and data collectors were trained on data collection procedure. Pretesting of the questionnaire were conducted on 5% students from primary school other than the school where the actual study was conducted, then the questionnaire was assessed for its clarity, understandability, completeness and reliability prior to actual data collection. The overall activity was controlled by the principal investigator of the study. Data quality was controlled by designing the proper data collection materials and through continuous supervision. Questionnaires were checked for completeness and consistency during data collection, management, storage and analysis. The data was entered and cleaned by principal investigator before analysis.

The data was cleaned, coded and entered to Epi info version 3.5 and exported to SPSS version 20.0 for analysis. The normality distribution of the data was assessed by using histogram. Descriptive analysis was applied to describe variables of the study. Associations of predictor variable with the dependent variable (refractive error) were computed using logistic (bivariate and multivariate) regression. Crude and adjusted Odds ratios were computed for each explanatory variable to determine the strength of association with outcome variable and to control the effect of confounding factors. Variables statistically associated with the outcome variables in the first model were taken to the final model to appreciate the maintenance of their association. P value<0.05 was considered significant. Ethical clearance was obtained from Research and Ethics Committee of Debre Markos University. Permission from the school administration and respective government office was obtained to perform the intended study. Prior to data collection, study participants were briefed about the benefit, harm and objective of the study. Verbal or written assent from students and written consent from family or guardian of the study participants was gained after explaining the objective and procedures of the study to be conducted. All study-related information was remained confidential with the study investigator

only. Non-maleficent was one of the fundamental principles of the study during the data collection procedures. Students found to have refractive errors during the study got eye glass prescription and students who had other ocular problem sent to Ras Desta hospital for further management and follow up, among them three were operated for strabismus correction.

## 4. RESULT

### 4.1. Socio-Demographic Characteristics

A total of 1800 primary school students (38.6% male and 61.4%female) with age range from 6 to 19 were included in the study with a response rate of 99.4%. Age group from 10-14 was a predominant. Among participants 31.3% were from Arada sub city, 65.9% were from Gullele and 2.8% were from other sub cities of Addis Ababa. See table 1

Table-1. Socio demographic characteristics of primary school students in Arada and Gullele sub cities, April 2014

Variable	Characteristics	Frequency	Valid Percent
<b>Age</b>	5-9 yrs	312	17.3
	10-14 yrs	1154	64.1
	15-19 yrs	334	18.6
<b>Sex</b>	Male	695	38.6
	Female	1105	61.4
<b>Grade</b>	1-3	584	32.4
	4-6	637	35.4
	7and 8	579	32.2
<b>Educational Performance</b>	1-10	432	24.0
<b>In rank</b>	11-20	515	28.6
	21-30	379	21.1
	>31	356	19.8
	Not known	118	6.6
<b>Address</b>	Arada	563	31.3
	Gullele	1187	65.9
	Others	50	2.8
<b>Ethnicity</b>	Amhara	775	43.1
	Oromo	461	25.6
	Gurage	290	16.1
	Others	92	5.1
	Tigre	73	4.1
	silte	58	3.2
	Wolaita	51	2.8
<b>Religion</b>	Orthodox	1463	81.3
	Muslim	275	15.3
	Protestant	58	3.2
	Others	4	.2
	Total	1800	100.0

## 4.2. Visual Acuity

### 4.2.1. Visual Acuity without Correction

Among the 1800 students, a majority (95%) of students had normal visual acuity (6/6 and 6/9). Ninety-one (5.2% for right eye), 85(4.7% of left eye) of students had visual acuity of 6/12 and below. See table 2 below

**Table-2.** Visual acuity of the right and left eyes without Pinhole Correction among elementary school students found in Arada and Gullele sub cities, Addis Ababa Ethiopia, April 2014.

Characteristics	Unaided Visual acuity of Right eye		Unaided visual acuity of Lt eye	
	Frequency	Valid Percent	Frequency	Valid Percent
6/6	1423	79.1	1379	76.6
6/9	286	15.9	336	18.7
6/12	43	2.4	35	1.9
6/18	8	.4	19	1.1
6/24	10	.6	8	.4
6/36	9	.5	5	.3
6/60	0	.0	5	.3
3/60	10	.6	7	.4
<3/60	10	.6	6	.3
Light perception	1	.1	0	.0
Total	1800	100.0	1800	100.0

### 4.3. Visual Acuity with Pinhole Correction

Visual acuity was repeated with pinhole correction for 100 students who have visual acuity less than and equal to 6/12.100students for right eye and 99 students for left eye. Among which approximately half (48%) of students had normal visual acuity for the right eye and 53.6% of for the left eye. Thirty-six percent of students had visual acuity less than or equal to 6/12 for the right eye and 16% of which had no improvement with pinhole. Thirty two percent of students left eye had visual acuity less than or equal to 6/12 and among these 14.1% of students were unable to be corrected with pinhole. See table 3 below.

**Table-3.** Visual acuity of the right and left eyes with pinhole correction among elementary school students in Arada and Gullele sub cities, Addis Ababa, April 2014.

Characteristics	Visual acuity of Rt eye with pinhole correction		Visual acuity of Lt eye with pinhole correction	
	Frequency	Valid Percent	Frequency	Valid Percent
6/6	9	9.0	16	16.2
6/9	39	39.0	37	37.4
6/12	11	11.0	11	11.1
6/18	7	7.0	6	6.1
6/24	5	5.0	5	5.1
6/36	4	4.0	3	3.0
6/60	7	7.0	5	5.1
3/60	2	2.0	2	2.0
No improvement	16	16.0	14	14.1
Total	100	100.0	99	100.0

#### 4.4. Visual Acuity with Best-Corrected Vision

Those children found with some visual problem have undergone through the second phase of eye examination. Forty-four (69.9%) of participants had best visual acuity 6/6 and 6/9, the rest 18(28.6%) had best corrected vision less than and equal to 6/12 and 1(1.6%) had no improvement for right eye. Forty-one (68.3%) had best corrected vision 6/6 and 6/9, 18(30%) had best corrected vision less than and equal to 6/12 and 1(1.7%) had no improvement. See table 4 below.

**Table-4.** Best corrected visual acuity among elementary school students in Arada and Gullele sub cities, Addis Ababa, April 2014.

Characteristics	BCVA of RT eye		BCVA of LT eye	
	Frequency	Valid Percent	Frequency	Valid Percent
6/6	33	52.4	30	50.0
6/9	11	17.5	11	18.3
6/12	10	15.9	12	20.0
6/24	2	3.2	5	8.3
6/36	4	6.3	1	1.7
6/60	2	3.2	0	0.0
No improvement	1	1.6	1	1.7
Total	63	3.5	60	3.3

#### 4.5. Other Eye Problems and History of Spectacle Use

Other eye problems were complained by 215 study participants among them 73(34%) had received treatment and 142(66%) had not received any treatment. Out of the total study participants, 41(2.3%) were wearing spectacle before and 1759(97.7%) have no history of spectacle use.

#### 4.6. Prevalence of Refractive Error

The prevalence of refractive errors resulting in some form of vision problem (i.e., visual acuity, <6/12) in either eye or both in our study subjects was 4%(i.e., 71 out of 1789)

#### 4.7. Types of Refractive Error

Among 71 students who have refractive error; 19 (26.7%), 12 (17%), 10 (14), 6 (8.4%) and 3 (4.2%) had Myopia, Astigmatism, Myopic astigmatism, Hyperopia, Hyperopic astigmatism on both eyes respectively. The remaining 21(29.6%) respondents have Anisometropia. See table 5



**Table-5.** Types of refractive error among primary school students in Arada and Gullele sub cities, Addis Ababa, April 2014.

Type of refractive error	Right eye		Left eye	
	Frequency	valid Percent	Frequency	Valid Percent
Myopia	23	31.9	22	31.0
Hyperopia	7	9.7	6	8.5
Astigmatism	15	20.8	14	19.7
Myopic Astigmatism	10	13.9	11	15.5
Hyperopic Astigmatism	5	6.9	4	5.6
Amybyopia	7	9.7	3	4.2
Normal	5	6.9	11	15.5
Total	72	100.0	71	100.0

#### 4.8. Management Plan

Among the participants majority (96.5%) were with no need of further management, 3.4% had given spectacle prescription and the rest were referred to ophthalmologist.

#### 4.9. Factors Associated with Refractive Error

Bivariate analysis showed a statistically significant association of age, sex, visual impairment and history of ocular injury with refractive error. After controlling for the effects of potentially confounding variables using multivariate logistic regression analysis, sex and visual impairment are found to be statistical significant predictors of refractive error. Age and ocular injury, which showed statistical significant association with refractive error in bivariate analysis, did not show the same significant association in the multivariate analysis. According to our study, refractive error tends to be more prevalent in females and among children with visual impairments. See table 6 below.

**Table-6.** Factors associated with refractive error

VARIABLE	CHARACT- ERSTICS	REFRACTIVE ERROR		COR(CI)	SIG	AOR(CI)
		YES	NO			
Age	5 to 9	8(2.6%)	304(97.4%)	.431(.186-.999)	.133	0.520(0.221-1.220)
	10 to14	44(3.8%)	1103(96.2%)	0.653(.376-1.135)	.335	0.757(.431-1.332)
	15 to 19	19(5.8%)	311(94.2%)	1.000		1.000
Sex	Male	18(2.6%)	675(97.4)	0.525(.305-0.904)	.048	.573(.331-.994)
	Female	53(4.8%)	1043(95.2%)	1.000		1.000
Other eye disease	Yes	23(10.8%)	189(89.2%)	1.000		1.000
	No	48(3.0%)	1529(97.0%)	0.258(0.153-0.434)	.000	.312(.180-.540)
History of ocular injury	Yes	7(10.8%)	58(89.2%)	1		1
	No	64(3.7%)	1660(96.3%)	0.319(0.140-0.727)	.134	.509(.211-1.232)

### 5. DISCUSSION

This study was conducted with the intention to assess refractive error in Addis Ababa schoolchildren. Among the total participants, 18(25.4%) were male and 53 (74.6%) were females.

The prevalence of refractory error in this study is 71 (4%). Among these 26.7%, 17%, 14%, 8.4% and 4.2% had Myopia, Astigmatism, Myopic astigmatism, Hyperopic, Hyperopic astigmatism on both eyes respectively.

The prevalence of refractive error is low when compared with the study done in Asia like India (13.9%), Pakistan (37.1%) and Nepal (32%)(17,19,20).But the prevalence in Nepal (2.9%) is generally lower than this study [14]. The WHO vision 2020 Global initiative for the elimination of avoidable blindness also revealed that the prevalence of myopia is increasing among children, particularly in urban areas of South-East Asia [4]. This may be because of differences in genetic susceptibility to refractive errors that vary among different races [15].

In studies done Africa, the prevalence of refractive error is found to be lower than this study. In Studies in Nigeria, South-Eastern Nigeria and South Africa reported a prevalence of 2.2% , 1.97% and 2.7% respectively ([16, 17] and [18]). It has been evident that approximately 80% of blindness in Ethiopia was believed to be avoidable; i.e., preventable or curable. According to the nationwide survey conducted to provide estimates of prevalence of low vision and blindness, refractive error was the second major cause of low vision accounting for 33.4%, and the third main cause of blindness accounting for 7.8 %. [3]. This difference could also be due to use of different measurement cut-off points, involvement of different age group and application of different method of classifying refractive errors. However, the finding in this study is comparable to study in Kenya where the overall prevalence of refractive error primary school was 5.2. [19].

The prevalence of refractive error is comparable with the studies done in Brazil (4.82%) [20]. Moreover, it is very strange that we have found the prevalence of refractive error is far low when compared to the nation-wide study of Ethiopia in 2006, which showed 33.4% prevalence of refractory error.[3]. However, the prevalence is higher than studies conducted in kola Diba and Debark town [2] and this may be because of target population difference with these studies. Beside, the study done in Gondar and central Ethiopia showed a higher prevalence refractory error [10, 13] compared to this study. The fact that the prevalence is low in this study may be due inclusion of all age group in the national study and participation of different age group students in other studies when compared to this study which only involved age group between 6-19. Moreover, the fact that this study could not reflect the national and WHO picture may be due to the lower sample size considered in this study.

There are three types of refractive error: myopia, hyperopia and astigmatism and sometimes in combination as myopic astigmatism and hyperopic astigmatism,. Myopia is the common cause of visual impairment in school age children. Many studies like the studies done in Debark, Kola Diba, Rural central Ethiopia, Gondar, Kenya and other places are evidence [2, 10, 13, 19], this is also true in our study where 32% of students with refractive error were myopic.

In this study, sex and presence of other eye disease are significantly related to refractive error. Female sex was found to be more vulnerable from studies done in India and Saudi-Arabia. According to the study done in primary school children in Saudi Arabia, the overall prevalence of refractive errors was 13.7%, higher among females [21]. Similarly, according to the study in

India, , refractive error was found in 13.09% children out of which 5.72% were boys and 7.36% were girls [22]. This might happen due to genetic differences between males and females.

Higher number of refractory errors were also evident in studies conducted in Gondar and central Ethiopia [10, 13]. Presence of other eye disease is associated with refractive error this is because children with refractive error claim their unable to see far or near objects properly as if they have other eye disease. However, factors like age, which were significant in studies conducted in Gondar, Rural central Ethiopia and Saudi Arabia ([10, 13] and [23]), were not evident in this study. In these studies, the older the child is the higher chance to have refractive error. The fact that that age is not related with refractory error may be due to small sample size and involvement of different population.

## 6. CONCLUSION

Refractive error is a common problem in school age children. The problem is common among female. Myopia is the commonest type of refractive error.

## 7. RECOMMEDATION

Based on the research findings, the following recommendations are forwarded

1. The result of this study indicates the need for a regular visual screening program for schoolchildren. That can help early detection of RE.
2. The screening program should be organized and implemented by health bureaus in collaboration with non-governmental organizations and other stakeholders. school teachers and community
3. Health workers should be given the necessary training about detecting visually impaired children as a result they can carry out the school screening of the nearby primary school.
4. Ways of providing spectacles either free of charge or at a reduced cost should be given due consideration for those children with refractive errors who cannot afford to buy the Spectacles.

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## 9. ACRONYMS AND ABBREVIATIONS

AOR: Adjusted Odd Ratio, BCVA: Best Corrected Visual acuity, CI: Confidence Interval: COR: Crude Odds Ratio, DS: Diopter Spherical: DC: Diopter Cylindrical, IAPB: International

Agency for Prevention of Blindness, LP: Light perception, MOH: Ministry of health, MOE: Ministry of education, NGO: Nongovernmental organizations, NLP: No Light perception, RDDH: Ras Desta Damtew Hospital, SNNPR: South Nations Nationalities and People Region, VA: Visual Acuity, VCS: Vision Care Service, WHO: World Health Organization

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