

# Visual Acuity and Uncorrected Refractive Error among Primary School Children in Abakaliki, South-East Nigeria

Peter Ndubisi Okanya<sup>1</sup>, Chinonyelum Thecla Ezeonu<sup>1</sup>, Chinyelu Nkem Ezisi<sup>2</sup>, Chinenyenwa RoseMary Okanya<sup>2</sup>, Orji Maria-Lauretta Chito<sup>1</sup>, Agozie Chukwunedum Ubesie<sup>3</sup>

## ABSTRACT

**Aim:** To determine the pattern of visual acuity and prevalence of uncorrected refractive error among primary school children in Abakaliki, south-east Nigeria.

**Study Design:** A cross-sectional study.

**Duration and Settings of the Study:** This study was conducted from October 2022 to February 2023, among primary school students in Abakaliki, Ebonyi State, Nigeria.

**Methods:** Children aged 6 to 12 years old were selected from both public and private schools, in Abakaliki metropolis. Interview administered questionnaire was used for data collection. Visual acuity (VA) was taken with Snellen's Visual Acuity chart, both monocularly and binocularly. VA with pinhole was taken for both right and left eye individually.

**Results:** A total of 2,187 school going children were assessed. The mean age of the children was  $9.5 \pm 2$  years. Male-to-female ratio was 1:1.01. The prevalence of uncorrected refractive error was 5.7%. Normal VA ( $\geq 6/6$ ) was observed in 93.9% of the participants. There was a significant association between age and visual acuity ( $p < 0.001$ ). Female were significantly more likely to have impaired visual acuity.

**Conclusion:** Uncorrected refractive error increases with age and is worse among female. Routine screening of school-aged children for refractive errors is recommended.

**Keywords:** Children; Refractive Error; Visual Acuity

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## INTRODUCTION

Vision plays an important role in interpreting one's environment and enhances learning capability.<sup>1,2</sup> It is demonstrated that three-quarter of all learning is visual

### Correspondence:

**Agozie Chukwunedum Ubesie**

agozie.ubesia@unn.edu.ng

Department of Pediatrics, College of Medicine, University of Nigeria, Enugu State

### Author(s) Affiliation:

<sup>1</sup> Department of Pediatrics, Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State

<sup>2</sup> Department of Ophthalmology, Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State

<sup>3</sup> Department of Pediatrics, College of Medicine, University of Nigeria, Enugu State

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learning.<sup>3</sup>

Ametropia results when the eyes fail to properly focus light on the retina, thus leading to blurred image formation.<sup>4</sup> Failure of the eyes to focus an image on the retina leads to blurred vision known as a refractive error.<sup>5</sup> Refractive error are classified as hypermetropia, myopia, astigmatism. To achieve clear vision, these errors should be corrected using optical aids such as spectacle, contact lenses, and/or through surgeries.<sup>4</sup> Uncorrected refractive error results when nothing is done to achieve visual clarity in affected individuals.

Uncorrected refractive error affects many people around the worldwide, including Nigeria.<sup>5</sup> It has remained the most common etiology of visual impairment and second to cataract as the most common cause of blindness worldwide.<sup>6</sup> The World Health Organization (WHO) estimates that more than two billion people suffer from distant or near visual impairment and one billion of these are avoidable or preventable.<sup>7</sup> Uncorrected refractive error accounts for

88.4 million of this population.<sup>7</sup> Nearly 20 million children are visually impaired globally and more than half of them are school going. The most common cause is uncorrected refractive error. Click or tap here to enter text. In Nigeria, uncorrected refractive error is responsible for 57.1% of moderate visual impairment.<sup>8</sup> Uncorrected refractive error may potentially affect the learning and educational attainment of affected school children.<sup>6</sup> Such affected children struggle to visualize and strain to visualize images on the classroom board, partially shutting their eyelids during classroom sessions. They are also likely to fall behind in school activities.<sup>9</sup> Undetected and uncorrected refractive errors lead to visual impairment, risk of societal exclusion, challenges integrating into current societal structures and systems, as well as familial and socioeconomic difficulties. A person who becomes blind due to uncorrected refractive error at a younger age, would suffer more blind person years than a person who becomes blind from cataract in old age.<sup>10</sup>

The diagnoses of refractive errors can easily be made by assessing visual acuity (VA). They are the simplest to treat among the preventable causes of blindness and visual impairment. There is no VA screening program currently for children in Abakaliki and this study sought to obtain the baseline prevalence data that would support the implementation of such a program. The school provides a good environment for the successful implementation of an all-inclusive eye health program.

## METHODS

The study was carried out in Abakaliki metropolis, Ebonyi State, South-East Nigeria. According to the Ministry of Education and Universal Basic Education Board, there are a total of 1166 primary schools in Ebonyi state with 56 registered primary schools located in the Abakaliki metropolis. Thirty-one of these schools are private while twenty five are public. This gave a private to public school ratio of 6:5. Thus, six private and five public schools were selected giving a total of eleven schools for the study. Ebonyi State registered a total of 68,221 primary school children, and 21,090 of these school children attend primary school within the Abakaliki metropolis. This cross-sectional study was carried out among primary school children aged 6-12 years, selected from public and private primary schools in the Abakaliki metropolis, within a period of four months from October 2022 to February 2023. Ethical approval was obtained from the Health Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State Universal Education Board, and from heads of the schools. The research procedure conformed to the tenets of the World Medical Association (WMA), Declaration of Helsinki. A written informed consent was obtained from the parents/guardian of each study participants and from older children aged 7 to 12 years old. Data obtained from each participant were kept confidential by entering them into password-protected computer software that was accessible to the principal

researcher, alone. Research assistants were recruited for the study and were trained. They included an ophthalmology senior registrar, two pediatric registrars, an optometrist, two ophthalmic nurses and two education assistants.

A properly illuminated classroom was selected in each school for VA assessment of each student. A Snellen's VA chart was used in assessing the VA of each student, both monocular and binocularly. The chart was placed six meters away from the study participant, who seated comfortably on a chair. The student was instructed to read the chart from top to bottom, while occluding other eye respectively. Those students whose VA was worse than 6/9, pinhole VA of each eye was taken respectively. Those students, who's VA would improve with pinhole, refraction was performed with streak retinoscope, each eye respectively.

VA less than 6/9 was regarded as impaired VA while VA equal or better than 6/6 was termed as normal. All the data was recorded on a predesign questioner, for each student. The data was analyzed with Statistical Package for Social Sciences (SPSS) version 23 (SPSS, Inc., Chicago, Illinois, USA). Socio-demographic characteristic and the refractive status of the students were analyzed and presented in frequency and percentages in the form of tables. While the relationship between categorical variables such as refractive error, and socio-demographic characteristics were determined using the Chi-square test with Fisher's exact test adopted where assumptions of the Chi-square test is violated. The variables that were significantly associated were further subjected to the logistic regression model. All tests were conducted at 5% level of significance.

## RESULTS

A total of 2,187 school going students aged 6 to 12 years, were assessed for VA and refractive error. Table 1 represents the socio-demographic characteristics of the study participants. The mean age of the study participants was  $9.5 \pm 2.0$  years. The number of study participants recruited from the private schools was 1252 (57.2%). Basic (elementary) five had the highest number of study participants (18.61%). Out of the 2,187 students whose VA was assessed, 2053 (93.9%) had VA of 6/5 – 6/6 in both the right and the left eye. The age with the highest prevalence of abnormal VA was 11 years. Students aged 12 years had the highest prevalence of normal VA while those aged 8 years had the lowest.

Table 2 is the result of the refractive status of the study participants. One hundred and thirty-four study participants (6.1%) had abnormal unaided VA for both left and right eyes. Nine of the 134 students (6.7%) with abnormal unaided VA had normal VA when aided with their glasses/contact lenses.

Table 3 shows the association between VA and selected variables of the study participants. Students between the ages of 11 years and 12 years had the highest frequency of impaired VA with highest frequency of female than

**Table 1: Socio-demographic characteristics of the study participants (n=2187)**

| Age (years)            | Frequency (N) | Percentage |
|------------------------|---------------|------------|
| 6                      | 234           | 10.70      |
| 7                      | 265           | 12.12      |
| 8                      | 213           | 9.74       |
| 9                      | 305           | 13.95      |
| 10                     | 334           | 15.27      |
| 11                     | 409           | 18.70      |
| 12                     | 427           | 19.52      |
| Age (years): Mean ± SD |               | 9.5 ± 2.0  |
| Sex                    |               |            |
| Male                   | 1089          | 49.79      |
| Female                 | 1098          | 50.21      |
| School Type            |               |            |
| Public Schools         | 935           | 42.75      |
| Private Schools        | 1252          | 57.25      |
| Class in School        |               |            |
| 1                      | 307           | 14.04      |
| 2                      | 378           | 17.28      |
| 3                      | 366           | 16.74      |
| 4                      | 388           | 17.74      |
| 5                      | 407           | 18.61      |
| 6                      | 341           | 15.59      |

SD= standard deviation, N=number.

**Table 2: Refractive and visual Status of Primary School Children in Abakaliki Metropolis (n=2187)**

| Variable                 | N    | %    |
|--------------------------|------|------|
| History of spectacle use |      |      |
| Yes                      | 10   | 0.5  |
| No                       | 2177 | 99.5 |
| Unaided VA RE            |      |      |
| Normal (VA $\geq$ 6/6)   | 2053 | 93.9 |
| Impaired (VA $\leq$ 6/9) | 134  | 6.1  |
| Unaided VA LE            |      |      |
| Normal (VA $\geq$ 6/6)   | 2053 | 93.9 |
| Impaired (VA $\leq$ 6/9) | 134  | 6.1  |
| Aided VA RE              | 9    | 0.4  |
| Aided VA LE              | 9    | 0.4  |
| Pinhole VA RE            | 125  | 5.7  |
| Pinhole VA LE            | 125  | 5.7  |
| Refractive Error         |      |      |
| Yes                      | 134  | 6.1  |
| No                       | 2053 | 93.9 |

VA = Visual acuity, RE = Right Eye, LE = Left Eye,  $\geq$  = equal or more than,  $\leq$  = equal or less than, N = number, % = Percentage

male. The prevalence of impaired VA differed significantly among different categories of age, sex, school type, class in school, and history of spectacle use.

Table 4 is the binary logistic model of VA on the significantly associated selected variables of the study participants. The result shows that study participants are more likely to experience poor VA as age increases (OR, 1.4; 95% CI: 1.217-1.611). The result further revealed that female study participants are more likely to experience poor VA compared to their male counterparts ( $p = 0.001$ ). The VA status was found to be uniform among different categories of classes in school.

## DISCUSSION

This study revealed that 6.1% of the study participants had poor visual acuity ( $< 6/6$ ). The value is similar to the figures from previous studies by Ekpenyong et al (5.7%)<sup>11</sup> and Megbelayin et al (6.9%)<sup>12</sup> in Southern Nigeria. The value, however, is lower than figures from studies by Ubajaka et al (26.1%)<sup>13</sup> and Kotingo (28.9%)<sup>9</sup> in various parts of Nigeria. The lower figure in the current study could be due to younger children recruited in the study compared to older children in the former studies. Earlier studies have shown that older children are more likely than younger ones to have impaired VA.<sup>14,15</sup> In contrast, the current study recorded a higher value of 6.1% than studies by Chuka Okasa (2.6%)<sup>16</sup> and Ajaiyeoba et al. (1.26%).<sup>17</sup> This could be attributed to VA  $\geq 6/6$  used in the current study against VA  $\geq 6/9$  and  $\geq 6/18$  used in other studies as a cut-off for a normal visual acuity. A VA of  $\geq 6/6$  during screening would detect all participants with abnormal VA thus a higher percentage of participants with abnormal VA in this study than the other studies.

The presence of poor visual acuity in this study was found to be more common among female than their male counterparts. A similar trend in female preponderance was observed in studies outside Nigeria by Kingo et al<sup>18</sup> in Tanzania and Fotouhi et al<sup>19</sup> in Iran. The more female preponderance could be attributed to prolonged reading habits and more house chores they engaged in.<sup>20</sup> Near work such as prolonged reading has been implicated as a risk factor for visual impairments.<sup>21</sup> However, other studies reported no difference in the occurrence of poor visual acuity and gender.<sup>22,23</sup> The current study also revealed that there was a significant association between the occurrence of poor visual acuity and age. Impaired visual acuity was more common among participants between 9 to 12 years in the current study. Okoro et al,<sup>24</sup> Ekpenyong et al<sup>14</sup> and Muma et al<sup>15</sup> made similar observations of older children presenting with impaired visual acuity. The reason for this could be that older children take part in more near tasks such as reading. The prevalence of uncorrected refractive error in this index study is 5.7%. This is similar to works by Ajaiyeoba et al in Ilesha (5.8%)<sup>17</sup> and Ayanniyi et al in Ilorin (6.8%).<sup>25</sup> This is despite using a visual acuity of  $< 6/6$  as a cut-off for impaired or poor visual acuity. However, the

**Table 3: Association between Unaided VA and Selected Variables of the Study Participants**

| Variable                 |  | Unaided VA      |                   | p-value |
|--------------------------|--|-----------------|-------------------|---------|
|                          |  | Normal<br>N (%) | Impaired<br>N (%) |         |
| Age (years)              |  |                 |                   |         |
| 6                        |  | 232 (99.1)      | 2 (0.9)           | < 0.001 |
| 7                        |  | 257 (97.0)      | 8 (3.0)           |         |
| 8                        |  | 210 (98.6)      | 3 (1.4)           |         |
| 9                        |  | 285 (93.4)      | 20 (6.6)          |         |
| 10                       |  | 313 (93.7)      | 21 (6.3)          |         |
| 11                       |  | 363 (88.8)      | 46 (11.2)         |         |
| 12                       |  | 393 (92.0)      | 34 (8.0)          | 0.001*  |
| Mean ± SD                |  | 9.4 ± 2.0       | 10.4 ± 1.5        |         |
| Gender                   |  |                 |                   |         |
| Male                     |  | 1041 (95.6)     | 48 (4.4)          | 0.001   |
| Female                   |  | 1012 (92.2)     | 86 (7.8)          |         |
| School Type              |  |                 |                   |         |
| Public                   |  | 891 (95.3)      | 44 (4.7)          | 0.017   |
| Private                  |  | 1162 (92.8)     | 90 (7.2)          |         |
| Class                    |  |                 |                   |         |
| Basic 1                  |  | 307 (100)       | 0 (0.0)           | < 0.001 |
| Basic 2                  |  | 259 (95.0)      | 19 (5.0)          |         |
| Basic 3                  |  | 346 (94.5)      | 20 (5.5)          |         |
| Basic 4                  |  | 357 (92.0)      | 31 (8.0)          |         |
| Basic 5                  |  | 372 (91.4)      | 35 (8.6)          |         |
| Basic 6                  |  | 312 (91.5)      | 29 (8.5)          |         |
| History of spectacle use |  |                 |                   |         |
| Yes                      |  | 0 (0.0)         | 10 (100)          | < 0.001 |
| No                       |  | 2053 (94.3)     | 124 (5.7)         |         |

VA = Visual Acuity, N= Numbers, % = Percentage, SD = Standard Deviation

T\* Test was applied and for other Chi-Square test is applied

incorporation of participants older than those in the index study could have counterbalanced the effect on prevalence.<sup>26</sup>

The prevalence in the index study is higher than 2.8% obtained by Akinremi et al in Ilorin<sup>27</sup> 2.2% by Opubiri et al<sup>28</sup> in Bayelsa, 0.9% by Ogbonnaya et al<sup>29</sup> in a rural area in Ebonyi, and 1.9% by Chuka Okosa<sup>16</sup> in a rural setting in Enugu. The higher prevalence in the current study could have stemmed from the operational definition of VA (<6/6) used during screening. Akinremi et al,<sup>27</sup> Opubiri et al,<sup>28</sup> Ogbonnaya et al<sup>29</sup> and Chuka Okosa<sup>16</sup> had <6/9, <6/<sup>12</sup> <6/9, and <6/9 respectively as operational definitions of VA. An Ethiopian study by Nebiyat et al<sup>30</sup> recorded a prevalence of 4.4% which is lower than the current study. This could be a result of higher operational criteria employed during screening for refractive error in this study. The present study had a low prevalence of 5.7% when compared with the study by Okoro et al<sup>24</sup> in Akoka, Lagos (21.3%). Although the same working definition for impaired or poor

visual acuity and a similar age group of participants were used for both studies, the present study was carried out in many schools with 2187 participants evaluated while Okoro et al<sup>24</sup> evaluated 187 participants in one school. This may have influenced the difference in prevalence. Moreover, the smaller number of participants in the former study may have exaggerated the prevalence.

The current study also has a lower prevalence of 5.7% than those by Olatunji et al<sup>31</sup> in Sokoto (9.7%), Orugun et al<sup>32</sup> in Zaria (8.9%), and Abah et al<sup>33</sup> in Zaria (8%). The difference was in part due to differences in the methodologies and the smaller number of participants in the other studies relative to the index study. These factors could have exaggerated the prevalence in other studies. The index study also had a low prevalence figure when compared with studies by Ali et al<sup>34</sup> in Ethiopia (19.8%). This difference in prevalence could be due to the varied operational definitions of refractive errors, the number of study participants in the studies, and ethnic

**Table 4: Binary Regression Model of VA on the Selected Variables of the Study Participants**

| Variable    | B      | Adjusted OR | p-value | OR    |       |
|-------------|--------|-------------|---------|-------|-------|
|             |        |             |         | Lower | Upper |
| Sex         |        |             |         |       |       |
| Male        | -0.616 | 0.540       | 0.001   | 0.373 | 0.781 |
| Female      |        | 1           |         |       |       |
| School Type |        |             |         |       |       |
| Public      | -0.629 | 0.533       | 0.002   | 0.361 | 0.786 |
| Private     |        | 1           |         |       |       |
| Class       |        |             |         |       |       |
| Basic 2     | 0.198  | 1.219       | 0.632   | 0.541 | 2.745 |
| Basic 3     | 0.180  | 1.198       | 0.584   | 0.628 | 2.283 |
| Basic 4     | 0.502  | 1.652       | 0.098   | 0.911 | 2.994 |
| Basic 5     | 0.238  | 1.269       | 0.376   | 0.749 | 2.148 |
| Basic 6     |        | 1           |         |       |       |

VA = Visual acuity,  $\beta$  = Regression coefficient, OR = Odd ratio, CI = Confidence interval, < = less than

differences. Similarly, studies by Ali et al,<sup>34</sup> Sarma et al<sup>6</sup> and Prabha et al<sup>35</sup> revealed a high prevalence of 19.8%, 23.5% and 20.9% respectively. These discrepancies may be due to ethnicity-related alterations in genetic vulnerability to refractive errors, with Asian nations having a higher prevalence of refractive errors.<sup>36</sup> Furthermore, different operational definitions of refractive errors may account for the disparity in prevalence.

## CONCLUSION

The poor visual acuity among primary school children in the Abakaliki metropolis was 6.1% while the frequency of uncorrected refractive error 5.7%.

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