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ORIGINAL ARTICLE

Prevalence and Patterns of Refractive Errors among School-aged Children in Delta State, Southern Nigeria

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ABSTRACT

Background: Globally, visual impairment is a major public health concern among children and adolescents and 67% of cases are due to uncorrected refractive error. This study assessed the prevalence and pattern of refractive errors among school-age children in Agbor, Delta State, Nigeria.

Methods: This school-based cross-sectional study was carried out among 822 school age children selected using multistage sampling technique. Pre-tested, structured, interviewer-administered questionnaire was used to collect information on sociodemographic characteristics and ocular history of the participants. Eye examination was performed using the modified Refractive Error Study in School Children (RESC) protocol. The final prescription and the best-corrected visual acuity visual acuity were recorded. Data was analyzed using IBSM SPSS version 22 and statistical significance was set at $p<0.05$.

Results: The mean age (SD) of the participants was 10.1 (3.05) years and 458 (55.7%) were females. The prevalence of refractive error among the participants was 4.4%. Myopia was the commonest form (75%), followed by astigmatism (16.7%) and hyperopia (8.3%) among those with refractive errors. Participants' sociodemographic characteristics were not significantly associated with the occurrence of refractive errors ($p<0.05$).

Conclusion: The prevalence of refractive error in the school children was high with myopia being the commonest form. The occurrence of refractive error among the school children was not dependent of their sociodemographic characteristics. The Delta State Government should take steps to strengthen implementation of the school health programme.

Keywords: Prevalence; Pattern; Determinants; Uncorrected refractive errors; School children; Southern Nigeria

INTRODUCTION

Globally, at least 2.2 billion people have impaired vision, and of these, at least 1 billion could have been prevented, with a higher burden on low- and middle-income countries.[1] Worldwide, the leading cause of visual impairment is uncorrected refractive error (URE), accounting for up to 43 percent of cases with more than 90% of persons living in developing nations. [2, 3] Uncorrected refractive error is responsible for visual impairments in 101.2 million persons and blindness in 124 million persons. [4, 5] Visual impairment affects approximately 19 million children and adolescents 5 to 15 years of age with about 12.8 million (67%) cases due to uncorrected refractive error. [2]

Refractive error is a continuum and changes in refracting status may occur throughout life. Refractive errors result from complex interplay of developmental, genetic, internal and external factors that may influence eye growth, size, and shape which also changes throughout life. The symptoms of refractive errors vary depending on the type (myopia, hyperopia or astigmatism), degree and age of patient.[6] In general, infants are hyperopic at birth, become slightly more hyperopic until seven years, and then experience a myopic shift until the eye reaches its adults dimensions, usually at around seventeen years. [7]

The impact of uncorrected refractive errors in children is much more serious because of the potentially long duration of their lives as compared to older people. Blindness due to refractive errors usually manifests at an early age and the number of blind-person-years due to refractive error is approximately twice as high as cataract related blindness. [8] Consequently, childhood blindness and vision impairment produce many years of living with these disabilities if not addressed promptly and properly. [7] This may reduce educational and employment opportunities, productivity and quality of life for individuals, families and communities. [1, 9]

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Uncorrected refractive error has a considerable impact on learning and academic achievement and career opportunities especially in under-served and under-resourced communities. Studies have reported causal association between visual acuity and children's academic performance. [10, 11, 12]

Refractive errors do not only affect educational outcomes but also extend to quality of life, personal and psychological well-being. [13] Adolescents with vision impairment have been reported to have significantly lower quality of life, psychosocial and school functioning scores.[14] Myopia has been linked with increased levels of anxiety and low self- esteem among school age children. [13, 15]

Therefore, early detection and management of refractive error is very much important to prevent visual impairment, blindness and its sequel. Vision screening is a practical, efficient, and cost-effective approach of identifying and preventing possible vision problems or eye conditions that are likely to lead to visual impairment in school age populations. Vision screening should be followed by appropriate referral, treatment and management involving the use of lenses (spectacle or contact lenses), refractive surgeries and use of intra ocular lenses. [16]

The mandate to develop the school eye health guidelines for implementation and its integration into school health services stems from the National School Health Policy. [17] One of the approaches to implementation of the school eye health care component includes health services such as prevention, identification of children at risk for visual impairment including uncorrected refractive errors, referral, early uptake of eye care services and follow up measures. However, the level of implementation is still sub-optimal as many school children with poor vision due to refractive errors remain undiagnosed. Identifying and adequate treatment of school children with uncorrected refractive errors will help improve the eye care status of school population. Thus, enabling school children benefit maximally from the school system. In addition, the global goal to sustainable development can be linked with children's vision, since restoring an individual's sight is the single most cost-effective health intervention to reduce poverty. [18]

Several studies in various geographical zones of Nigeria have assessed the burden of refractive errors among school age children. However, most of these studies were conducted in urban areas which have higher literacy level, socioeconomic status and health facilities, while some focused on only primary school children or only secondary children. [19, 20] Therefore, to fill this gap and provide baseline data for intervention, this study assessed the prevalence and pattern of refractive errors among primary and secondary school age children in Agbor, Delta State, Nigeria.

METHODOLOGY

This school-based cross-sectional study was carried out in Ika South Local Government Area (LGA), one of the 27 LGA in North West of Delta State in the South-South geo-political zone of Nigeria. The projected population projected for Ika South Local Government Area in 2021 was approximately 2.5 million. The LGA has 12 political wards, two public secondary health facilities, 14 Primary health Care (PHC) centres and two private eye clinics. Ika South LGA is divided into six education zones which consist of 57 government primary schools, 20 government secondary schools, 51 approved private primary schools and 28 approved private secondary schools. Only a few of the schools have facilities such as sick bay, first aid box, visual acuity charts, etc. but none had sick bay personnel or preschool screening programme in place. None of the schools had trained personnel such as school nurses, resident/visiting doctors and trained first aiders. [21]

The study population included school children aged 5 to 17 years from selected government and private primary and secondary schools in the LGA. Children between 5 and 17 years of age who were present on the day of examination and whose parents signed the informed consent were included. Exclusion criteria included children who were sick, had eye injuries or eye diseases such as corneal opacities, cataracts or fundus pathology, etc. that can affect visual functions; children who were allergic to any ingredient in 1% cyclopentolate solution; children who refused to continue the examinations due to eye discomfort during cyclopentolate administration (e.g. burning, photophobia, irritation) and those that were uncooperative (e.g., children who move eyeballs excessively during examination).

The minimum sample size was calculated using the Cochran's formula, $n = (z^2pq)/d^2$ [22] where p = prevalence of refractive errors of 9.7% from a previous study among school children in Anambra State, [19] at 95% confidence interval and degree of accuracy of 0.03 with a design effect = 2. Considering a non-response rate = 10%, a sample size of 822 was estimated.

The participants were selected by multistage sampling technique comprising of three stages. Stage one involved selection of educational zones - Three out of the six education zones were selected using simple random techniques (by balloting). Stage two involved selection of schools - Stratified sampling technique was used to select the public/private primary and secondary schools while using proportional allocation to size method to determine the number in each stratum. A total of 23 schools

comprising 10 government primary, six private primary, two government secondary and five private secondary schools were selected using simple random technique by balloting. In stage three, eligible children were selected from classes in each school using simple random sampling technique by balloting.

Data collection was by interviewer-administered questionnaire to obtain participant's socio-demographic information, ocular history, past medical and surgical history. Data collection was done between September and December 2021. Three research assistants (final year optometry students) were trained for two days on questionnaire administration technique and how to carry out visual acuity. The training session included key lectures on refractive errors and procedure for visual acuity as well as practical sessions on how to measure visual acuity. The questionnaire was pretested among school children in selected schools Ika North East LGA and adjustments made thereafter.

The eye examination was performed using the modified Refractive Error Study in School Children (RESC) protocol. [23] Visual acuity (VA) was measured at a distance of 6m using the Snellen tumbling E chart and Snellen letter chart. Children who wore glasses had their VA taken while wearing their glasses (Aided VA). The presence of ocular deviation (phoria and tropia) was determined using the cover test. Ocular health examination (including internal and external) was performed for all children examined. Subjective refraction followed by cycloplegic refraction using cyclopentolate hydrochloride (1.0% solution) was carried out for all children. Retinoscopy was done 30 minutes after the instillation of the cyclopentolate hydrochloride. The final prescription and the best-corrected VA were recorded. Medication was given for minor ocular conditions at no cost at the time of the examination while those who needed further medical or diagnostic work-up were referred to an eye specialist for further evaluation. For those with best corrected visual acuity worse than 6/12, a complete ophthalmic examination was performed.

Refractive error was assigned as the cause of the visual impairment if in the absence of any obvious pathology, vision improved to 6/6 or better with refraction. Hyperopia is defined as a spherical power of 2.00 diopters sphere (DS) in both eyes or in one eye (if the other eye is emmetropic). Myopia is defined as a spherical power of −0.50 DS in both eyes or in one eye (if the other eye is emmetropic). A cylindrical power of −0.50 diopters cylinder (DC) in both eyes or in one eye (if the other eye is emmetropic) was considered as astigmatism.

The questionnaires were checked for accuracy and completeness in the field before data entry and analysis was done using SPSS version 22. Univariate analysis was carried out on socio-demographic data and presented as frequencies and percentages. Bivariate analysis was done using chi-square test of association to determine the association between participants' socio-demographics characteristics and occurrence of refractive error. p-value less than 0.05 was considered as statistically significant.

Ethical approval (ADM/E 22/A/VOL. VII/14831091) was obtained from the Ethics and Research Committee University of Benin Teaching Hospital (UBTH), Benin City. Permission was sought from the Ika South Local Government Education Secretary, Post-primary Education Board and head teachers of the selected schools. Written informed consent was obtained from participants parents/guardians and assent obtained from selected school children before participating in the study and confidentiality of records was observed. Spectacle correction and follow-up was recommended for all participants who had refractive errors. Children with other ocular conditions were referred for further specialist evaluation. Follow-up with phone call was also made to ensure that school children with refractive errors had accessed the referral health facilities.

RESULTS

A total of 830 school children participated, however, only 822 questionnaires had complete data for analysis giving a response rate of 99%. The mean age of the children was 10.1±3.1 years with the highest proportion of them, 361 (43.9%) in the age group 9 to 12 years. The highest of them were males 364 (44.3%), in primary school 499 (60.7%) and resided in urban areas 413 (50.2%). (Table 1) One hundred and thirty-two (16.1%) of the children had an ocular history of eye problem, out of which 82 (62.1%) have had an eye test done. One hundred and two (77.3%) of those who had an ocular history of eye problem reported using spectacles, of which 46 (45.1%) were prescription spectacles. The highest proportion of those using prescription spectacles started after 12 years of age, 18 (39.1%). Two hundred and eighty-one (34.2%) of the respondents had family history of prescription spectacles use. (Table 2)

A total of 36 (4.4%) of the children had refractive errors and 786 (95.6%) were emmetropic. The prevalence of refractive errors among the children was 36 (4.4%). The prevalence of myopia was 27 (3.3%), astigmatism 6 (0.7%) and hyperopia 3 (0.4%). Among those who had refractive error, myopia was the commonest refractive error 27 (75%), this was followed by

Table 1: Socio-demographic characteristics of participants

Variables	Frequency (n=822)	Percent
Age group (years)		
5 – 8	298	36.3
9 – 12	361	43.9
13 – 17	163	19.8
Sex		
Male	364	44.3
Female	458	55.7
Class		
Primary	499	60.7
Secondary	323	39.3
Place of residence		
Urban	413	50.2
Rural	409	49.8
Birth order		
1 – 3	591	71.9
> 3	231	28.1

Mean Age (SD) = 10.1 (3.1) years

Table 2: Ocular health history of participants

Variables	Frequency	Percent
History of eye problem (n=822)		
Yes	132	16.1
No	690	83.9
Ever had eye test (n=132)		
Yes	82	62.1
No	50	37.9
Spectacle use (n=132)		
Yes	102	77.3
No	30	22.7
Prescription spectacles (n=102)		
Yes	46	45.1
No	56	54.9
Age at first spectacle use (years) (n=46)		
5 – 8	12	26.1
9 – 12	16	34.8
> 12	18	39.1
Family history of prescription spectacle use (n=822)		
Yes	281	34.2
No	541	65.8

Table 3: Prevalence and types of refractive errors among participants

Variables	Frequency	Percent
Presence of refractive errors (n=822)		
Yes	36	4.4
No	786	95.6
Types of refractive errors (n=36)		
Myopia	27	75.0
Astigmatism	6	16.7
Hyperopia	3	8.3

astigmatism 6 (16.7%) and hyperopia was present in 3 (8.3%). (Table 3)

The prevalence of refractive error was highest among children 12 - 17 years of age 8 (4.9%), males 19 (5.2%), in secondary 19 (5.9%), residing in urban areas 23 (5.6%) and with family history of spectacle use 16 (5.7%). However, these were not statistically significant - age (p=0.905), sex (p=0.380), class (p=0.129), place of residence (p=0.133) and family history of spectacle use (p=0.251). (Table 4)

Table 4: Association between participants' demographic characteristics and occurrence of refractive error

Variables	Refractive Error			
	No (n=786) n (%)	Yes (n=36) n (%)	χ^2	p-value
Age group (years)				
5 – 8	286 (96.0)	12 (4.0)	0.200	0.905
9 – 12	345 (95.6)	16 (4.4)		
13 – 17	155 (95.1)	8 (4.9)		
Sex				
Male	345 (94.8)	19 (5.2)	0.771	0.380
Female	441 (96.3)	17 (3.7)		
Class				
Primary	482 (96.6)	17 (3.4)	2.309	0.129
Secondary	304 (94.1)	19 (5.9)		
Place of residence				
Urban	390 (94.4)	23 (5.6)	2.262	0.133
Rural	396 (96.8)	13 (3.2)		
Birth Order				
1 – 3	563 (95.3)	28 (4.7)	0.376	0.540
> 3	223 (96.5)	8 (3.5)		
Family history of spectacle use				
Yes	265 (94.3)	16 (5.7)	1.317	0.251
No	521 (96.3)	20 (3.7)		

DISCUSSION

This study which assessed the prevalence and pattern of refractive errors revealed that the prevalence of refractive errors was 4.4%. That is, almost one in twenty of the school age children had refractive errors. The effects of refractive error among school age children cannot be over emphasized. Uncorrected refractive error is a major cause of visual impairment among school children and impacts both individuals and society leading to limited educational performance amongst children, fewer opportunities for work, which in the long run leads to lower quality of life and poverty.[1, 9]

The prevalence in this study is lower than what was reported in a meta-analysis which revealed that the pooled prevalence of refractive error in Nigeria children was 5.9%, [24] but higher than that reported in a study in Southern Nigeria (2.2%). [20] Higher prevalence rates have also been reported in Ghana (7.5% - 25.6%) [25, 26] and Northwest Ethiopia. [27] The differences in prevalence could be attributed to variations in study methodologies, geographical locations and ethnicity. [28, 29] Myopia was the commonest and accounted for three-quarters among those with refractive errors, followed by astigmatism and then hyperopia. This is similar to what has been reported elsewhere in Southern Nigeria,[20] Nairobi, Kenya [30] and Northwest Ethiopia [27] but is in contrast to studies in Ghana where the most prevalent refractive error was astigmatism.[25, 26] This might be due to differences in study methodologies, geographical locations and ethnicity.

The prevalence of refractive errors was higher among older children aged 12 - 17 years, though not statistically significant. This is similar to what has been reported elsewhere. [31, 32, 33] In contrast, significant association between older age and occurrence of refractive errors have been reported by other studies. [25, 34] Studies have reported the prevalence of refractive errors to be significantly higher among females [34, 35, 36] while some reported equal prevalence in the two sexes. [37] As reported elsewhere, [25, 34] the prevalence of refractive errors was higher among urban dwellers and those with positive family history of spectacle use.

It is noteworthy that more than a third of those who reported a history of eye problem have not had their eye examined in the past. The benefits of eye examination by a trained professional cannot be over-emphasized as it provides the opportunity for comprehensive eye examination as well as identifying a range of other eye problems other than uncorrected refractive errors. It is also worth mentioning that though more than three-quarters of those with history of eye problem reported using spectacles, less than half of these were prescription/medicated spectacles. The use of non-prescription spectacles or inappropriate lens prescription bought on the streets or peddlers can worsen an individual's vision and cause more discomfort such as ache, blurring vision, and squinting as reported by some of the children.

The school-based nature of this study limits the generalizability of the findings as it did not include school age children who do not attend school. Therefore, community-based studies that will include non-school going children are

recommended for the future. Another potential limitation could be inter-observer error during visual acuity test procedure, though the training of research assistant would have minimized this.

In conclusion, the burden of refractive errors is high among the school children in the study area with myopia being the commonest form. The Delta State Government should take steps to strengthen the implementation of the school health programme with proper integration of the national school eye guidelines. The school health services of the should carry out periodic eye screening in schools to ensure early detection and referral for adequate and prompt management of eye conditions. In addition, continuous health education and awareness campaigns should be carried out by the Ministry of Education to promote knowledge of the effects of uncorrected refractive errors on the learning abilities and development of children among the population and other stakeholders (school management, teachers and parents) s educated about the effects of uncorrected refractive errors on the learning abilities and development of children.

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