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Myopia prevalence in school-aged children in Garki District of Abuja, Nigeria

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Background: Prevalence of myopia is increasing globally, hence it poses a significant public health risk due to the association of high myopia with debilitating eye disorders.

Aim: The aim of this study was to determine the prevalence of myopia in school children.

Setting: The study was conducted in primary and secondary schools in Garki district, Abuja, Nigeria.

Methods: A cross-sectional, multistage, random sampling involving 1028 school children (aged 5–14 years), comprising 484 boys (47.1%) and 544 girls (52.9%), was conducted. Examination performed included visual acuities, pen torch and ophthalmoscopy examination of the anterior and posterior segments, retinoscopy under cycloplegia and subjective refraction.

Results: The prevalence of myopia (–0.50 dioptre [D] or more) in this study was 3.5%. Approximately 3.4% of the children had mild myopia (–0.50 to –3.00 D), 0.1% had moderate myopia (–3.25 D to –6.00 D) and none had high myopia. Myopia ranged from –0.50 D to –4.25 D. The mean spherical equivalent for myopia (right eye) was –1.11 D. The prevalence of hyperopia, astigmatism and amblyopia was 5.8%, 1.9% and 0.7%, respectively. Overall, the prevalence of refractive error was 11.2%.

Conclusion: The prevalence of myopia is relatively low in a sample of school children in Garki district of Abuja, Nigeria. However, the majority of myopic children in this study without spectacles (88.9%) are a cause for concern, which could reflect the low usage of refractive error services among school children in the district.

Keywords: myopia; prevalence; hyperopia; astigmatism; refractive error.

Introduction

Hypotheses about the aetiology of myopia date back to 350–400 BC when it was believed to be caused by a lack of 'pneuma' in the eye, high water content and excessive near work among other reasons.[1] Since then, there have been inconsistencies in myopia theories. Rosenfield[2] explained that the relationship between myopia development and performance of sustained near work makes it difficult to distinguish between environmental and hereditary causes. High myopia can result in preventable blindness and visual impairment in adulthood from eye diseases such as myopic maculopathy, glaucoma and retinal detachment.[3] Research evidence in South-East Asia links reduced levels of outdoor play and less dopamine secretion with significantly high prevalence of myopia.[4,5] In Nigeria, myopia is identified as one of the major causes of visual impairment and thus represents a significant public health burden.[6]

Approximately 153 million people in low-resource economies with restricted access to eye health services are visually impaired.[7] Consequently, they are less productive economically and socially because of uncorrected refractive errors such as myopia.[7,8] Estimates from 2000 to 2050 indicate significant increases in myopia prevalence globally and it is predicted that by 2050 there will be approximately 5 billion people affected.[9] In an estimate of the global potential economic productivity loss related to myopia in 2015, uncorrected myopia and myopic maculopathy account for approximately $244 billion (bn) and $6 bn, respectively.[8]

Although myopia is more prevalent in Asian countries, reports from the Nigerian National Blindness Survey indicate that 52.0% of moderate visual impairments are caused by myopia and uncorrected refractive errors.[6] Prevalence estimates of myopia in population-based studies across the world range between 1.0% and 78.4%.[10] In West Africa, myopia prevalence ranges from 0.7% to 4.5%[11,12,13,14,15]; in East Africa, it is 1.3% – 5.6%[16,17,18,19]; in South Africa, it is 2.5% –10.4%.[20,21,22,23]

In Nigeria, the prevalence of myopia in school children in various regions ranges between 0.7% and 4.5%[11,14,15,24,25] Myopia prevalence from studies conducted in the Western,[25] Southern,[14] Northern[24] and Eastern[11,15] parts of Nigeria were reported as 0.7%, 1.7%, 2.9%, 2.7% and 4.5%, respectively. The difference in myopia prevalence in studies conducted in Nigeria could be attributed to differences in study design, age group, definition criteria as well as socio-economic and geographical factors.

A literature search did not reveal myopia prevalence studies conducted in any population of school children in Abuja. Therefore, the results of the present study would serve as a baseline for future studies and a guide for myopia control strategies in the region. The aim of this study was to determine the prevalence of myopia in schoolchildren aged 5–14 years. The study is clinically and economically relevant given the potential sight-threatening complications associated with high myopia and the need to reduce the cost of eye care. The study highlights the importance of routine vision screening in schools and the need to improve health promotion and service delivery.

Methods

This report is part of a major study on myopia control in Nigerian school children. The study design was cross-sectional to assess the prevalence of myopia among primary and junior secondary school students (age 5–14 years) in the Garki district, Abuja, Nigeria. Abuja is the federal capital city of Nigeria located in the North-central region with an estimated population of 3.2 million.[26] The inhabitants represent the diverse and numerous ethnic groups in Nigeria. The Garki district occupies the South-western part and represents the principal business and administrative centre of the city.[27] There are 17 primary schools and 11 junior secondary schools in Garki district of Abuja.[28,29] Participants were aged from 5 to 14 years. This age group was selected because they are more vulnerable to the development of myopia and its progression.[30,31]

Sampling

A multistage, stratified random sampling strategy was used to select 1068 school children from five schools (three primary and two junior secondary schools). The sampling frame consists of a list of all primary and secondary schools in the Garki district of Abuja (n = 28: primary units) and class arms (students of primary 1–6 to junior secondary school [JSS] 1–3) within each primary unit (secondary units). The sampling was performed in stages using smaller sampling units at each stage. The sampling frame was compiled using the Federal Capital Territory/Universal Basic Education Board (FCT/UBEB) database and the list of classes and students in each selected school. The proposed minimum sample size for this study was determined using the formula[32]:

$$n = \frac{z^2 p(1-p)}{d^2} \quad \text{[Eqn 1]}$$

where:

n = sample size, z = the standard normal deviate (1.96), which corresponds with the 95% confidence interval, p = estimated proportion in target population to have a specified attribute 4.5% (0.045), d = precision or margin of error set at 0.013 (one-fourth of assumed prevalence in case of small p).[32]

Sample size (n) therefore = $(1.96)^2$ (0.95) (0.045)/$(0.013)^2$ = 971. The sample size required is 971.

Provision for non-response rate = 10% (97).

Total = 971 + 97 = 1068 students.

Male and female black students of Nigerian nationality from age 5 to 14 years were included in the study. Children excluded from the study are those with strabismus, narrow anterior chamber angles, intellectual disability and eye diseases.

Data collection procedures

The school principals provided classrooms for eye examinations. Four optometrists trained in research ethics protocol conducted the eye examinations. A data record form was developed to obtain demographic data, ocular health history and results of eye examinations. Ocular health history includes questions about the usage of spectacles to determine the number of myopic children wearing spectacles. The principal investigator (PI) conducted retinoscopy, while other optometrists conducted other procedures such as visual acuity (VA) measurement, ophthalmoscopy, external eye examination, instillation of eye drops and subjective refraction. Anterior segment was assessed with the use of a pen torch and Keeler direct ophthalmoscope was used to assess the crystalline lens, vitreous and fundus. Visual acuity was measured with the LogMAR (Good-lite) VA chart. The Snellen equivalent was recorded. The Good-lite near point card was used to measure the near VA. Children with good visual acuities (6/6 or 6/4.8, N.5) were fogged with +1.50 dioptre (D) to screen for latent hyperopia. For the fogging method, +1.50 D lens was placed in the trial frame of one eye and gradually reduced while the child was fixating at the Log MAR chart at 4 m. Near VA was checked at 0.33 m – 0.40 m. Children who passed the fogging tests were those with good visual acuities who also experienced blur vision with +1.50 D lens at distance and/or near. Children without obvious refractive errors (those who had good V/A's and passed the fogging tests) were excluded from further refractive procedures. Children with entry VA worse than 6/6 or those that failed the fogging tests at distance and/or near were reserved for cycloplegic retinoscopy. The method described above is similar to the one used by Padhye et al.[33] in India. The anaesthetic agent (proparacaine hydrochloride, 5 mg) was instilled 5 min before instilling tropicamide (1%) eye drop. Another drop of tropicamide was instilled after 5 min. Retinoscopy with the Heine streak retinoscope was conducted in dim illumination after instilling a cycloplegic agent. Criteria for cycloplegia include the absence of retinoscopic reflex and a minimum pupil dilation of 6 mm. Their refractive status was concluded with subjective refraction the following day.

Operational definition

In this study, myopia was defined as spherical equivalent refraction of −0.50 D or more. The operational definition is consistent with other studies on myopia prevalence conducted across the world.[11,13,14,15,19,21,34,35,36,37,38]

Pilot study

The research instrument was pre-tested on 64 students in a primary school outside the district selected for the study. The administration of cycloplegic drops and retinoscopy was carefully timed. The average minimum time required for cycloplegia was noted and recorded to give an idea of what to expect during the main data collection process. Data collected during the pilot study were analysed. The result of the pilot study was used to refine the refractive procedures before the main study.

Data analysis

A study identification number was assigned to each participant. Only the identity code list and the consent forms had participants' names. All information collected during fieldwork was reviewed by the PI for accuracy. Statistical analysis was conducted by a statistician using the Statistical Package for Social Sciences (SPSS, version 20). Distribution of variables and proportions corresponding to 95% confidence intervals were presented in tables. The relationships between age and gender with myopia were investigated using chi-square and Pearson's correlation tests. For the relationship between age and myopia, the participants were classified under two age categories: younger age group (5–9 years) and older age group (10–14 years). Values < 0.05 were considered statistically significant. Descriptive statistics (VA and refractive errors) were presented with frequencies, ranges, means, medians and standard deviations.

TABLE 1: Descriptive statistics for visual acuity and refractive errors.

VA/Ref error	*n*	Mean	s.d.	Median	Min	Max	Skew	Kurtosis
VA RE	1028	0.92	0.22	1.00	0.00	1.25	−1.71	2.72
VA LE	1028	0.93	0.22	1.00	0.00	1.30	−1.69	2.79
RE sphere	1028	0.05	0.37	0.00	−4.00	2.75	−0.66	24.54
LE sphere	1028	0.06	0.35	0.00	−3.75	3.00	−0.29	26.61
RE sph eq	1028	0.02	0.37	0.00	−4.25	2.50	−1.59	28.54
LE sph eq	1028	0.03	0.35	0.00	−3.75	3.00	−0.82	27.30
RE cylinder	1028	−0.05	0.21	0.00	−3.00	0.00	−6.41	59.43
LE cylinder	1028	−0.05	0.20	0.00	−3.00	0.00	−7.85	84.36

RE, right eye; LE, left eye; VA, visual acuity; sph eq, spherical equivalent; N, total number of participants; s.d., standard deviation; Min, minimum; Max, maximum.

TABLE 2: Distribution of refractive errors by age.

Age (years)	*n*	%	Myopia (%)	Hyperopia (%)	Astigmatism (%)	Emmetropia (%)	Amblyopia (%)
5	39	3.8	0.0	0.0	0.0	3.8	0.0
6	57	5.5	0.1	0.1	0.2	5.2	0.0
7	89	8.7	0.2	0.1	0.5	7.9	0.0
8	91	8.9	0.0	0.8	0.1	8.0	0.0
9	101	9.8	0.4	1.0	0.3	8.0	0.2
10	141	13.7	0.2	1.1	0.1	12.3	0.1
11	161	15.7	1.1	1.0	0.0	13.5	0.1
12	145	14.1	0.8	1.3	0.4	11.7	0.0
13	112	10.9	0.4	0.4	0.2	9.8	0.1
14	92	8.9	0.4	0.2	0.2	8.0	0.2
Total	**1028**	**-**	**3.5**	**5.8**	**1.9**	**88.0**	**0.7**

Note: $p = 0.30$.

n, number of participants in each age level.

TABLE 3: Prevalence of myopia.

Myopia	Prev		95% CI	Gender		Age group (years) (%)	
	n	%		M	F	5–9	10–14
Myopia (≥ −0.50 D)	36	3.5	2.4–4.7	41.7	58.3	19.4	80.6
Mild (−0.50 D to −3.00 D)	35	3.4	3.3–3.6	-	-	-	-
Moderate (−3.25 D to −6.00 D)	1	0.1	0.0–0.3	-	-	-	-
High (≥ 6.25 D)	None	-	-	-	-	-	-

n, number of participants; Prev, prevalence; M, male; F, female; CI, confidence interval; D, dioptre.

Results

Out of 1068 students given consent forms, 1028 forms were returned and signed, indicating a response rate of 96.3%. Students without signed consent forms were not examined. One hundred and ninety-seven (19.2%) students who failed the VA test were booked for cycloplegic refraction. After the refractive procedures, seven amblyopic cases were confirmed, and 190 students had improved VA in one or both eyes. Among the 190 children with improved vision after refraction, there were 74 children who had low degrees of refractive error that did not meet the operational definition criteria. Participants diagnosed with refractive errors were 116 in number and 90 (77.6%) were found to have VA of 6/6 in both eyes. Twenty-six students (26.4%) had VA less than 6/6 at least in one eye after correction with spectacles. The descriptive statistics for VA and refractive errors are shown in Table 1. A total of 117 participants were given free spectacles as an intervention to prevent amblyopia and enhance their academic performance. One of the amblyopic participants was given spectacles as there was a one-line improvement in the VA of the poorer eye from 6/60 to 6/48.

The prevalence of myopia in this study was 3.5%, hyperopia was 5.8% and astigmatism was 1.9%. Amblyopia was seen in 0.7% and anisometropia (from 1.00 D) was seen in 0.3% of patients. The remaining 88.1% were emmetropes. Overall, the prevalence of refractive error was 11.2%. The prevalence and distribution of refractive errors by age groups are shown in Table 2. Three out of 36 myopia cases (8.3%) seen were associated with significant amounts of astigmatism. The range of myopia in this study was from −0.50 D to −4.00 D and spherical equivalent of myopia ranges from −0.50 D to −4.25 D. The highest magnitude of −4.25 D was seen in a 12-year-old male. The youngest myope in this study was a 6-year-old female child (−1.75 D) and the oldest myopes were four 14-year-olds, with myopia ranging from −0.50 to −1.25 D. Myopia was most prevalent in 11- and 12-year-olds accounting for 30.5% and 22.2%, respectively (Table 2). The mean age for myopes in this study was 11.14 ±1.9 years. Myopia was more frequent in the older age group (10–14 years; 80.6%) than the younger age group (5–9 years; 19.4%) and was statistically significant ($\chi^2 = 4.73$, $p = 0.03$, confidence interval [CI] = 0.18–0.94). Myopia was more frequent in female students (58.3%) than in male students (41.7%) but not statistically significant ($\chi^2 = 0.55$, $p = 0.46$, CI = 0.4–1.5) (Table 3).

TABLE 4: Chi-square analysis between age categories, gender and myopia.

Categories	Myopia		Mean	s.d.	Emmetropia		Mean	s.d.	Total		*p*
	n	%			*n*	%			*n*	%	
Age category											0.03
5–9 years	7	2.0	–1.14	0.35	337	98.0	0.01	0.08	344	100.0	-
10–14 years	29	4.9	–1.05	0.76	568	95.1	0.04	0.14	597	100.0	-
Total	36	3.8	-	-	905	96.2	-	-	941	100.0	-
Gender											0.46
Male	15	3.3	–1.17	0.91	434	96.7	0.03	0.11	449	100.0	-
Female (*n*)	21	4.3	–1.00	0.49	471	95.7	0.03	0.13	492	100.0	-
Total	36	3.8	-	-	905	96.2	-	-	941	100.0	-

s.d., standard deviation; *n*, number of participants.

TABLE 5: Prevalence of myopia in the present study compared to African countries and the rest of the world.

Study	Country	Ethnicity	Age (years)	Sample size	Criteria	Prev (%)
Present study	Nigeria	African	5–14	1028	≤ –0.50	3.5
Ebri et al.[14]	Nigeria	African	10–18	4241	≤ –0.50	1.7
Ezinne /Mashige[15]	Nigeria	African	5–15	1020	≤ –0.50	4.5
Faderin/Ajaiyeoba[40]	Nigeria	African	5–15	919	≤ –1.00	0.7
Atowa et al.[11]	Nigeria	African	8–15	1197	≤ –0.50	2.7
Balarabe et al.[24]	Nigeria	African	11–20	614	NR	2.9
Anera et al.[25]	Morocco	African	6–16	545	≤ –0.50	6.1
Jafer/Abonesh[19]	Ethiopia	African	7–15	570	≤ –0.50	2.6
Kumah et al.[13]	Ghana	African	12–15	2454	≤ –0.50	3.4
Naidoo et al.[21]	South Africa	African	5–15	5599	≤ –0.50	3.0
Magakwe et al.[23]	South Africa	African	6–18	324	≤ –0.50	10.4
Rashad et al.[39]	Egypt	African	8–12	352	≤ –0.50	9.3
Czepita et al.[51]	Poland	White	6–18	5724	≤ –0.50	13.1
Norouzirad et al.[57]	Iran	M-East	6–15	1130	≤ –0.50	14.9
Zadnik et al.[58]	United States	White	6–14	2583	≤ –0.75	10.1
Murthy et al.[59]	India	Asian	5–15	6447	≤ –0.50	7.4
Aldebasi[60]	Saudi Arabia	Middle East	6–13	5176	≤ –0.50	6.5
You et al.[61]	China	Asian	7–18	15 066	≤ –0.50	64.9

Prev, prevalence; NR, not reported.

Discussion

In this study, the findings on the prevalence of myopia in a sample of primary and secondary school children aged 5–14 years in Nigeria are presented. The prevalence of myopia was relatively low at 3.5% (95% CI: 3.3–3.7). Myopia was more prevalent in older age groups than in younger age group ($p = 0.03$), whereas gender did not influence the distribution of myopia. The odds of being myopic in children of the age group 5–9 years are 41% less than 10–14 years age group (odds ratio [OR]: 0.41, 95% CI: 0.18–0.94, $p < 0.05$) (Table 4). The findings of this study imply that myopia is relatively uncommon in this sample of children and the study highlights the need for improved vision correction among school children given the low usage of spectacles among the study population.

Similar to the present study, some studies[13,21] applied cycloplegia and reported similar findings, which include Kumah et al.[13] in Ghana (3.4%) and Naidoo et al.[21] in South Africa (3.0%). However, studies conducted in the Northern part of Africa by Anera et al.[25] (Morocco) and Rashad et al.[39] (Egypt) involving cycloplegia reported a higher myopia prevalence of 6.1% and 9.4%, respectively. The higher prevalence compared to the present study may be because of the older age of participants and ethnic variations as the children were predominantly North-Africans. The prevalence in the present study is higher than studies conducted in Nigeria by Ebri et al.[14] (1.7%) and Atowa et al.[11] (2.7%) who also applied cycloplegia. Other lower prevalence reported included Ovenseri et al.[12] (Ghana, 1.7%) and Faderin et al.[40] (Nigeria, 0.7%). The lower prevalence reported by Ebri et al.[14] may be attributed to participants' higher age range (10–18 years) than the present study. Furthermore, Ebri et al.[14] used a combination of tropicamide (1%) and cyclopentolate (1%), which could result in a stronger cycloplegic effect than what was used in this study.

Reports from other studies[41,42] conducted in Nigeria indicate the combination of tropicamide and cyclopentolate as a useful alternative to atropine as a cycloplegic agent. The studies also reported that the combination of tropicamide and cyclopentolate was more effective than the use of cyclopentolate alone. Tropicamide was chosen as the cycloplegic agent in this study based on its fast onset of action and shorter duration, which makes it easier to conclude the tests the following day. Moreover, investigations[34,43,44] indicate that two drops of tropicamide (1%) when preceded by the application of an anaesthetic agent provide reasonable cycloplegia. A major reason for the lower prevalence reported by Faderin et al.[40] may be attributed to the high cut-off (–1.00 D) applied to define myopia in their study. Furthermore, ethnic or socio-economic variation factors may be contributory to the difference in findings between the present study and that by Faderin et al.[40] However, Ezinneet al.[15] and Magakwe et al.[23] studied refractive errors in school children in Nigeria and South Africa, respectively, and reported a higher prevalence than that reported in the present study (Table 5). A higher participants' age range may have contributed to a relatively higher prevalence in their study.[23]

The results of the present study corroborate previous findings that indicate a higher prevalence of myopia in older children. An increase in myopia prevalence among older age groups was reported by studies in Nigeria,[15,45] African countries[13,21,22] and other parts of the world.[46,47,48] Grosvenor's classification of age-related prevalence of myopia indicates that approximately 2% of children are myopic at the age of 6 years, which could progress to 12% and 20% at ages 14 and 20 years, respectively.[49] Myopia prevalence increases throughout the school age until late teenage or early adulthood.[49] The age-related prevalence in the present study indicates approximate estimates of 3%, 6%, 11%, 6%, 31%, 22% and 11% among 6, 7, 9, 10, 11, 12 and 14 year-olds, respectively.

Gender did not influence the distribution of myopia in the present study (Table 4) as reported in other studies conducted in Kenya,[16] Ghana[13] and South Africa.[21,22] Females were found to be more myopic ($n = 21$, 58.3%) than men ($n = 15$, 41.6%). This may be because of a higher enrolment of female

participants. There were 544 women (52.9%) and 484 men (47.1%) enrolled in this study. Studies by Ezinneet al.[15] in Nigeria and Msiska et al.[50] in Malawi reported a significant association between myopia and the male gender. However, more studies[35,51,52,53] in other parts of the world reported higher myopia prevalence among women than men. Goss et al.[54] explained that the higher prevalence in women may be related to the earlier attainment of puberty in women than men. Women tend to have a lower age of cessation of myopia, which ranges from 14 to 15 years, compared to men, which ranges from approximately 15 to 16.5 years. Although there were variabilities in the cessation age of both genders, earlier onset, higher prevalence and faster rates of progression have been observed in women.[54]

Twelve out of 116 students with significant refractive errors were wearing spectacle prescriptions at the time of examination. Among the myopic children, only four out of 36 students were using spectacles at the time of conducting the eye examination. This indicates a low correction rate of 11.1%. The low correction rate could be because of the free spectacles on display at the examination venue, which implies children already wearing spectacles would want an additional one or an indication that there is low usage of refractive error services among school children in the district. Socio-economic factors such as restricted access to proper eye care in African countries could be another reason for the low usage of spectacles among the study population.[13]

Although some studies[12,36,37,38] have indicated an association between stigmatisation and spectacle wear, the majority of the participants were willing to wear spectacles to improve their vision. All children diagnosed with refractive errors received a free pair of spectacles. A limitation of this study is that only one private school was involved, which may reduce the generalisability of the results. Two private schools in the sampling frame declined participation in the study. This may be because of the inclusion of cycloplegic refraction (and its possible side effects) in the study protocol, which is considered to be invasive. The strengths of this study include its adequate sample size and a high response rate (96.3%). In general, the prevalence of myopia in this study is more comparable to studies conducted in children of African descents within the same age range involving the use of cycloplegic agents than in other parts of the world (Table 5). Reports indicate that the prevalence of myopia is higher among Asian children than among children in other regions of the world.[55,56]

Conclusion

The prevalence of myopia is relatively low in a sample of school children aged 5–14 years in the Garki district of Abuja. Considering Nigeria's large population and more importantly the increase in near-work activities and the association of high myopia with eye diseases, the high number of myopic children in this study without spectacles is a cause for concern, which could reflect the low usage of refractive error services among school children in the district.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

T.R.A. was responsible for the writing of the article. K.S.N. and S.O.W. were responsible for the review and editing of the article.

Ethical considerations

Based on the Declaration of Helsinki, informed consent was obtained from the parents of the participants. The consent forms were back-translated to Pidgin-English with Illustrations and photos of the research procedures to facilitate understanding for illiterate parents. Participants were informed about the proposed study and voluntarily chose to participate. Approval for the study was received from the University of KwaZulu-Natal Biomedical Research Ethics Committee. Written permission to conduct the study was obtained from the FCT Universal Basic Education Board, the FCT Public Health Department, the FCT Research and Ethics Committee and management of the schools before conducting the study (BFC436/19)

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Data availability

The data that support the findings of this study are available from the corresponding author, T.R.A., upon reasonable request.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not represent the official policy or position of any affiliated agency of the authors.

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