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## Original Research

### Refractive error and visual impairment in primary school children in Onitsha, Anambra State, Nigeria

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#### Abstract

**Background:** Vision problems have been shown to adversely affect the quality of life of children.

**Aim:** To determine the prevalence of refractive error and visual impairment in primary school children in Onitsha, Anambra State, Nigeria.

**Setting:** The study was conducted in a primary school in Onitsha, Anambra State, Nigeria.

**Methods:** A stratified random cluster sampling method was used to select primary schools in Onitsha North and South. A total of 1020 children were included in the study. Visual acuity measurements, ocular motilities, retinoscopy and fundae were performed.

**Results:** The prevalence of uncorrected, presenting and best corrected visual acuity was 86.6%, 86.6% and 86.6% respectively. Refractive error accounted for 86.6% of all causes of visual impairment (astigmatism (36.1%) and hyperopia (17.5%). Refractive error and visual impairment were highest among children aged between 5 and 7 years.

**Conclusion:** The prevalence of refractive error and visual impairment in primary school children in Onitsha, Anambra State, Nigeria is high. There is a need for services and strategies to address these conditions in that area.

#### Introduction

Refractive error (RE) is an optical defect of the eye that prevents the eye from focusing light on the retina, which is the cause of visual impairment (VI) and blindness worldwide. <sup>1</sup> (#CIT00004\_455) In 2006, 153 million people had uncorrected refractive error (URE) or visual impairment (VI) worldwide. <sup>2</sup> (#CIT00004\_455) The resulting VI can lead to health, socio-economic and educational problems in developing countries such as Nigeria. <sup>3</sup> (#CIT00005\_455) Refractive error and VI are preventable conditions. Refractive surgery, with spectacles being the most common and cost-effective method of correction.

Studies on the prevalence of RE and VI have been conducted in various parts of Nigeria. In the Southeastern region, <sup>4</sup> (#CIT00008\_455) and South-South, <sup>5</sup> (#CIT00009\_455) studies have reported the prevalence and causes of VI, with most being conducted on older children. However, there is a need to study RE and VI peculiar to children in each community, as this varies from

geographical and socio-economical differences, which may have a VI in Onitsha, Anambra State, Nigeria. Data on RE and VI will be used in this group. In addition, the information can be used as baseline

### **Methods**

Onitsha is an urban area located on the eastern bank of the Niger children from all the private and public schools in Onitsha North are projected to be 15 324 by the year 2017.<sup>10</sup> (#CIT0010\_455) A multi the baseline sample size was determined using the equation<sup>11</sup> (#C

$$N = (Z)^2 (1.0 - P) (P) / ([B][P])^2$$

where  $P$  is the anticipated prevalence of RE,  $B$  is the desired error previous studies conducted in Nigeria ranged between 7.3% and 2 estimates from previous studies, was used. The minimum sample adjust for anticipated absenteeism and non-participation rate, whi

Children aged between 5 and 15 years whose parents or legal guardians were children who gave verbal assent and/or signed assent, children younger than 5 years and older than 15 years, those who provide informed consent were excluded from the study. Ethical approval was given by the Biomedical Research and Ethics Committee (BE620/16) and Onitsha Declaration of Helsinki for research involving human subjects. The children in their schools. Each school provided a room in which the children would be called out of class to have their eyes tested

### Clinical examination

Clinical examinations were conducted by five optometrists in the 1 Anambra State, Nigeria. Examination procedures followed the original distance visual acuity (VA) was measured with a retro-illuminated Ocular deviations were evaluated with a cover test at both distance degree of tropia measured using corneal light reflex and neutralisati

Examination of the anterior segment was performed with a penlight used: two drops of 1% cyclopentolate eye drops administered 15 minutes administered. The light reflex and pupil dilation were checked after or greater and a light reflex was absent. Cycloplegic refraction was performed in a semi-dark room at a distance of 67 cm and a +1.50 D lens in the trial frame according to the manufacturer's instructions. The auto-refractor was used for rankings were obtained for each eye. Using the objective refractive error was determined using the trial frame. Refractive error was determined with or without pinhole.

Examination of the crystalline lens, vitreous and fundus was performed for those who had an unaided VA of 20/40 or worse in either eye to ascertain

### Pilot study

Prior to the main study, a pilot study was conducted among 50 primary school children to test the procedures, methods and logistics. All queries that arose from the pilot study were performed.

### Definition of terms

Uncorrected VA of 20/40 or less was regarded as mainly because of spherical error of 20/40 or less, less than 20/63 and 20/200 or less were used in defining myopia or more and astigmatism as  $-0.50$  D or more using subjective refraction

### Data management and analysis

Class enumeration and clinical examination data forms were reviewed. The assistance of a statistician was sought for the data analysis, which

Social Sciences (SPSS) version 24. Ranges, means, standard deviation, and correlation tests were used to investigate relationships between age and visual acuity.

### Ethical consideration

The study was approved by the Biomedical Research and Ethics Committee of the heads of the identified schools, Onitsha, Nigeria, and the study.

### **Results**

Of the 1020 primary school children aged between 5 and 15 years (97.8%) participated in the study. The participants included 443 (43.1%) males and 577 (56.9%) females. The mean age was  $9.01 \pm 2.5$  years and 389 (39%) were aged between 8 and 10 years.

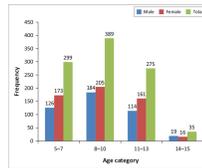


FIGURE 1: Demographic profile of experimental study population.

(<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

### Visual acuity

Of the 998 children examined, uncorrected VA of 20/32 or better in either eye was 20 (2%) and 20/40 or worse in the better eye and 20 (2%) wore spectacles. In the better eye, 13 (13.4%) had best corrected VA of 20/40 or worse. The prevalence of uncorrected VA of 20/40 or worse in the better eye was 13.4%.

**TABLE 1:** (<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

### Refractive error

Ninety-seven (9.7%) children who had VA of 20/40 or worse in either eye. Eighty-seven (87.6%) right eyes and 79 (81.4%) left eyes. However, pupil dilatation was not performed in 13 (13.4%) children. The absence of light reflex without full pupil dilation was observed in 13 (13.4%) children. The criteria for *cycloplegia dilation* in both eyes were satisfied in 84 (86.6%) children.

Hyperopia ranged from +1 D to 5 D with retinoscopy and from +1 D to +2 D with auto-refraction. Hyperopia decreased with increasing age and was highest among children aged 5-7 years. Myopia ranged from -1.00 D to -11.50 D with auto-refraction. Myopia increased with increasing age and was highest among children aged 14-15 years. Astigmatism of -0.50 D to -1.75 D was found in 24 (24.2%) right eyes and 38 (39.2%) left eyes with auto-refraction. Astigmatism of  $\geq 2.00$  D was found in 4 (4.1%) right eyes and 6 (6.2%) left eyes with auto-refraction. The prevalence of astigmatism was 4.1% in right eyes and 6.2% in left eyes. The prevalence of hyperopia ranged between 17.5% and 20.0% with retinoscopy, the prevalence of myopia ranged from 6.2% in 5- to 15 years with auto-refraction, the prevalence of myopia was 49.5%, while auto-refraction was 49.5%.

**TABLE 2:** (<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

Of the 97 children who had RE, 45 (46.4%) had myopia, 35 (36.1%) had hyperopia, and 17 (17.5%) had astigmatism. Of the 97 children who had RE, two (43.3%) children who had RE were males, while RE was highest among children aged between 14 and 15 years (**Figure 3 (#F0003\_455)**). Refractive error was not significantly associated with age (Pearson's  $\chi^2 = 0.00$ ) and gender (Pearson's  $\chi^2 = 4.17$ ,  $p = 0.04$ ). Myopia was significantly associated with age (Pearson's  $\chi^2 = 11.50$ ,  $p = 0.00$ ), while hyperopia and astigmatism were not significantly associated with age and gender (Pearson's  $\chi^2 = 0.00$ ,  $p = 0.00$ ).

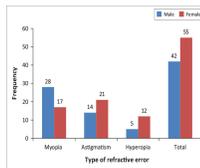


FIGURE 2: Distribution of refractive error by gender.

(<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

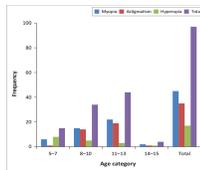


FIGURE 3: Distribution of refractive error by age group.

(<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

Out of 70 eyes of 35 children with astigmatism, 41 (58.6%) eyes

**TABLE 3:** (<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

### Ocular anomalies

Exotropia accounted for the highest proportion of deviations and 10 (1%) with distant fixation. Twenty-one (72.4%) of the tropias at near. The exterior and anterior segment abnormalities were observed in 10 (1%) children. Conjunctival abnormalities were present in two eyes of two (0.2%) children, and an abnormal lens was observed in 8 eyes of 12 (1.2%) children. Retinal degenerations, were present in 8 eyes of 12 (1.2%) children.

### Causes of visual impairment

Of the 97 children with uncorrected VA of 20/40 or worse in the better eye, 13 (13.4%) could not be improved to  $\geq 20/32$  in either eye was therefore 13 (1.3%) (**Table 4 (#T004\_455)**).

**TABLE 4:** (<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

Nine (69.2%) children who had VI were females and 4 (30.8%) were males. All children were aged between 8 and 10 years and no VI was found in children older than 10 years (Pearson's  $\chi^2 = 19.36$ ,  $p = 0.00$ ) but not with gender (Pearson's  $\chi^2 = 0.00$ ,  $p = 0.96$ ).

### **Discussion**

Except for a relatively large number of 8- to 10-year-olds and a response rate that was reasonably uniform. The high response rate in this study could be attributed to the fact that the children felt it was an opportunity to get their eyes checked. The teachers and Parent-Teacher Association (PTA) also contributed to the high response rate.

The prevalence of RE among primary school children aged between 6 and 15 years in this study (9.7%) is higher than the 2.2% reported by the World Health Organization (WHO) prevalence range of 2% – 10% reported in various studies. **Table 5 (#T005\_455)**, **6 (#CIT006\_455)**, **7 (#CIT007\_455)**, **8 (#CIT008\_455)**, **9 (#CIT009\_455)**, **10 (#CIT010\_455)**, **11 (#CIT011\_455)**, **12 (#CIT012\_455)**, **13 (#CIT013\_455)**, **14 (#CIT014\_455)**, **15 (#CIT015\_455)**, **16 (#CIT016\_455)**, **17 (#CIT017\_455)**, **18 (#CIT018\_455)**, **19 (#CIT019\_455)**, **20 (#CIT020\_455)**, **21 (#CIT021\_455)**, **22 (#CIT022\_455)**, **23 (#CIT023\_455)**, **24 (#CIT024\_455)**, **25 (#CIT025\_455)**, **26 (#CIT026\_455)**, **27 (#CIT027\_455)**, **28 (#CIT028\_455)**, **29 (#CIT029\_455)**, **30 (#CIT030\_455)**, **31 (#CIT031\_455)**, **32 (#CIT032\_455)**, **33 (#CIT033\_455)**, **34 (#CIT034\_455)**, **35 (#CIT035\_455)**, **36 (#CIT036\_455)**, **37 (#CIT037\_455)**, **38 (#CIT038\_455)**, **39 (#CIT039\_455)**, **40 (#CIT040\_455)**, **41 (#CIT041\_455)**, **42 (#CIT042\_455)**, **43 (#CIT043\_455)**, **44 (#CIT044\_455)**, **45 (#CIT045\_455)**, **46 (#CIT046\_455)**, **47 (#CIT047\_455)**, **48 (#CIT048\_455)**, **49 (#CIT049\_455)**, **50 (#CIT050\_455)**, **51 (#CIT051\_455)**, **52 (#CIT052\_455)**, **53 (#CIT053\_455)**, **54 (#CIT054\_455)**, **55 (#CIT055\_455)**, **56 (#CIT056\_455)**, **57 (#CIT057\_455)**, **58 (#CIT058\_455)**, **59 (#CIT059\_455)**, **60 (#CIT060\_455)**, **61 (#CIT061\_455)**, **62 (#CIT062\_455)**, **63 (#CIT063\_455)**, **64 (#CIT064\_455)**, **65 (#CIT065\_455)**, **66 (#CIT066\_455)**, **67 (#CIT067\_455)**, **68 (#CIT068\_455)**, **69 (#CIT069\_455)**, **70 (#CIT070\_455)**, **71 (#CIT071\_455)**, **72 (#CIT072\_455)**, **73 (#CIT073\_455)**, **74 (#CIT074\_455)**, **75 (#CIT075\_455)**, **76 (#CIT076\_455)**, **77 (#CIT077\_455)**, **78 (#CIT078\_455)**, **79 (#CIT079\_455)**, **80 (#CIT080\_455)**, **81 (#CIT081\_455)**, **82 (#CIT082\_455)**, **83 (#CIT083\_455)**, **84 (#CIT084\_455)**, **85 (#CIT085\_455)**, **86 (#CIT086\_455)**, **87 (#CIT087\_455)**, **88 (#CIT088\_455)**, **89 (#CIT089\_455)**, **90 (#CIT090\_455)**, **91 (#CIT091\_455)**, **92 (#CIT092\_455)**, **93 (#CIT093\_455)**, **94 (#CIT094\_455)**, **95 (#CIT095\_455)**, **96 (#CIT096\_455)**, **97 (#CIT097\_455)**.

**TABLE 5:** (<https://avehjournal.org/index.php/aveh/article/viewFile/455/>)

The prevalence of 9.7% for URE is higher than the 2.2% reported in Nigeria, specifically the 7.3% and 8.7% in Lagos, **28 (#CIT028\_455)**; however, the prevalence is lower than 22.5% and 58.0% reported in Bayelsa study could be because of the fact that the children in Bayelsa were older than the children in this study.

and normal VA could have been missed. In addition, the current study found higher rates of conditions than in the general population.<sup>9 (#CIT0009\_455)</sup> for the differences between them. For example, the current study of RE, while a sample size of 4225 and VA of 20/32 or worse were

Comparison of the current study with studies in Africa shows that **5 (#T0005\_455)**. The differences observed in the prevalence of RE among authors and differences in demographic variables. Moreover, lifestyle variations in the prevalence of RE.<sup>31 (#CIT0031\_455)</sup> Recently, increased near work and indoor activities common among urban dwellers, have been suggested to be factors influencing the prevalence of RE.<sup>32 (#CIT0032\_455)</sup> However, other studies have shown the prevalence of RE in developed areas.<sup>33 (#CIT0033\_455)</sup> Although racial and ethnic differences have also shown that genetically determined factors (such as eye color and light exposure) to impact RE development in black people.<sup>2 (#CIT0002\_455)</sup>

Various studies have shown that gender differences at the age of 6 years, with parameters of males and females being reported, which suggests that RE was found to be significantly higher in females (56.7%) than males (41.7%).<sup>9 (#CIT0009\_455)</sup> South-South Nigeria, <sup>9 (#CIT0009\_455)</sup> Kebbi State N

Studies have shown that the human eye grows by 5 mm from birth to 17 years of age.<sup>7 (#CIT0007\_455)</sup> The prevalence of RE has been reported to increase with age in the general population,<sup>7 (#CIT0007\_455)</sup> indicating the possibility of a relationship between RE and age. The highest (48.9%) among children 11 to 13 years old. Similar findings were reported in South-South Nigeria.<sup>9 (#CIT0009\_455)</sup> However, a study in Enugu State found a relationship between RE and age. The large age range of 12–21 years used in

Myopia was the most prevalent (46.4%) URE found in this study. In an urban environment engage more in indoor and near work activities.<sup>32 (#CIT0032\_455)</sup> Studies in Abia State<sup>8 (#CIT0008\_455)</sup> and Bayelsa State<sup>8 (#CIT0008\_455)</sup> condition among primary school children aged between 7 and 17 years in urban environments, variations in the prevalence rates could be attributed to the current study used a sample size of 998 and an age range of 7–17 years. In addition, the present study used a sample size of 4225 and an age range of 7–17 years. In addition, the present study

Studies in Tanzania and South Africa by Wedner et al.<sup>14 (#CIT0014\_455)</sup> found myopia as the most prevalent refractive condition among children aged between 5 and 17 years in Tanzania,<sup>14 (#CIT0014\_455)</sup> China,<sup>36 (#CIT0036\_455)</sup> Vietnam,<sup>37 (#CIT0037\_455)</sup> Egypt<sup>38 (#CIT0038\_455)</sup> studies was attributed to the high prevalence of myopia in Asians. Early detection and management being highly indicated for educational purposes.

In this study, myopia was found to increase with age, starting from grade 6 which is the grade for preparing and writing entrance examination. The onset of myopia. A possible reason could be the onset of juvenile myopia because of axial elongation that is usually caused by intensive near work. The progression starting from 12 to 17 years in Abia State, Nigeria, with the upward trend.<sup>15 (#CIT0015\_455)</sup> and South Africa,<sup>15 (#CIT0015\_455)</sup> with the upward trend.

Myopia was found to be significantly associated with males ( $p = 0.001$ ) and near work activities, such as computer video games, chatting on phones, reading, and household chores. Msiska et al.<sup>17 (#CIT0017\_455)</sup> also found myopia to be significantly associated with males.<sup>17 (#CIT0017\_455)</sup> Mayeku<sup>18 (#CIT0018\_455)</sup> reported contrary results in Tanzanian and South African studies.<sup>18 (#CIT0018\_455)</sup> did not find any significant association between gender and myopia. The prevalence of myopia was found to be among the reasons for the differences observed in the prevalence of astigmatism. The prevalence of astigmatism are important, as most asthenopic symptoms that could be associated with astigmatism of  $-0.50$  D or worse found in this study was high.

with increased near work. The prevalence is lower than 38.8% reported in South-South Nigeria and comparable to 6.1% and 7.8% recorded in South-South Nigeria and discrepancies could be the inclusion of diverse age and ethnic groups.

With-the-rule astigmatism was the most common type found in this study. Similar findings were reported by Atif et al.<sup>16</sup> (#CIT0016\_455) and Naidoo et al.<sup>15</sup> (#CIT0015\_455) found astigmatism to increase with age, the variability did not find astigmatism to increase with age, the variability of gender difference in the prevalence of astigmatism in this study, the

The prevalence of hyperopia was low (Table 5 (#T0005\_455)), and involved in near work and less outdoor activities, thus reducing the prevalence. The prevalence in this study is higher than those reported in other Nigerian studies but lower than those reported in other studies (Table 5 (#T0005\_455)). This wide variation could be because of the differences in the various studies. For example, Ahuama and Atowa<sup>8</sup> (#CIT0008\_455) reported a prevalence of 1.3% and higher (Table 5 (#T0005\_455)). The study by Ahuama and Atowa<sup>8</sup> (#CIT0008\_455) could have increased the prevalence of hyperopia, as it is well reported in other studies (Table 5 (#T0005\_455)),<sup>19</sup> (#CIT0019\_455) Hyperopia was found to decrease because of the fact that this younger age group is prone to be more involved in near work compared with the older age groups. Similar findings were reported in Chile<sup>39</sup> (#CIT0039\_455) as well as in China,<sup>36</sup> (#CIT0036\_455) and the present study, a result similar to that reported by Opubiri et al.<sup>18</sup> (#CIT0018\_455) but contrary to findings obtained by Kawuma and Mayeku<sup>18</sup> (#CIT0018\_455) refractive error in some of these studies could also have influenced the prevalence of hyperopia.

The prevalence of VI was 1.3%, indicating that VI is relatively uncommon in this study that reported in other Nigerian studies by Megbeleyin and Asana<sup>21</sup> (#CIT0021\_455) (Table 5 (#T0005\_455)). It is, however, not possible to make generalizations based on different backgrounds and methodologies used. Most (84%) uncorrected VI was reported in other studies.<sup>9</sup> (#CIT0009\_455),<sup>15</sup> (#CIT0015\_455),<sup>19</sup> (#CIT0019\_455),<sup>43</sup> (#CIT0043\_455),<sup>44</sup> (#CIT0044\_455),<sup>45</sup> (#CIT0045\_455),<sup>46</sup> (#CIT0046\_455) amblyopia, retinal disorders, corneal opacity and albinism, which were reported in Ghana by Kumah et al.<sup>20</sup> (#CIT0020\_455) This study also recorded a prevalence of VI.

Several limitations of our study must be acknowledged. First, some of the children aged 5 and 6-year-olds was difficult because of poor attention span, lack of cooperation and other population-based RESC surveys and the fact that the sample was from one state or country. Future studies should include all children in Onitsha.

In conclusion, this is the first RESC study undertaken in Onitsha, and the prevalence of myopia in primary school children were 9.7% and 1.3%, respectively. These findings need to conduct local studies to establish regional baseline data to guide the screening for teachers and school healthcare may ensure early detection and management.

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### Competing interests

The authors declare that they have no financial or personal relationships that could have influenced the work reported in this study.

### Authors' contributions

N.E.E. and K.P.M. made equal contributions to the writing of this article.

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