Refractive errors among school children in Addis Ababa, Ethiopia

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ABSTRACT

Objective: To determine the prevalence of refractive errors among school children aged 6-18 years in the city of Addis Ababa, Ethiopia.

Methods: A cross sectional study of refractive errors examined 1800 students in four randomly selected elementary schools during March, 2014. Subjects were selected by multistage random sampling. The children were examined by a team of ophthalmic nurses, optometrists and an ophthalmologist who performed visual acuity testing, cycloplegic refraction and slit lamp examination. Visual impairment was defined as V/A $\leq$ 6/12.

Results: A total of 1800 (695 boys and 1105 girls) students were included in the study with a response rate of 99.4%. Refractive errors in either eye were 71 (4.0%) (95% CI 3.9-4.0). Of these myopia $\leq$ 1.oD was found to be higher 19 (26.7%) cases followed by astigmatism $>\pm -$ 1.5D in 12 (17%) cases. Being female and the presence of other eye diseases increases the odds of refractive error.

Conclusion and recommendation: The prevalence of refractive errors in school children is significant in Addis Ababa, highlighting the need for school screening and optical intervention programs.

Key words: Refractive errors, Visual impairment, School children, Ethiopia

INTRODUCTION

Uncorrected refractive errors are the main cause of low vision and the second cause of blindness. Although refractive errors (myopia, hyperopia and astigmatism) can be easily diagnosed and corrected with spectacles or other refractive corrections to attain normal vision[1,2], they affect the whole spectrum of the population irrespective of age, gender, and ethnic group. Uncorrected refractive errors have severe consequences for the individual, family and society. Myopia in particular, can have an impending negative impact on career choice, ocular health, and sometimes self-esteem. School-aged children constitute a special 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[2-5].

The World Health Organization (WHO) estimated 153 million people with visual impairment due to uncorrected refractive errors, of whom eight million are blind and 145 million have low vision. 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[1,3]. The impact of blindness due to refractive errors in children can be considered in terms of blind person-years and would place a greater socio-economic burden on society[2,5] more than the impact of cataract blindness in old age. Ethiopia is one of the developing countries in Africa, with poor health service coverage especially eye health care and is believed to have one of the world's highest rates of blindness. Although over 80% of blindness and visual impairment is avoidable[6], refractive error is the second leading cause of low vision (33.4%) and blindness (7.8%) in Ethiopia. In a study done in Debark and Kola Diba towns of northern Ethiopia, the prevalence of visual impairment due to refractive errors in school children was 7.6 %[2].

According to a study in India, refractive error was found in 13.09% of the children, out of which 5.72% were boys and 7.36% were girls[7]. In comparison to urban and rural India, prevalence of uncorrected refractive error was 5.46% in urban and 2.63% in rural children[8].

According to a study done in Geta Hospital Nepal in 2007, among students checked for refractive error, it was found in 32.0%[9]. In Saudi Arabia according to the study done in primary school children, the overall prevalence of refractive errors was 13.7%, higher among females[10]. In Brazil, in school children the prevalence of uncorrected refractive error was 4.82%[11]. In northern Ethiopia, in school children the prevalence rate of visual impairment due to refractive errors was 7.6%, myopia was observed to be the most dominant state of refractive error (i.e. 98%)[2]. The study, which was done in rural central Ethiopia primary schools, revealed that uncorrected refractive error is a common cause of visual impairment among school children accounting for 9.5%[12]. In another study, which was done in Gondar town

northwestern Ethiopia, all forms of refractive errors were more common among females than males. Moreover, the overall prevalence of refractive error was 9.4%. The high prevalence of refractive errors among school children indicates the need for regular school-screening programs. Hence we assessed the prevalence of refractive error and factors associated with refractive error among school children in Addis Ababa.

MATERIALS AND METHODS

Study area: Addis Ababa is the capital city of Ethiopia with a population of more than 3 million. The city has ten sub cities and 730 primary schools. A cross-sectional study was conducted in four public primary schools of Arada and Gullele sub cities of Addis Ababa, Ethiopia.

Sample size determination: The sample size was calculated using the formula for estimation of a single population 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[13] giving any particular outcome to be within 2% 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. A design effect of 2 for multistage sampling, thus the sample size was: $n = (z/\alpha/2)\ 2P(1-P)/d$, $n = (1.96)2 \times 0.094(1-0.094)/(0.02)2 = 818$.

A design effect of 2 for multi stage sampling, and 10% non-response rate and the final sample size was 1800.

Sampling procedure: A multistage sampling technique was used. Four schools in two sub cities were selected randomly out of 22 government primary schools in Addis Ababa. 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 simple random sampling by computer generated random numbers was finally used to identify study subjects from each of the grades. Day time students who are physically and psychologically healthy for eye examination were included in the study.

Operational definitions

Presence of significant refractive error: Visual acuity less than and equal to 6/12 in one or both eyes and when the visual acuity is improved with spectacle.

*Myopia***:** Vision is better for near than far objects and also needs corrective lenses with spherical equivalent of -1.00 Diopter (D) or greater in one or both eyes.

*Hyperopia***:** Vision is better for distant than near objects, and needs corrective lenses with spherical equivalent of +2.00 D or more in one or both eyes.

Astigmatism: Vision < 6/12 and that need a cylindrical power of 1.50 D or greater.

Data collection procedure: Pretested, structured questionnaire were used to collect data. Visual acuity was measured in the school compounds in well-lighted class rooms using the Snellen E chart. Pinhole and cycloplegic refraction were performed by an optometrist for those who had visual acuity less than and equal to 6/12. An ophthalmologist did slit lamp examination for those children with poor vision not corrected by spectacle.

Quality control: To assure quality of the study, two nurses and two optometrists were recruited and trained on data collection procedure. Pretesting of the questionnaires was conducted on 80 students in different schools. All completed questionnaire were examined for completeness and consistency during data collection, management, storage and analysis. The data were entered and cleaned by the principal investigator before analysis. The principal investigator of the study supervised the overall activity.

Data analysis: The data collected were entered into Epi info version 3.5.3 and exported to SPSS. They were cleaned and coded using SPSS version 20.0 for analysis. Descriptive analysis was applied to describe variables. Association of predictor variable with the dependent variable (refractive error) was 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. P value < 0.05 was considered statistically significant.

Ethical consideration: Ethical clearance was obtained from Research and Ethics Committee of Debre Markos University and from Ministry of education. Verbal ascent from students and written informed consent from family was obtained. All study-related information was kept confidential with the study investigators only. Students found to have refractive errors or eye problems got further management and follow up.

RESULTS

Socio-demographic characteristics: There were 1800 participants (38.6% male and 61.4% female) aged 6 to 18 years from four randomly selected schools, with a response rate of 99.4% (Table 1).

Table 1: Sociodemographic characteristics of school children in Addis Ababa, Ethiopia, April 2014

Variables	Characteristics	Frequency	(%)
Age (years)	5-9	312	17.3
	10-14	1154	64.1
	15-18	334	18.6
Sex	Male	695	38.6
	Female	1105	61.4
Grade in school	1-3	584	32.4
	4-6	637	35.4
	7 and 8	579	32.2
Educational performance in rank	1st-10th (excellent)	432	24.0
	11th-20th	515	28.6
	21st-30th	379	21.1
	>31st	356	19.8
	Not known	118	6.6
Address	Arada	563	31.3
(sub city)	Gullele	1187	65.9
	Others	50	2.8
Ethnicity	Amhara	775	43.1
	Oromia	461	25.6
	Gurage	290	16.1
	Tigrai	73	4.1
	Silte	58	3.2
	Wolaita	51	2.8
	others	92	5.1
Religion	Orthodox	1463	81.3
	Muslim	275	15.3
	Protestant	58	3.2
	Others	4	0.2
	Total	1800	100

Visual acuity without correction: Among the 1800 students, a majority of students had normal visual acuity (6/6 and 6/9) for the right eye (95%) and for the left eye (95.3%) (Table 2).

Table 2: Visual acuity without correction among school children in Addis Ababa Ethiopia, April 2014

Variable	Unaided visual acuity of right eye		Unaided visual acuity of left eye	
Characteristics	Frequency	(%)	Frequency	(%)
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	0.4	19	1.1
6/24	10	0.6	8	0.4
6/36	9	0.5	5	0.3
6/60	0	0.0	5	0.3
3/60	10	0.6	7	0.4
<3/60	10	0.6	6	0.3
Light perception	1	0.1	0	0.0
Total	1800	100	1800	100

Visual acuity with pinhole correction: Visual acuity was repeated with pinhole correction for 100 students who had visual acuity less than and equal to 6/12. Among which approximately half (48%) of students had normal visual acuity for the right eye and 53.6% 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 14.1% of students were unable to be corrected with pinhole for the left eye (Table 3).

Table 3: Visual acuity with pinhole correction among school children in Addis Ababa, Ethiopia, April 2014

Characteristics	Visual acuity of right eye with pinhole		Visual acuity of left eye with pinhole	
	Frequency	(%)	Frequency	(%)
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
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	99	100

Visual acuity with best-corrected vision: The children found with some visual problem had to undergo the second phase of eye examination. Forty-four (69.9%) of them 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 for the left eye (Table 4).

Table 4: Best corrected visual acuity (BCVA) among school children in Addis Ababa, Ethiopia, April 2014

	BCVA of right eye		BCVA of left eye	
Characteristics	Frequency	(%)	Frequency	(%)
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

Other eye problems and history of spectacle use: Other eye problems (childhood common allergic diseases) were mentioned by 215 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 spectacles.

Prevalence of refractive error: The prevalence of refractive errors (i.e., visual acuity less than or equal to 6/12) in either eye or both was 4% (i.e., 71 out of 1789).

Types of refractive error: Among 71 students who had refractive error; 19 (26.7%) had myopia, 12 (17%) had astigmatism, 10 (14%) myopic astigmatism, 6 (8.4%) hyperopia, and 3 (4.2%) hyperopic astigmatism on both eyes respectively. The remaining 21 (29.6%) had different types of refractive errors on both eyes (Table 5).

Table 5: Types of refractive errors among school children in Addis Ababa, April 2014

Type of refractive error	Right eye		Left eye	
	Frequency	(%)	Frequency	(%)
Myopia	23	31.9	22	31
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
Amblyopic	7	9.7	3	4.2
Normal	5	6.9	11	15.5
Total	72	100	71	100

Management plan: Among the participants, the majority (96.5%) did not require any further management, 3.4% were given spectacles and the rest were referred to an ophthalmologist.

Factors associated with refractive errors: Bivariate analysis showed a statistically significant association of age, sex, other eye diseases and history of ocular injury with refractive error. Being in the age group of 15-18 years increases the odds of having refractive error with [COR 2.32 (1.001-5.383)]. Being female increases the odds of having refractive error with [COR 1.906(1.107-3.281)]. Not having other eye diseases decreases the odds of having refractive error with [COR 0.258(0.153-0.434)] and not having history of ocular injury decreases the odds of having refractive error with [COR 0.319(0.140-0.727)]. After controlling for the effects of potentially confounding variables using multivariate logistic regression analysis; sex and other eye diseases were found to be statistically significant predictors of refractive error. Being female increases the odds of refractive error with [AOR1.744(1.006-3.025)] and not having other eye diseases decreases the odds of refractive error with [AOR312(.180-.540]**.** Age and ocular injury, which has 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, sex and other eye diseases remained to be statistically significant predictors of refractive error (Table 6).

Table 6: Factors associated with refractive error among school children in Addis Ababa, Ethiopia, April 2014

Variable	Characteristics	Refractive error		COR(CI)	P-value	AOR(CI)
		Yes	No			
Age (years)	5 - 9	8(2.6%)	304(97.4%)	1.00	0.310	1.00
	10 -14	44(3.8%)	1103(96.2%)	1.516(.706-3.254)	0.338	1.457(.675-3.147)
	15 - 19	19(5.8%)	311(94.2%)	2.322(1.001-5.383)	0.133	1.924(.820-4.517)
Sex	Male	18(2.6%)	675(97.4)	1.00		1.00
	Female	53(4.8%)	1043(95.2%)	1.906(1.107-3.281)	0.048	1.744(1.006-3.025)
Other eye disease	Yes	23(10.8%)	189(89.2%)	1.00		1.00
	No	48(3.0%)	1529(97.0%)	0.258(.153-.434)	<0.001	0.312(.180-.540)
History of ocular injury	Yes	7(10.8%)	58(89.2%)	1.00		1.00
	No	64(3.7%)	1660(96.3%)	0.319(.140-.727)	0.134	0.509(.211-1.232)

DISCUSSION

This study was conducted to assess refractive error and associated factors in Addis Ababa school children. The prevalence of refractive error was 4%. The prevalence of refractive error in this study is comparable with other studies done in Iran 3.8%[5], Brazil 4.82%[11] and Saudi Arabia 4.5%[10]. The prevalence of refractive error is low compared with the studies done in Asian countries such as India 13.9% , Pakistan 11.4% and Nepal 32%[7-9]. This might be due to differences in genetic susceptibility to refractive errors that vary among different races.

In studies done in Africa, the prevalence of refractive errors is found to be lower than this study. Like the studies done in Nigeria which reported a prevalence of 2.2%, and 1.97% respectively[4,14]. The prevalence in Kenya was a bit higher 5.2%[15]. This difference could be due to use of different measurement cut-off points and involvement of different age groups. Studies done in Kola Diba (7.6%), Debark town (9.5%) and central Ethiopia (9.4%) shows a higher prevalence of refractive error 7% -9%[2,12,13] compared to this study. This might be due to target population difference and participation of different age group students.

Spectacle use of 2.3% is comparable with the study done in South Africa 2.7%[16], and higher than the study done in rural Central Ethiopia 0.26%[12]. The reason could be socio-economic factors; one is spectacles are not accessible at affordable price for the majority, the other is in rural Ethiopia individuals with refractive error dislikes the social stigma associated with wearing spectacles.

From participants diagnosed as having refractive error, myopia was the common cause of visual impairment in school age children (26.7%). Many studies like Debark, Kola Diba, rural central Ethiopia, Gondar (31.6%) , Kenya and other places are evidence for this finding[2,12,13,15]. The prevalence of refractive error was high among females, like in central Ethiopia and Gondar studies[12,13]. Presence of other eye diseases is associated with refractive error. It would be early and difficult to reach a firm conclusion based on our data, this needs well designed study to explain the cause and effect relationship. As age increases, the prevalence of refractive error increased[12,13]. This fact was entirely supported by the findings of our study, but cannot show significant association with refractive error in multivariate analysis this could be target population differences which needs further large studies to be verified.

CONCLUSIONS

Refractive error is a common problem in school children. The problem is common among females. Myopia is the commonest type of refractive error. Gender and presence of other eye diseases are found to be significant predictors of refractive error.

RECOMMENDATIONS

The results of this study indicates the need for a regular visual screening program for school children that can help early detection of refractive error. Further large studies are recommended to explore more on the association of age, other eye diseases and ocular injury to refractive error.

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